AGROECOLOGY: INTRODUCTORY HANDBOOK FOR FARMERS

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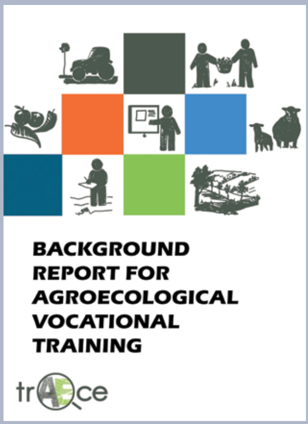
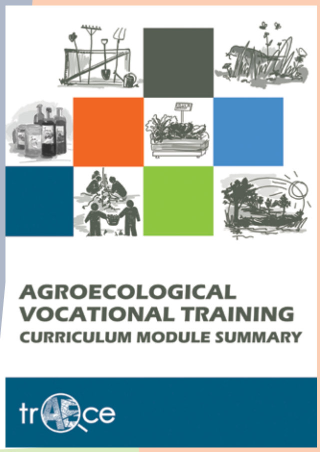


This agroecological situation analysis aims to investigate and describe the current state of agroecology in conceptual definition and practice in five countries in Europe (Austria, Czech Republic, Hungary, Portugal and Romania). It identifies applicable international and national policies as well as campaigns initiated by numerous non-governmental initiatives and research institutes that impact the adoption of agroecological principles in farming practices. At the training level, it offers a summary of the possibilities for advancing training and education in agroecology.

For whom do we recommend the report?

Policymakers, farmers, practitioners, educators, advisors

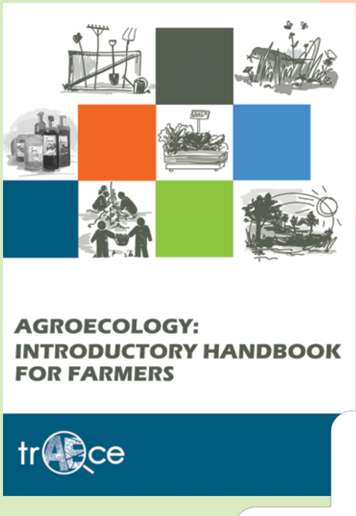
The training curriculum summary outlines in detail the learning content, structure, and expected outcomes of a practice-oriented training course, which is comprised of 6 modules: (1) An overview of agroecology (2) Permaculture farm design (3) Economic strategy and business model (4) Agroecology in action on the farm (5) Added value creation and marketing (6) Social benefits of agroecology.



For whom do we recommend the curriculum summary?

Trainers, educators, teachers, opinion-leader farmers looking to be future trainers, advisors

Offering extensive teaching material, this handbook accompanies the curricula of the training modules and is comprised of 6 chapters: (1) An overview of agroecology (2) Permaculture farm design (3) Economic strategy and business model (4) Agroecology in action on the farm a) Arable crop production b) Small-scale diversified vegetable production and market gardening c) Grassland and livestock management (5) Added value creation and marketing (6) Social benefits of agroecology. Agroecological keywords, concepts, terms or acronyms appearing in the chapters are underlined and explained in the glossary.

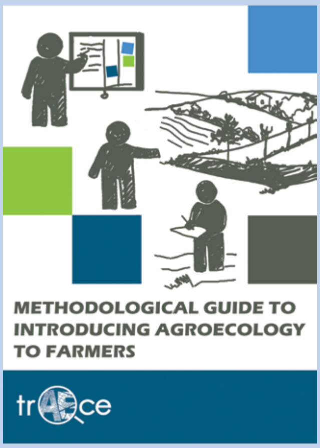


For whom do we recommend the handbook?

Farmers, practitioners, trainers, educators, advisors

These short motivational films assist the learning process by documenting model agroecological practices in different European countries or introducing topics found within specific chapters:

The little film icon indicates these short films in both the handbook and the curriculum summary.



This methodological guide contains methods and effective teaching tools that aim to provide practical expertise for each of the modules of the agroecological vocational training. The aim is to facilitate the knowledge transfer to farmers and learners interested in agroecology.

For whom do we recommend the guide?

Trainers, educators, teachers, opinion-leader farmers looking to be future trainers

All the books are available in pdf on our website:

https://traece.eu/documents/

TRAECE PROJECT – BACKGROUND OF THE AGROECOLOGY: INTRODUCTORY HANDBOOK FOR FARMERS

The handbook you are reading is the result of an international collaboration and exchange of experience and knowledge. Experts from 6 institutions in 5 European countries (Austria, Czech Republic, Hungary, Portugal and Romania) worked together to describe a clear, practical approach to agroecology (AE) and to provide training tools for farmers and instructors that aim to assist in integrating agroecological principles into their practices. Training methods described and supplementary tools created were supplemented with the input of practitioner farmers through co-creation workshops. The first step in the project was for each partner team to develop a country-specific agroecology situation analysis, which identified relevant political discourses, regulations, actors, practices, networks, etc., while documenting a comprehensive view of the level of knowledge of farmers regarding agroecology-based activities. The report also documented current AE-related training courses and learning opportunities that are available at different levels (see the downloadable reports: https://traece.eu/documents/). Based on these situation analyses, the AE vocational training program designed for farmers was elaborated and refined by the project team and complemented with this manual, which incorporated the results of pilot training sessions and was complimented with short educational films. In order not to limit knowledge transfer to one-off training sessions and to more effectively spread knowledge of AE practices, the project team also developed a methodological guide designed for trainers and educators for introducing agroecology to farmers (see the downloadable guide: https://traece.eu/documents/)

The trAEce partner consortium believes that EU directives can be translated into good practices at the farm level. Given that incentives and subsidies may not have the necessary impact required for wide scale adoption of agroecological practices if they are not accompanied by awareness-shaping training and transitional support for farmers. Consequently, practice-oriented vocational training courses that promote well-established good practices should be considered an effective method to increase farmers' knowledge of AE.

THE PURPOSE AND THE CONTENT OF THE GUIDE

This handbook is designed for farmers with the aim of transforming agroecology into more than a discipline for research institutes, and to provide tangible (practical) solutions in concrete areas of farming. It can be considered as supporting reference material for the Agroecological vocational training course's six sessions. Accordingly, this handbook is also divided into 6 chapters: An overview of agroecology (2) Permaculture farm design (3) Economic strategy and business model (4) Agroecology in action on the farm (5) Added value creation and marketing (6) Social benefits of agroecology. The chapters cover a wide range of issues which cover aspects of agroecological applications on the farm, at a wider scale in food chains, and through advocacy and action as part of a global social movement.

The chapters of the handbook build on each other, starting with basic problem statements for which we seek answers within the discipline of agroecology, and to which we propose practical solutions in the different chapters. Our aim is to provide elements that contribute to the understanding and action of the threefold dimensions of AE: the action-research approach, the principle-based practice and the social movement, where cultural expression, social organisations, human rights, environmental justice and ecosystems are interconnected.

In order to understand and interpret any unfamiliar agroecological keywords, concepts, terms or acronyms appearing in the text, we have compiled a glossary of relevant agroecology terminology. **In the manual, we have underlined these terms so the reader can look them up in the glossary.**

The reader may also notice a film icon throughout the text, drawing attention to one or more of 8 short videos created during the trAEce project. For each chapter we indicate when we recommend watching a specific video. A video may be related to a specific topic or serve as an introduction to the entire chapter.

Finally, if you wants to immerse yourself in additional literature on agroecology, we recommend consulting the references listed at the end of each chapter.

ERASMUS+ Agroecological Vocational Training for farmers

AN OVERVIEW OF AGROECOLOGY

Authors:
Jaroslav Bernas, Lanka Horstink, Jan Moudrý

1.1 THE FOOTPRINT OF AGRICULTURE

1.1.1 CONSEQUENCES OF THE INDUSTRIALISATION OF AGRICULTURE

Humans have practised agriculture as the main source of food for human communities for at least 10,000 years. Agriculture changed the way humans organise themselves (building towns and cities) and possibly facilitated concepts we now associate with modern society: that of ownership, labour (becoming specialised), as well as the rise in inequality due to social differentiation, and even the prevalence of warfare. Farming has one of the largest social and ecological footprints (see more on page 180) of human activity, even competing with energy production. This footprint became noticeable in feudal times when slavery and colonisation fuelled cheap food production, which in turn fuelled the industrialisation of Europe, and later, the whole world. But it was when food production itself was industrialised, a process that started in the second half of the 19th century, that agriculture exponentially accelerated its impact on physical and social ecosystems.

The industrialisation of agriculture was greatly intensified in the 1960s with the so-called Green Revolution (see more on page 182), a 'technological package' developed by the United States of America (USA) to take advantage of the leftover chemicals (from bombs and poison) and equipment (like tanks) from the Second World War within a context of real food scarcity in a post-war scenario. It enabled the USA to export yield-increasing farm technologies at a good price rather than ship food aid (first to Europe when it was rebuilt after the war, later to countries in the Global South (see more on page 182)). The Food and Agriculture Organisation of the United Nations (FAO)[1] describes the Green Revolution package as high-yielding varieties of cereals combined with a significant increase in the use of synthetic fertilisers and pesticides, with intensive irrigation.

Despite the increase of per capita production yield of industrialised agriculture, hunger still prevails to the present day. The increase in crop production not for food but for making profit is premised on fossil fuel-based synthetic inputs, high mechanisation and irrigation, and the monoculture of cash crops (with each country specialising in a few cash crops). We show next how we are all paying a high price for these apparent advantages. To begin with, the environmental costs of this type of production model that depletes soils, agroecosystems (see more on page 177), and water are not included in the price of the food we pay. On top of this, large businesses from the agriculture sector (or agribusinesses) are subsidised through funding instruments such as the CAP in the European Union, which results in food prices much lower than those practised by small farmers, who do not have the structure to access these instruments, highly bureaucratic and mainly eligible for large properties.

The modern food system is also characterised by extreme concentration in several key areas of agribusiness. In a market where only one or a few companies dominate — such as the extremely large corporations in each section of the food chain that buy, process, transport, package, and retail the food products — the consumers and the producers who depend on these companies have little or no control over the quality, prices, and other characteristics of the products offered to them. Figure 1.1 depicts the so-called hourglass shape of the agri-food system and offers evidence of cartel-like control in several key markets. The agri-food system consists of two large groups, each at one end of the food chain: farmers and consumers. Between the two, the markets are mediated by a small number of very large companies, which effectively gives them control over sectors, such as those exemplified (grain trade, retail, agrochemicals, seeds).

1 http://www.fao.org/docrep/x0262e/x0262e06.htm

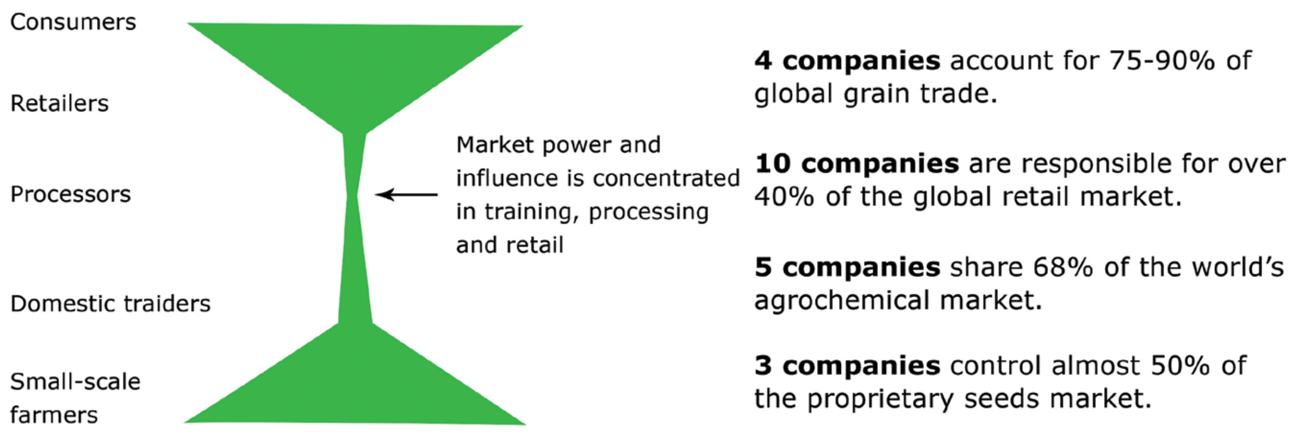


Figure 1.1: Concentration in food markets. Source: adapted from IAASTD 2009/Ketill Berger and UNEP/Grid-Arendal (hourglass graph) and Oxford Farming Conference, 2012 (sectoral data)

The modern food system has also not brought the relief in hunger and poverty that was part of the promise of the Green Revolution. There is no food shortage, but there is extreme inequality in its distribution. At the same time, subsidies to large agribusinesses give them the power to manipulate the price at which they buy as well as at which they sell, thus out-competing producers from the Global South (Patel & McMichael, 2009). The result is greater poverty in rural areas among smallholders, as only larger farmers can survive through economies of scale achieved with very large crop production, while rural wages are kept low.

But despite the worldwide rise of industrialised agriculture and its domination of resources, around the world millions of hectares of agricultural land persist under sustainable or indigenous management (see more on page 189), using techniques uniquely adapted to local ecosystems and cultures, such as sustainable seed collection, raised fields, terraces, polycultures, communitarian practices and agroforestry (see more on page 177) systems (Altieri, 2009). These practices have for millennia been similar to what we now call agroecological, aiming to secure a living within and not despite the landscapes on which the communities depend, shaping them, preserving them, and contributing to their biodiversity (see more on page 177). An example of a successful symbiotic relationship between farmers and their landscape are the sustainable farming practices found in the National Nature Reserve of Costa Vicentina, in Southwest Portugal, where farming has been made interdependent with the unique endemic species (see more on page 180) of the territory. In fact, the landscape that we now call Mediterranean Habitat was formed with the influence of human presence, exhibiting great biodiversity even today. These techniques of enhancing biodiversity allow farmers to use only what the land can provide, minimising costs and the ecological footprint, ensuring food autonomy, preserving social networks and cultural heritage, as well as contributing to the country's food sovereignty (see more on page 181). The contribution of these smallholders is still very significant. A recent estimate places the amount of food produced by smallholders (under 2 ha) at least at 30-34% of the global food supply, although it is much higher in some regions (Ricciardi et al., 2018). Additionally, as we will see in this chapter, smallholder farms provide other benefits, such as crop species richness, higher average nutrition, climate resilience (see more on page 185), and low food wastage (Ricciardi et al., 2018).

1.1.2 ENVIRONMENTAL IMPACTS OF AGRICULTURE

By environmental impacts (see more on page 181), we mean the adverse effects of human activity, among others, on the quality of the environment, on human health, and on the number of abiotic or biotic (see more on page 176) raw materials available (Kočí, 2012). The impacts of several human activities are well known, as measured against sustainability principles. For example, in terms of environmental protection, only a part of the population actively supports this goal, and often even their behaviour is not consistent enough. This also applies to agriculture, for which, on the one hand, a number of rules and legislative measures are being introduced to limit damaging inputs in the interest of environmental protection. Nevertheless, in its highly intensive forms, it often leads to excessive environmental damage. Agriculture is an anthropogenic (see more on page 177) activity with the largest area impact of all human activities. Agroecosystems are the most widespread type of terrestrial habitat and occupy about a third of the land (Šarapatka & Niggli, 2008). Their size is directly related to the need of mankind to make a living, and to a large extent, it emulates population growth. From the beginning of the twentieth century to the present, the world population has increased four or five-fold from 1.6 billion to its current size in the range of 7.8 billion people, according to various sources. This growth brings with it an ever-increasing consumption of natural resources and agricultural products. With the growing population curve, the pressure on new habitats and management intensification on existing agricultural areas increases. The pressure to use other areas, of more or less untouched nature, for economic purposes is increasing, and agricultural activities' environmental impacts are deepening. Thus, agriculture affects the environment in two main ways:

- Converting natural habitats into agricultural habitats and intensifying farming with the resulting negative impacts, either directly, such as through the release of agrochemicals or soil compaction, or indirectly through increased natural resources consumption.

- The increase in use of fossil fuels and energy in general, or the reduction of agrobiodiversity under the influence of the needs of the global agricultural and food market.

The increase in the environmental impacts of agricultural and food activities thus has repercussions on all the components of the environment: biodiversity, soil, water, and air as well as climate. These repercussions will be discussed in the next sections.

Impacts of agriculture on biodiversity

Biodiversity is considered an indicator of landscape stability, and agroecological approaches contribute to increasing this stability. The higher the diversity of animal and plant species present in a farm, the greater its resilience, as in its capacity to recover from an extreme climate event, which are occurring ever more frequently (Altieri et al, 2015).

Biodiversity can be affected by agriculture in several ways. Historically, agricultural activity has contributed to increasing diversity in specific time periods. For example, in Central Europe, there was partial deforestation between the 12th and 15th centuries, which diversified the landscape and created habitats suitable for other species of animals and plants. However, with the increasing intensification of agriculture during the twentieth century, the trend was reversed, and biodiversity was significantly reduced and damaged, in particular by intensive forms of farming. In parallel with the globalisation of agriculture and food there has also been a decrease in the diversity of cultivated crops, and thus a decrease in agrobiodiversity (see more on page 176) , which further aggravates the decrease in biodiversity. The main causes of the reduction of biodiversity due to agricultural activities are, in addition to the direct conversion of natural habitats to agricultural land, the effects resulting from the intensification of agriculture and its chemicalisation. In the last 100 years alone, 850,000,000 hectares of natural habitats have been converted into agricultural ecosystems, mainly through deforestation and wetland drying. Factors reducing biodiversity and agrobiodiversity include:

- Narrowing the range of crops (insufficient crop rotations, absence of species or varietal mixtures, catch crops, cover crops, intercropping);
- loss of organic matter in the soil (replacement of livestock manure and green manure with synthetic fertilisers, exclusion of perennial crops from sowing procedures);
- degradation of landscape elements serving as biocentres and bio-corridors (see more on page 177) for many organisms (e.g., in the Czech Republic and former Czechoslovakia, due to the intensification of agriculture between 1948 and 1990, almost three-quarters of the vegetation in the agricultural landscape was lost); and finally
- many direct effects of the use of agrochemicals - synthetic fertilisers and pesticides.

Knowing these factors helps to understand what needs to be reversed to enhance biodiversity. In response to this situation, farm management systems aimed at protecting the environment and promoting environmental sustainability have begun to develop in recent decades. Farm management in accordance with the principles of agroecology (AE) contributes significantly to the protection or even the restoration and promotion of biodiversity.

The intensity of the agricultural system has a great influence on biodiversity, also called agrobiodiversity. At the same time, the areas managed by environmentally friendly forms of agriculture are usually more diverse. A number of studies have looked at the impacts of organic farming on biodiversity and found that organic farms have more than 85% more plant species, a third more bats, 17% more spiders and 5% more bird species (Fuller et al., 2005; Hole et al., 2005). As another example, nine times more companion plants (see more on page 179) and beneficial weeds tend to grow there, and one can find 15% more ground beetles and 25% more earthworms than in fields in integrated agriculture (Mäder et al., 2002). More species of accompanying plants are also confirmed by Kopke (2002), who finds 20 to 400% more species of wild plants on the ground, including many endangered spontaneous plant species (Rydberg and Milberg, 2000). A 30% higher species diversity of the accompanying flora (see more on page 176) is also reported by Bengtsson et al. (2005). Even though extensive agricultural systems can also hurt biodiversity, this increases significantly with the heightened intensity of agricultural activity.

Impacts of agriculture on soil and the water cycle

The need for soil and water for food production is a fundamental issue. Agricultural production is under pressure from the demand for quality food, but, on the other hand, this opens up the problem of freshwater shortages. Today, countries in the southern part of Europe are already facing this problem, and countries in Central Europe are expected to start experiencing this trend through the next century.

About 1/3 of water consumption in Europe is linked to the agricultural sector, especially crop production. Agriculture affects the water cycle (see more on page 182) both its available quantity and its quality, which is often closely linked to the intensity of farming and inputs of plant protection products and fertilisers. Future scenarios of precipitation distribution and their frequency in Central Europe predict a general decrease in fresh water as well as changes in their distribution within space and time. With appropriate agrotechnical practices and the support of socio-political solutions, a significant streamlining of water use in agriculture can be achieved. This would mean, among other things, making more water available not only for the production itself but especially for the conservation of water throughout the agroecosystem (Bernas et al., 2020).

The issue of water management in the landscape is increasingly addressed in connection with the issue of climate change, drought and the intensification of agricultural production. Agricultural production has an impact on the soil environment, while the type of soil management will impact surface water quality, causing for example eutrophication (see more on page 181). Although, on the one hand, we are aware of the importance of soil and its contribution to the water presence, on the other hand, the soil is often taken for granted. Due to anthropogenic impact, the soil is disturbed and degraded, with often irreversible consequences for soil fertility (see more on page 186). We can consider soil erosion, reduction of organic matter content in soils, inappropriate modifications of soil water regime, inappropriate agrotechnology and poor crop rotation, acidification of soils, pollution of the environment, soil salinisation, land occupation, and the like, to be fundamental problems of soils with an impact on their hydrological regime (see more on page 182). It is necessary to realise that any negative intervention in the soil environment affects both the productive and non-productive ecological functions of the soil. The productive functions can be understood as e.g., food production, biomass producing, a source of renewable and non-renewable raw materials, or a source of nutrients for plants and animals. The non-productive functions are presented by e.g., living space for biodiversity, an environment for infiltration, accumulation and retention of water, the ability of decomposition and mineralisation, self-cleaning ability, as well as cultural and historical functions (Šarapatka & Niggli, 2008).

Erosion is a major soil problem worldwide. The issue of erosion is mainly associated with non-compliance with good agricultural practices and inappropriate tillage. Due to the intensification of agricultural management and economic pressure, there is a preference for crops with high yields and a rapid economic effect. Crop rotations are simplified. Broad-row crops (e.g., maize) are preferred to facilitate heavy machinery use, which have a minimal anti-erosion effect, and in many cases, the crops are grown repeatedly on the same land or occupy an excessive proportion of arable land. Due to soil erosion, the soil profile (see more on page 187) is reduced, and the soil is degraded altogether. Smaller and lighter particles are carried away due to rain water runoff, especially organic matter, which fundamentally influences the formation of the soil structure (see more on page 187) and significantly affects soil hydrology (see more on page 186). Finer particles and organic matter are very important to soil fertility, soil aggregation, soil aeration (see more on page 186), as well as for the chemical, physical and biological properties of soils essential to the soil fertility (Kutílek & Nielsen, 1994).

High values of surface water runoff cause more intense soil erosion. Reducing the organic matter content and simplifying crop rotation and other effects on the soil can affect soil biodiversity, which affects the soil structure, creates preferential water outflow pathways, and affects soil porosity. Together with the reckless use of mineral fertilisers, the reduction of organic matter can result in the contamination of surface waters and their increased eutrophication. A significant problem is leaving the soil without vegetation cover during part of the year when the hard chunks of soil on the soil surface are mechanically disturbed. The result is a reduction in the soil's infiltration capacity, an increase in surface runoff, and, as a result, an increase in both water and wind erosion of the soil (Brady & Weil, 2008).

Another current problem that directly affects the hydrological function of soils is the land occupation for the construction of buildings, services and technical structures, roads, etc. The consequences of increasing the area of paved areas are reflected in changes in the hydrological and climatic behaviours.

Finally, from the intensive agriculture perspective, soil drainage is an important tool for increasing the productive capacity of soils. However, in many cases, it leads to a reduction in water retention of soils and disruption of their function. The issue of drainage is also related to the modification of watercourses, which often leads to changes in natural fluctuations in the groundwater level, hydrological conditions, and hydrographic network.

This overview of human influence on the behaviour of water in the landscape through soils very briefly summarises the main problems. When managing the landscape, it is necessary to be constantly aware of the importance of how water behaves in interconnection with soils, with the latter contributing significantly to its formation (Bernas et al., 2020).

Impacts of agriculture on air and climate

Agricultural activity is part of ecosystems and most processes (e.g., agrotechnical operations, fertilisation, and pest control) in agricultural production systems have an impact on the environment. This involves reducing water and soil quality through the excessive use of fertilisers, pesticides, production of acidifying substances and greenhouse gases (GHG) production. Agriculture contributes significantly to global GHG emissions and thus to anthropogenic climate change. At the same time, agriculture also has a huge potential to contribute to climate change mitigation.

Agricultural GHG are mainly carbon dioxide (CO_2), methane (CH_4), and nitrous monoxide (N_2O) and all of them together are primarily presented as CO_2 equivalent (CO_2eq). The majority of CO_2 emissions are the combustion of fossil fuels in connection with agricultural processes, biomass burning, the management system and tillage methods and related oxidation processes, or the production and application of fertilisers and plant protection products (Niggli et al., 2009; IPCC, 2015). One of the most important sources of agricultural GHG is animal product consumption and enteric fermentation (see more on page 181). The CH_4 emitted by cattle and sheep, generated during digestion - enteric fermentation - accounts for 40% of agricultural GHG emissions in the EU-27, roughly 4% of all emissions in the EU. This share of emissions is the first place to look for GHG reductions in agriculture. Next GHG production is related to fertilisation. Nitrogen is a key nutrient required for fertile soils. Yet its use and manufacture are linked to high levels of emissions all along with their life cycles. N_2O emissions from managed soils account for almost 40% of agricultural emissions in the EU. These emissions are generated by applying nitrogen fertilisers to farmland and the ensuing chemical processes, regardless of the source of the nitrogen: synthetic mineral nitrogen or organic nitrogen sourced from legumes, manure, crop residues, mulch, and compost. In addition, emissions from mineral nitrogen fertiliser production amount to about 1.75% of total EU emissions (Müller et al., 2016).

AGRICULTURAL GHG	SOURCE
CO_2	Burning of fossil fuels Organic matter degradation in soil
CH_4	Enteric fermentation Residue burning Manure management
N_2O	Application of synthetic nitrogen fertiliser Animal manure Crop residues retained in the field

Figure 1.2: Summary of agricultural GHG sources. Source: own editing

Manure management (see more on page 183) also contributes significantly to GHG emission. Responsible for 15% of agricultural GHG emissions and about 1.5% of total EU emissions, CH_4 and N_2O emissions from manure management make up the third-largest agricultural emissions category. The key factor in reducing such emissions lies in how the manure is handled, because the amount of CH_4 emitted is highly dependent on the anaerobic conditions and temperature in the manure management systems. Better manure storage and treatment can significantly reduce greenhouse gas emissions of both N_2O and CH_4, by 50% and 70%, respectively.

Food waste (see more on page 181) is a significant contributor as well. In the EU, emissions related to food waste along the whole value chain correspond to about 10% of GHG emissions. One-third of the food produced globally goes to waste. The current levels of waste are unsustainable and can be reduced drastically with a corresponding potential to reduce emissions along the value chain (Müller et al., 2016)

Climate change is having a significant impact on agricultural systems worldwide and can be a major factor in ensuring long-term sustainable food production. Emissions from agriculture accounted for more than 12% of the total GHG emissions produced on Earth. The agricultural sector is the second-largest emitter (of all greenhouse gases together) after fossil energy use and the largest producer of CH_4 and N_2O.

As a significant contributor to GHG emissions, agriculture is also among the first sectors to suffer from the impact of climate change: many farmers, especially small scale farmers have already been affected by harvests being destroyed or damaged by the changing climatic conditions. Extreme weather events, heat waves and droughts will be increasingly frequent in the future and will also impact farmers in the EU. At the same time, agricultural production is the basis of the global food supply for the world´s citizens. Thus, it is important to scrutinise how agriculture can help reduce GHG emissions and how it may best prepare for the unavoidable negative impacts of climate change while still ensuring food security.

	MEASURE	MITIGATION EFFECT
Crops and farming system management	Improve crop varieties and productivity	Reduces direct (and indirect) emissions (see more on page 179) per kg yield
	Improve residue management e.g., avoid biomass burning	Reduces direct emissions
	Introduce legumes into grasslands (to enhance productivity)	Reduces direct nitrous oxide and indirect emissions
	Reduce reliance on external inputs (e.g., include nitrogen fixing plants into crop rotations)	Reduces direct and indirect emissions
Fertiliser, manure, and biomass management	Reduce use and production of synthetic fertilisers	Reduces direct and indirect emissions (1 to 10 kg CO_2-eq per kg N)
	Reduce fertiliser (N) input (Only 20% of all N produced in synthetic fertilisers is actually used by plants in conventional agriculture)	Reduces nitrous oxide emissions
	Avoid leaching and volatilisation of N from organic fertilisers during storage and application	Reduces nitrous oxide emissions
	Improve storage management of manure prevent methane emissions from manure heaps and tanks)	Reduces direct methane emissions
	Compost manure	Reduces direct nitrous oxide emissions

Soil management	Use organic fertilisers (production emissions from organic fertilisers have to be accounted for e.g., compost production)	Increases soil organic carbon (see more on page 187); Reduces emissions from synthetic fertiliser production
	Optimise crop rotations e.g., use perennials in crop rotations	Increases soil organic carbon: 0.8t CO_2-eq/ha/y
	Use of legumes (to fix nitrogen); use cover crops and intercropping; avoid bare fallows	Increases soil organic carbon, reduces emissions
	Reduced tillage or no tillage	Increases soil organic carbon
Animal husbandry	Avoid use of concentrate feed	Reduces indirect emissions: Avoids deforestation/land use change and corresponding soil carbon losses
	4-5% of lipids as feed additives	Reduces methane emissions by 15-20% or more
	Monogastric animals instead of ruminants	Reduces methane emissions per kg meat (but due account has to be given to the origin of the feed used)

Figure 1.3: Mitigation measures in agriculture and their indicative mitigation potential.
Source: own editing adapted from Müller et al., 2011

1.2 PRESENTING AGROECOLOGY

1.2.1 DEFINITION OF AGROECOLOGY

Agroecology can be broadly characterised as a science, a set of practices and a social movement inspired by ecological principles as well as social justice based on food sovereignty. As a scientific discipline and practise it relies on ecological theories to study the formation, management, and evaluation of agricultural production systems in order to optimise their economic efficiency while protecting natural resources and simultaneously ensuring livelihoods and the right to food. FAO (2018) offers us the following definition: '*Agroecology is an integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of food and agricultural systems. It seeks to optimise the interactions between plants, animals, humans and the environment while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system.*'

Within agroecology, attention is directed towards the ecological, environmental, and social dimensions of agriculture and food, focusing on the question of how to achieve the transformation of the current system to sustainable agriculture and food systems. The key to agroecology is its holistic and systemic approach. In this more comprehensive approach, agroecology is considered a global and multidimensional phenomenon of rethinking humans' relationship to and interdependence with nature as well as changing the value system in a post-industrial society.

Agroecology is described by a variety of definitions, most of which adhere to similar foundations and specifically build on the complexity of the sustainability (see more on page 188) of agriculture and all of its functions. For the purpose of this course, our understanding of agroecology is the following: Agroecology is developed from knowledge that combines real-life practices and experience as well as transdisciplinary (see more on page 189) scientific experiments. It is further enriched by the traditions of people living harmoniously in ecosystems that naturally contribute towards the sustainability of food systems (see more on page 181). Agroecological practices aim to nurture soil ecosystems, nutrient recycling, the conservation of energy, and the dynamic management of biodiversity. AE is also the flag of a social movement that includes peasants (see more on page 184), rural communities, neo-rurals, indigenous (see more on page 182) communities, activists, and researchers from academia with the goal of reshaping the relations within food systems, promoting proximity and solidarity between consumers and producers. Finally, in AE systems, both consumers and producers tend to challenge and transform power structures in society, building self-governing communities that endeavour to loosen corporate control over food systems in order to achieve people's food sovereignty.

The European Association for Agroecology[2] sustains that agroecology as a science, practice and movement should encompass the whole food system, from the soil to the organisation of human societies. According to them, it is imbued with values and based on a set of shared core principles. As a science, AE prioritises holistic and participatory approaches, as well as a transdisciplinarity that embraces different knowledge systems. As a practice, it is based on the sustainable employment of local renewable resources, local farmers' knowledge and priorities, the cautious use of biodiversity to provide ecosystem services and resilience, and solutions that provide multiple benefits (environmental, economic, social) from the local to the global level. As a movement, it defends smallholder and family farming, farmers and rural communities, food sovereignty, local and short food supply chains, diversity of indigenous (sustainable) seeds and breeds, and healthy quality food. Promoters of agroecology believe that the whole is more than the sum of its parts and therefore foster interactions between actors in science, practice, and movements. Rather than focusing on the narrow components of agricultural production and their immediate environmental impact, as has become the norm in research projects and university courses, agroecologists embrace the complexity of improving today's food systems.

The global problems humanity faces, including the accelerated loss of biodiversity and freshwater, the continued degradation of our ecosystems, and rising inequality resulting in pervasive and persistent hunger and poverty, are deemed systemic. This means that they are interconnected and interdependent, causing any aggravation in one of the problems to replicate through the whole system, deepening the other problems or creating new ones (Altieri & Nicholls, 2020). Within this web of interconnected challenges, agriculture is considered to be a powerful change factor, and agroecology could therefore be a global methodology for healing our planet. Two proponents of this approach, Altieri and Nicholls (2020, p. 525), advocate that '*as a powerful systemic approach, agroecology reveals that the way we practice agriculture can provide opportunities for improving environmental and human health, but if done wrongly, agriculture can cause major health risks.*'

A systemic approach or systems thinking is defined as the capability of identifying and understanding systems, predicting their behaviours, and coming up with modifications to produce desired effects (Arnold & Wade, 2015). A systemic approach is by definition transdisciplinary, interdisciplinary and open to multiple perspectives. It contemplates the interconnections within the system, drawing from practice rather than letting predefined theories lead the practice, while not shying away neither from ethical issues nor from confronting the unequal power relations in food systems. The landmark HLPE report (2019), which consolidated agroecological principles from several sources, holds the systems approach as one of

2 https://www.agroecology-europe.org/

the criteria by which agricultural practices can be classified as more or less agroecological. This approach is defined as 'embracing the management of interactions among components, rather than focusing only on specific technologies' (HLPE, 2019, p. 14). This means looking at food networks as well as agricultural social networks, at the relationships between consumers and producers, food markets, public food policies, wages and product compensation, health issues, as well as questions of access to food and production resources.

The principles for designing and governing agroecological systems using the science and practice of agroecology, with its focus on diversity, resilience, and landscape restoration, have the potential to assist humanity in weathering current and future crises at several levels—pest outbreaks, changes in climate, financial collapses, and even pandemics (Altieri & Nicholls, 2020). In contrast, the industrial approach has a narrow ecological and social focus, is extremely dependent on external inputs, and has proven to be very vulnerable, e.g. to extreme climate events (Altieri et al., 2015).

Additionally, as pointed out by Francis et al. (2003), agroecology's strength lies in the fact that it looks beyond the farm and its agroecosystem, embracing the wholeness and interconnectivity of the entire food system in all its dimensions (ecological, economic, social, ethical, cultural). In this sense, agroecology forces us to think beyond production practices and the more immediate environmental impacts at the field and farm level (Francis et al., 2003).

Strong advocates of agroecology, such as Altieri, Gliessman, Guzmán, Wezel and De Schutter, among others, agree that agroecology implies looking holistically at agroecosystems and food systems, not just individual farms. Agroecology simultaneously embraces the objective of making food and farming systems more resilient and sustainable and that of defending farmers' and communities' livelihoods and rights. By placing agroecological principles and practices in a socioeconomic and political context, the science, practice and movement of agroecology thus embrace a systems approach by definition.

1.2.2 HISTORY OF AGROECOLOGY

The history of agroecology can be traced back to the beginning of the twentieth century as an area of common interest between scientists in ecology and in agronomy. Initially, those studying agroecology focused on the ecology of agricultural systems, looking at soil, plants, insects, and their interactions, mostly at the farm level. After the 1950s, agroecology developed further, in parallel with the spread of biodynamic agriculture and organic farming.

It was only in the 1970s that socioeconomic and cultural factors were incorporated in the science of agroecology, thanks to pioneers such as Prof. Efraim Hernandez X., who based his research and educational programmes in agroecology on indigenous systems and knowledge, linking the environmental aspects of food systems with the socioeconomic reality farmers were living in (Hernandez & Ramos, 1977).

Soon, other key agroecological scientists such as Gliessman (1978) and Altieri (1989) started promoting a vision of agroecology not only as a way to '*study, diagnose and propose alternative low-input management of agroecosystems*', but also to throw light on the '*fundamental problems that lie behind the technology-induced environmental crisis and rural poverty affecting the agricultural regions of the world*' (Altieri, 1989, p. 37). Gliessman was inspired by the sustainable peasant farming systems in Mexico, which had escaped the Green Revolution and were still based on the sustainable management of agroecosystems. He suggested that '*the greater the structural and functional similarity of an agroecosystem to the natural ecosystems in its biogeographic region, the greater the likelihood that the agroecosystem will be sustainable*' (Gliessman, 1998). By the 1980s, with the simultaneous rise of the environmental movement, agroecology had become a comprehensive study of food systems and a set of practical skills for farmers to use. At the same time, it had also become embedded in a critique of and protest against the modern food system and industrialised agriculture, prompting the now-common claim that agroecology is at the same time a science, a practice, and a political movement (Wezel et al., 2009). In this period, the most common definition of agroecology was '*the application of ecological concepts and principles to the design and management of sustainable agroecosystems, or the science of sustainable agriculture*' (Gliessman, 2018, p. 599). The first courses in agroecology were born in Mexico and later spread to California in the USA (Stephen Gliessman), to Spain (with the 1987 founding of the Institute of Sociology and Peasant Studies at the University of Cordoba by Eduardo Sevilla Guzmán), Italy and other countries in Europe. By the end of the 1990s, the definition of agroecology had been modified to include the entire food system, encompassing its ecological, economic, and social dimensions (Francis et al., 2003). By the turn of the twenty-first century, agroecology had become a global phenomenon. The fact that worldwide agroecology is mostly practised by peasant and smallholder farmers, has prompted its adoption as the banner of a socio-political movement defending environmental and social justice in food systems (Krebs & Bach, 2018). La Via Campesina is an example of this movement, consisting of about 200 million farmers who have adopted agroecology as the alternative to the hyper-industrialised and proprietary global food system from which they are either excluded or in which they fail to thrive. This movement started in South and Central America but has now spread to other regions of the world, such as Africa (in particular West Africa), where farmers and scientists work together to rescue sustainable low-input, low-impact practices while also developing new, low-cost techniques that regenerate land, close the nutrient cycles and improve farmers' livelihoods. In the twenty-first century, therefore, an action component was added to the definition of agroecology, which is now referred to as the '*integration of research, education, action and change that brings sustainability to all parts of the food system: ecological, economic and social'* (Gliessman, 2018, p. 599).

Agroecology as a political movement is indissociable from the concept of food sovereignty —'*the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their food and agriculture systems*'— as reasserted by the Declaration of the International Forum for Agroecology announced at Nyéléni, Mali, in 2015 (International Forum for Agroecology, 2015).

More recently, agroecology has entered the discourse of international and supranational institutions. The turning point for this inclusion can probably be ascribed to the mention of the field in the landmark publication on the state of the art in agriculture (IAASTD, 2009) as well as the efforts of the UN Special Rapporteur on the Right to Food (see more on page 189) from 2008-2014, Olivier De Schutter, in advocating for the adoption of agroecology in the battle against food insecurity and food injustice (see for example De Schutter, 2014)[3]. In particular FAO, with its focus on smallholder farmers, recognises agroecology as key to eradicating hunger, poverty and inequality in food systems and the regeneration of the agroecosystems[4].

3 In the second decade of the twenty-first century, a number of landmark publications unmasked the false promises of industrialised agriculture and presented agroecology and peasant/ small-holder farming as an alternative: The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD, 2009), the reports from the UN Special Rapporteur on the Right to Food from 2008-2014 and the Trade and Environment Review Wake Up Before It Is too Late produced by UNCTAD (UNCTAD, 2013).

4 http://www.fao.org/agroecology/overview/en/

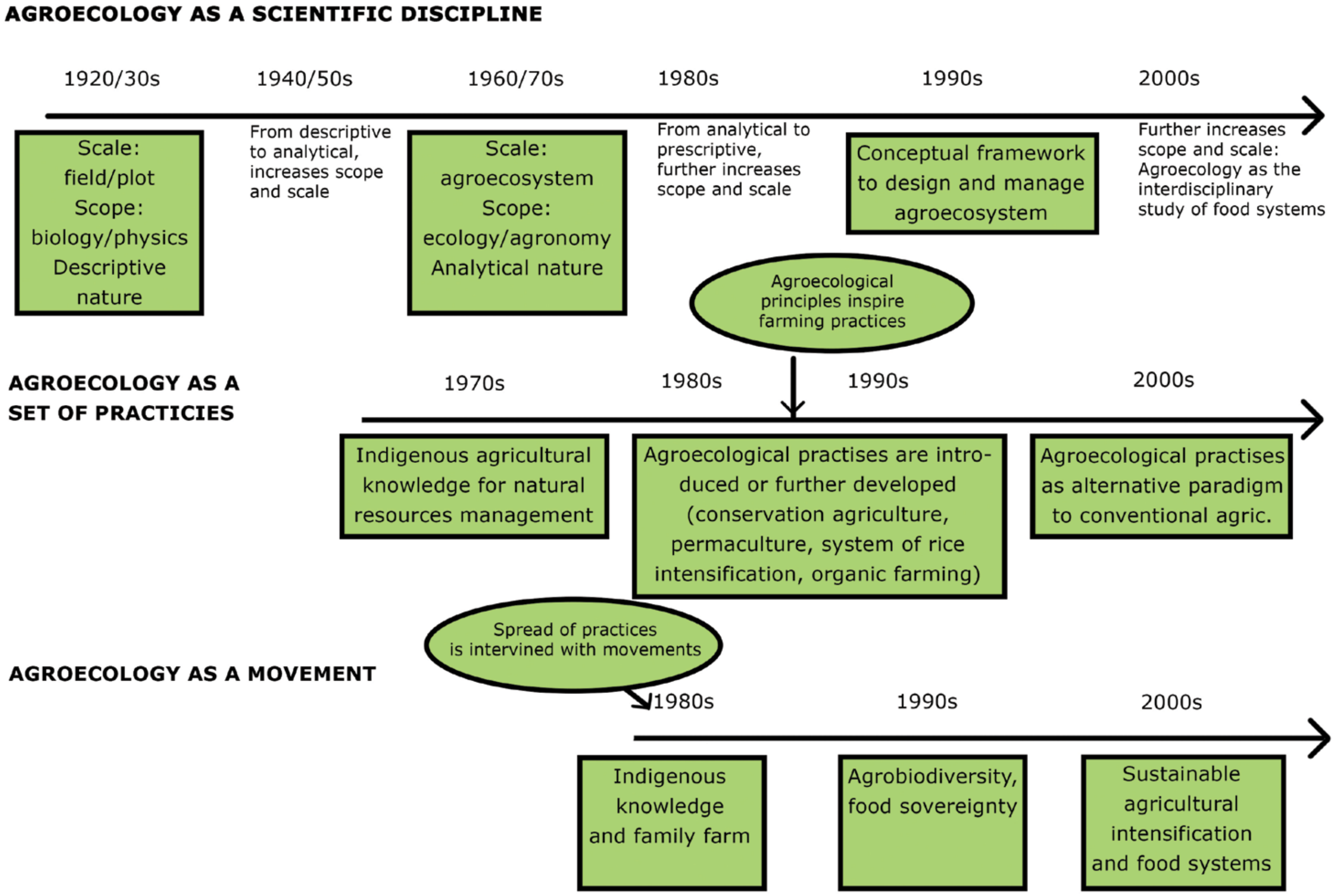


Figure 1.4: The history of the development of agroecology. Source: adapted from Silici, 2014

1.2.3 PILLARS AND PRINCIPLES OF AGROECOLOGY

Within a holistic approach, agroecology is sustainably based on three basic pillars or dimensions - agricultural, ecological, and socioeconomic. The agricultural activities themselves represent the agricultural pillar, while the ecological pillar refers to the environment and its protection and support. The socioeconomic pillar concerns people and the quality of life in rural areas. More recent thinkers and practitioners have added a fourth to these basic pillars or dimensions: the political pillar (CIDSE, 2018, discussed in this section). Agroecological practices aim to support all these dimensions at various levels - from the field and the farm to the regions and territories.

The interpretation and implementation of agroecology continue to be a matter of debate. Most of its proponents will agree that agroecology is essential for addressing the worsening food systems crises. How to go about this varies according to the proponent and their personal beliefs, leading Méndez, Bacon & Cohen (2013) to speak of ‘multiple agroecologies’. Whereas one camp views agroecology as just one tool in the toolbox, focusing on techniques and practices, another camp, embracing ‚transformative agroecology’, focuses on challenging the current production paradigm, which perpetuates injustices in food systems, and strive for equity and protection of rights (Anderson & Anderson, 2020). The latter authors imagine agroecology to exist on a spectrum that slides from preserving ‘current conditions’ to ‚transformative’ actions (Anderson & Anderson, 2020). In this section, we will present some of the more transformative proposals for agroecological principles.

The CIDSE Task Force (2018) report gives us indications on how we should evaluate and use the principles that are proposed on this spectrum of agroecology. They understand principles as a ‚set of broad guidelines that constitute the building blocks of agroecology, its practice and implementation' and state that the principles not only should be applied progressively, but also differentiated according to locations, leading to different practices being used in other places and contexts (CIDSE, 2018, p. 4).

FAO (2018) contributed to the operationalisation of agroecology by identifying ten elements (principles) of agroecology to help guide the transition (see more on page 189) towards sustainable farming and food systems. These elements combine insights from pioneer scientists as well as extensive stakeholder inputs. The ten elements are diversity, co-creation and sharing of knowledge, synergies, efficiency (see more on page 180), recycling, resilience, human and social values, culture and food traditions, responsible governance, and circular (see more on page 178) and solidarity economy[5] (see more on page 187).

According to the report produced by another UN organisation, the High-Level Panel of Experts on Food Security and Nutrition (HLPE, 2019), there is no ‚one-size-fits-all' solution for our food system challenges. The HLPE therefore proposes to complement FAO's ten elements with three key development goals - **improve resource efficiency, strengthen resilience, and secure social equity / responsibility** - as well as three scales of application: the field, the farm, and the food system (HLPE, 2019, p. 41).

Steve Gliessman (2016), recognising the idea of a spectrum of agroecological practices from less or none to complete, proposes five levels of transitioning. **The first level** refers to increasing the efficiency of industrial / conventional production systems. **The second level** sees the substitution of industrial / conventional practices by alternative ones. **Level three** completely redesigns the production system so that all the root causes of the food systems' challenges are addressed. **Level four** is about reconnecting those who produce the food with those who consume it and bypass the large distribution corporations. And finally, **level five** fulfils all the fundamental objectives of agroecology: a new global food system, with appropriate public policies and governance structures, that is based on equity, participation, democracy, and justice.

The Swiss NGO Biovision's ‚Agroecology Criteria Tool'[6], developed in 2020, takes all these contributions one step further, combining the five levels of transition proposed by Steve Gliessman (2016) with FAO's ten elements of agroecology (2018) to create a tool for assessing the degree of transformation of a farm, project, or policy. This tool is further informed by criteria drawn from the work of DeLonge, Miles & Carlisle (2016), resulting in the framework presented in Figure 1.5, where the transitional levels and the now 11 elements or principles of agroecology interact.

5 http://www.fao.org/agroecology/overview/overview10elements/en/
6 https://www.agroecology-pool.org/methodology/

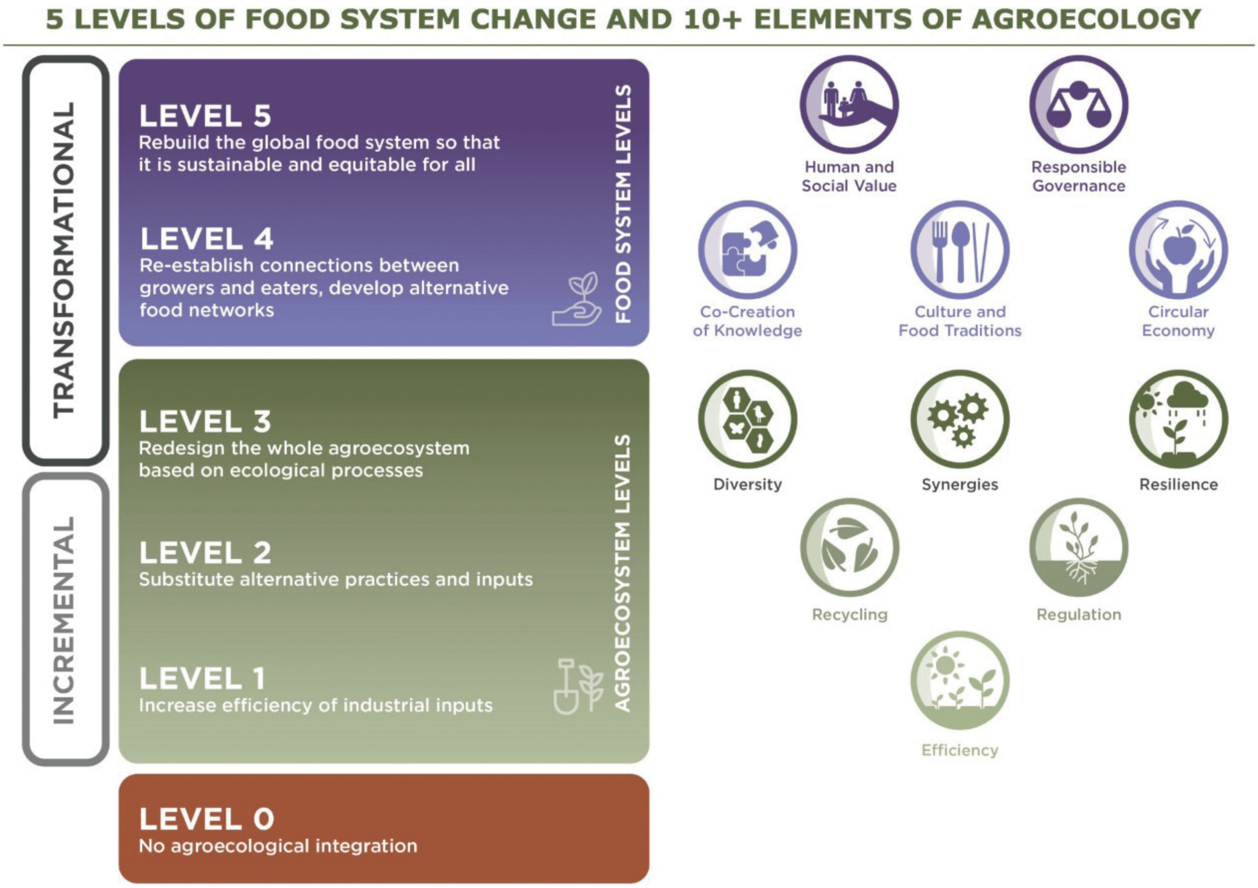


Figure 1.5: Overview of the 5 levels of food system change and the elements of agroecology. Source: adapted from Biovision[7]

In parallel, the comprehensive report by the International Panel of Experts on sustainable Food Systems (IPES-Food, 2016) compares the outcomes of current specialised industrial farming (see more on page 182) with those of diversified agroecological systems and, by questioning what is keeping industrial agriculture in place, despite overwhelming evidence as to its enormous failings, offers pathways to transition towards diversified agroecological systems. The expert panel offers seven key recommendations that help support a transformative shift towards diversified agroecological systems (IPES-Food, 2016, p. 65):

1. Develop new indicators for sustainable food systems.

2. Shift public support towards diversified agroecological production systems.

3. Support short circuits & alternative retail infrastructures.

4. Use public procurement to support local agroecological produce.

5. Strengthen movements that unify diverse constituencies around agroecology.

6. Mainstream agroecology and holistic food systems approaches into education and research agendas.

7. Develop food planning processes and ‚food policies' at all levels.

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7 https://www.agroecology-pool.org/methodology/

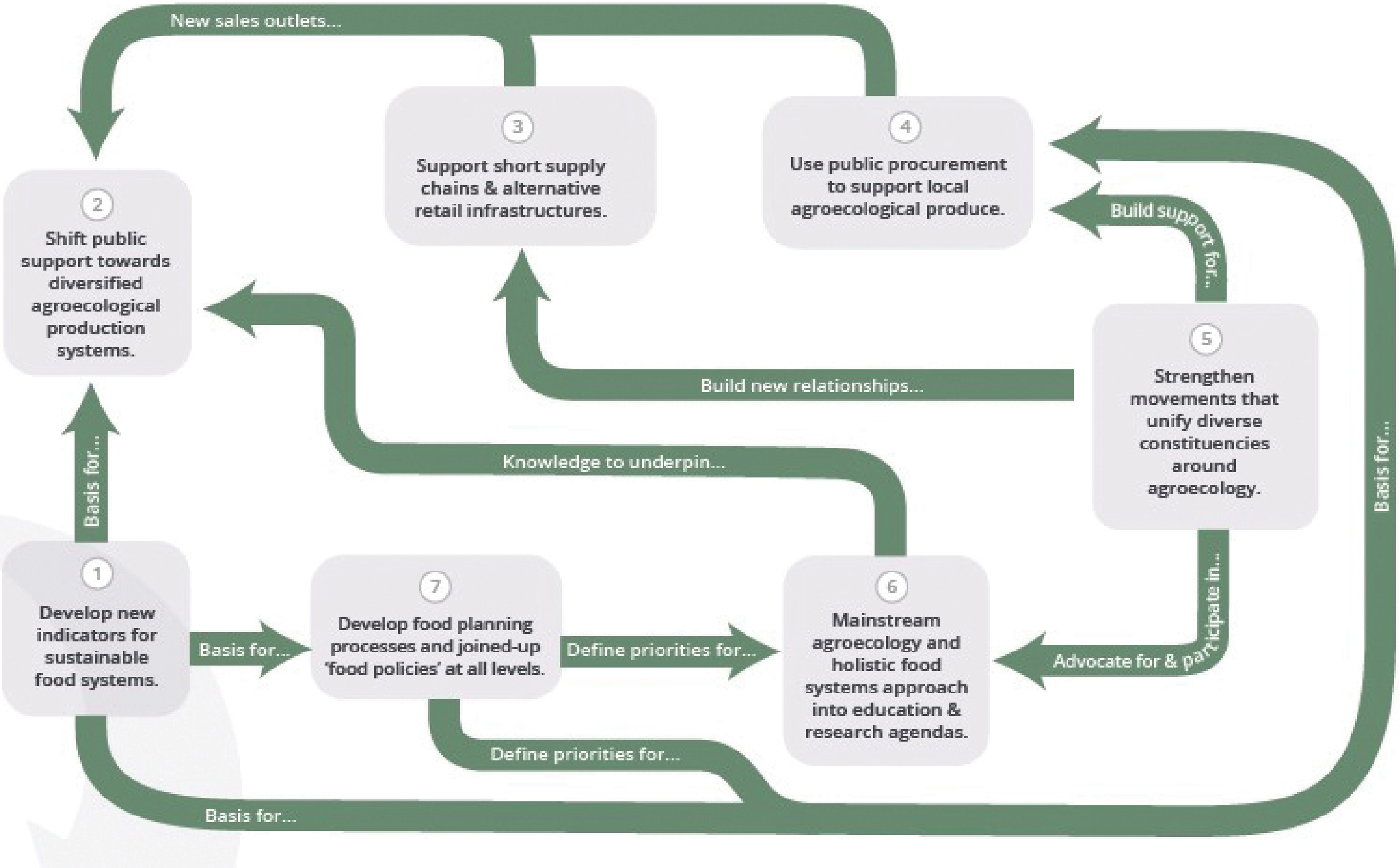


Figure 1.6: Pathways to diversified agroecological systems. Source: adapted from IPES-Food, 2016

The different writings and works on the concepts and principles of agroecology are only recently converging towards a common vision. The previously mentioned report of the CIDSE task force (CIDSE, 2018) has been especially helpful in strengthening the framework that can support agroecology that truly lives up to its inspirations from ecological scientists, peasant farmers, and proponents of food sovereignty. For this reason, we will present this framework in detail. Based on their extensive review of thinkers and practitioners in agroecology, the CIDSE researchers have come up with 24 principles for agroecology, organised according to a set of four dimensions (CIDSE, 2018, p. 6-9) as shown in Figure 1.7. Figure 1.8 summarises the above presented key principles as well as the key characteristics of agroecology in a helpful infographic.

1. THE ENVIRONMENTAL DIMENSION OF AGROECOLOGY

1.1. Agroecology enhances positive interaction, synergy, integration, and complementarities between the elements of agro-ecosystems (plants, animals, trees, soil, water, etc.) and food systems (water, renewable energy, and the connections of re-localised food chains).
1.2. Agroecology builds and conserves life in the soil to provide favourable conditions for plant growth.
1.3. Agroecology optimises and closes resource loops (nutrients, biomass) by recycling existing nutrients and biomass in farming and food systems.
1.4. Agroecology optimises and maintains biodiversity above and below ground (a wide range of species and varieties, genetic resources, locally-adapted varieties/breeds, etc.) over time and space (at plot, farm and landscape level).
1.5. Agroecology eliminates the use of and dependency on external synthetic inputs by enabling farmers to control pests, weeds and improve fertility through ecological management.
1.6. Agroecology supports climate adaptation and resilience while contributing to greenhouse gas emission mitigation (reduction and sequestration) (see more on page 182) through lower use of fossil fuels and higher carbon sequestration (see more on page 178) in soils.

2. THE SOCIAL AND CULTURAL DIMENSION OF AGROECOLOGY

2.1. Agroecology is rooted in the culture, identity, tradition, innovation and knowledge of local communities.
2.2. Agroecology contributes to healthy, diversified, seasonally- and culturally-appropriate diets.
2.3. Agroecology is knowledge-intensive and promotes horizontal (farmer-to-farmer) contacts for sharing of knowledge, skills, and innovations, together with alliances giving equal weight to farmer and researcher.
2.4. Agroecology creates opportunities for and promotion of solidarity and discussion between and among culturally diverse peoples (e.g., different ethnic groups that share the same values yet have different practices) and between rural and urban populations.
2.5. Agroecology respects diversity between people in terms of gender, race, sexual orientation and religion, creates opportunities for young people and women and encourages women's leadership and gender equality.
2.6. Agroecology does not necessarily require expensive external certification as it often relies on producer-consumer relations and transactions based on trust, promoting alternatives to certification such as PGS (Participatory Guarantee System) and CSA (Community-Supported Agriculture).
2.7. Agroecology supports people and communities in maintaining their spiritual and material relationship with their land and environment.

3. THE ECONOMIC DIMENSION OF AGROECOLOGY

3.1. Agroecology promotes fair, short distribution networks rather than linear distribution chains and builds a transparent network of relationships (often invisible in formal economy) between producers and consumers.
3.2. Agroecology primarily helps provide livelihoods for peasant families and contributes to making local markets, economies and employment more robust.
3.3. Agroecology is built on a vision of a social and solidarity economy.
3.4. Agroecology promotes diversification of on-farm incomes giving farmers greater financial independence, increases resilience by multiplying sources of production and livelihood, promoting independence from external inputs and reducing crop failure through its diversified system.
3.5. Agroecology harnesses the power of local markets by enabling food producers to sell their produce at fair prices and respond actively to local market demand.
3.6. Agroecology reduces dependence on aid and increases community autonomy by encouraging sustainable livelihoods and dignity.

4. THE POLITICAL DIMENSION OF AGROECOLOGY

4.1. Agroecology prioritises the needs and interests of small-scale food producers who supply the majority of the world's food and it de-emphasises the interests of large industrial food and agricultural systems.
4.2. Agroecology puts control of seed, biodiversity, land and territories, water, knowledge and the commons into the hands of the people who are part of the food system and so achieves better-integrated resource management.
4.3. Agroecology can change power relationships by encouraging greater participation of food producers and consumers in decision-making on food systems and offers new governance structures.
4.4. Agroecology requires a set of supportive, complementary public policies, supportive policymakers and institutions, and public investment to achieve its full potential.
4.5. Agroecology encourages forms of social organisation needed for decentralised governance and local adaptive management of groups and networks at different levels, from local to global (farmers organisations, consumers, research organisations, academic institutions, etc.).

Figure 1.7: 4 dimensions of agroecology. Source: CIDSE, 2018, p. 6-9.

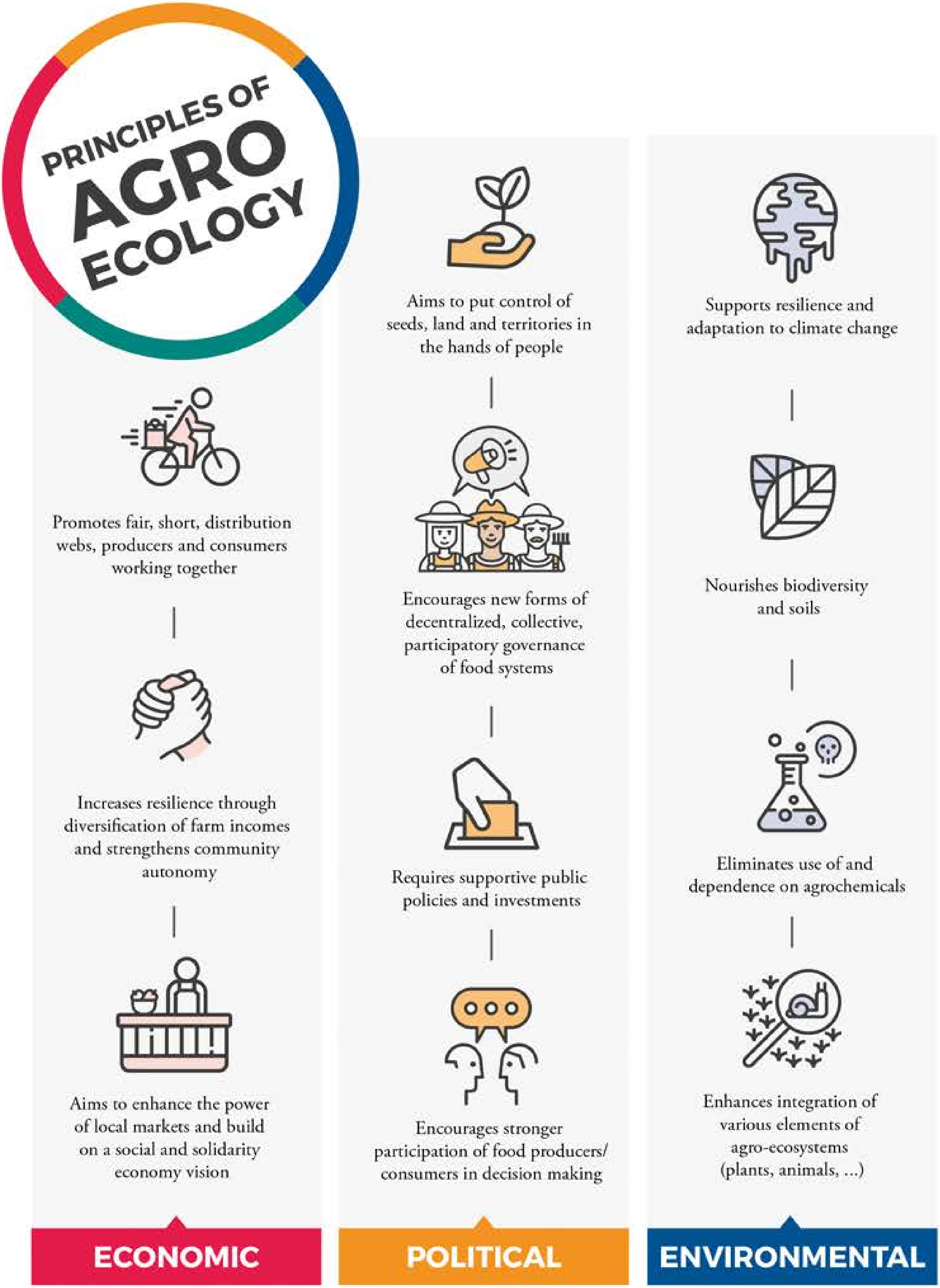
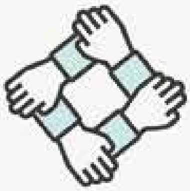


Figure 1.8: The principles, dimensions and facets (expressions) of agroecology. Source: CIDSE, 2018

Promotes farmer to farmer exchanges for sharing knowledge



Strengthens food producers, local communities, culture, knowledge, spirituality

Promotes healthy diets and livelihoods

Encourages diversity and solidarity among peoples, encourages women and youth empowerment

SOCIO-CULTURAL

THE 3 FACETS OF **AGROECOLOGY**

AGROECOLOGY IS:

1. A scientific research approach involving the holistic study of agro-ecosystems and food systems;
2. A set of principles and practices that enhance the resilience and sustainability of food and farming systems while preserving social integrity;
3. A socio-political movement, which focuses on the practical application of agroecology, seeks new ways of considering agriculture, processing, distribution and consumption of food and its relationships with society and nature.

WHAT ARE THE PRINCIPLES OF **AGROECOLOGY**

THESE PRINCIPLES ARE A SET OF BROAD "GUIDELINES" THAT CONSTITUTE THE BUILDING BLOCKS OF AGROECOLOGY, ITS PRACTICE AND IMPLEMENTATION:

» Agroecology promotes principles rather than rules or recipes of a transition process.

» Agroecology is the result of the joint application of its principles and the values that lies behind them to the design of alternative farming and food systems. It is therefore acknowledged that the application of the principles will be done progressively.

» The principles are valid across the diversity of territories and lead to various practices in different places and contexts.

» All principles should be interpreted in the context of improving integration with the natural world, and justice and dignity for human and non-human actors and processes.

There is no food sovereignty without agroecology. And certainly, agroecology will not last without a food sovereignty policy that backs it up.

Ibrahima Coulibaly

Find out more:
https://agroecologyprinciple.atavist.com

1.2.4 AGROECOLOGY IN EUROPE

Agriculture in Europe produces large amounts of food for European populations and has become one of the major export sectors. With the intensification of agriculture in Europe, significant social and environmental impacts have emerged, such as the loss of biodiversity, pesticide contamination of soils, water, and food, and eutrophication of waterbodies. Industrialised agricultural and food systems are also a major contributing factor to the decline in numbers of farms in Europe, and the major use of antibiotics has led to serious human health problems. In this respect, agroecology can provide insights into important pathways and guide the design, development, and promotion of the transition towards sustainable farming and food systems (Wezel et al., 2018b).

Although the first mentions of agroecology are more than a hundred years old, for example, in the countries of Eastern Europe, the agroecological concept has been developed mostly since the 1990s. This is mainly related to the intensification of agriculture in the second half of the twentieth century and the orientation of agricultural research towards the production function. Agroecology is also strongly linked to sustainable agricultural activities, in particular organic farming (Moudrý et al., 2018). The development of the conceptualisation of agroecology in European countries is heterogeneous, with science predominating, followed by practice and to a lesser degree the idea of AE as a social movement (Gallardo-López et al., 2018).

The current trend of expansion and evolution of agroecology throughout Europe is appreciable. As a science, movement, and practice, agroecology is flexible, which allows many to embrace the concept with many different ways of applying it. However, this flexibility can also cause fragmentation and a lack of joint participation from the diverse actors actively supporting its expansion. Academic agroecology is still largely disconnected from the agroecology movement. In Europe, the scientific component of agroecology remains the most recognised so far, when compared to the Global South. In academia, there is no strong consensus on what education in agroecology is. Additionally, there is a geographic imbalance in academics and research, with AE mainly present in the West and North and dominated by the English language. While academic institutions are increasingly using the term agroecology for their programmes, this may not be the case for practical institutions, such as farmer schools. It is to be expected that there exist many more initiatives, networks, and associations in Europe that deal with agroecology but that do not use the term explicitly and thus are not visible within this framework. To support the farms' transition to agroecology and the growth of other bottom-up agroecology initiatives for farming as well as the development of sustainable food systems, stakeholders must join forces to obtain political support at both the national and European levels (Wezel et al., 2018a). The main scale where the concept of agroecology has been applied is at the level of farming systems, followed by regional level, agroecosystems, and, finally, agri-food systems. At the first level, organic agriculture is prevalent, evidencing the close relationship between sustainability and agroecology concepts. The regional scale is focused on the use of the land, biodiversity, and landscape, with an interest in translating sustainability issues to agricultural policies. At the scale of the agroecosystem, we can find the application of the systems approach, considering ecological, economic, and political aspects. Finally, at the scale of the agri-food system the tendency is to reinforce the global dimension of agriculture from an agroecological perspective, observing the coexistence with other disciplines and emphasising an interdisciplinary approach, where socio-political aspects are addressed, involving the guarantee of food sovereignty and security. According to the scale at which the concept of agroecology is used, it has transcended from the farming system to the agri-food system, without losing its characteristic as research that balances these two scales (Gallardo-López et al., 2018).

1.3 THE ADDED VALUE OF AGROECOLOGY

1.3.1 POLITICAL, LEGAL AND ECONOMIC BARRIERS FOR SMALLHOLDER FARMERS

Ecological farming, which takes into account all the elements of the food systems, not only the balance of natural resources (water, soil, seeds, endogenous flora and fauna) but also the well-being of animals and humans in the farm-food system, requires free choice and free access of the farmer to the resources he/she needs. This choice and access cannot always be taken for granted. In particular, smallholder farmers and peasants are often discriminated against in a capitalist agricultural model that favours large-scale, mechanised, and specialised cash crop farming with easy access to investment capital so as to realise the economic model of neoliberal (i.e., post-1990s) capitalism. The latter model provides monopolies to large agribusinesses that control commercial seeds and the synthetic chemicals required to grow them. These monopolies as well as geopolitical events drive up the price of inputs and inevitably drive many farmers out of business because the production costs are higher due to the inherently small scale, which is precisely what guarantees the realisation of the principles of agroecology. Additionally, large corporations, as well as governments (for example, China and Israel), are buying up large areas of farmland, sometimes expelling the peasant or indigenous farmers who were farming this land, often pushing these families to perform underpaid rural work or to leave for the city's suburbs, being subjected to tremendous social stress as a result (for more on large corporate control of agricultural resources, in particular through the control of land, seeds, and other inputs, see for example Howard, 2009; Oxford Farming Conference, 2012; ETC Group, 2013; De Schutter, 2014; Horstink, 2017; IPES-FOOD, 2019).

Farmers increasingly face legal and political hurdles that challenge their autonomy. For example, restrictive seed laws in many countries are aiming to stop farmers from accessing the largest seed bank in the world, their own seeds (as an example, see the case of India in Silva & Garcia, 2016), through legislation that only allows the use of certain seeds registered in a catalogue with inherent administrative burdens and costs that only big corporations can handle. Even though commercial seeds do not make up more than 20% of all the seeds used by farmers (ETC Group, 2017), their producers enjoy special privileges, with greater access to the markets and, in some instances, fines for farmers that use their own seeds instead of buying them.

Additionally, most public and private investments in research and development are still destined for the technologies and practices based on the 1960s vision of a ‚Green Revolution' and hyper-industrialised agriculture (Herren & Haerlin, 2020), ignoring their impacts on the environment and climate change (large irrigation projects that contribute to freshwater depletion are an example of these investments). Finally, European agricultural subsidies are designed to benefit the larger landholders, leaving smallholder farmers to fend for themselves, often depending on a second job to make ends meet. Although the public commitments of EU governments to a ‚European Green Deal', including the greening of agriculture, the protection of biodiversity, a substantial increase in organic farming, as well as ambitious climate adaptation strategies, the discourses of politicians are still mostly geared to large, cash crop farming solutions. Many politicians are listening to the agribusiness' claims that sustainability and climate adaptation can only be achieved through technological innovation using biotechnologies (see more on page 177) protected by patents and shrouded in secrets. This, despite the fact that genetically modified organisms (GMOs) (see more on page 182), which have been around for over twenty years, have not lived up to any of their societal promises (end of hunger, end of pests), nor are their claims of economic benefits applicable to anyone but the companies that sell the seed-chemical packages year after year or very large landholders (to which the tens of thousands of smallholder farmer suicides in India due to crop failures and subsequent crippling debts after adopting BT cotton attest).

When farmers turn to ecological farming, in particular agroecology, with its emphasis on on-farm inputs, knowledge sharing, and network building, they are able to free themselves from the treadmill that many farmers are condemned to get stuck in, i.e., the vicious circle of obtaining all their inputs from outside of their farm: buying new seeds every year, with more chemicals and irrigation needed each year as the soil deteriorates and weeds become more resistant. Farmers who invest in the agroecosystems of which their farms are a part are able to rely on the inputs their farms are then able to provide and thus reduce their costs.

1.3.2 IMPACTS AND OUTCOMES OF AGROECOLOGY

In agricultural practice, the support of agroecological principles has been gaining ground more slowly than in science. Familiarisation with various problems and the negative impacts of intensive conventional agriculture on production, the quality of the output as well as the environment increases the interest of farmers in scientific information and their willingness to apply the learnings of agroecological research. On-farm research (see more on page 184), shared between farmers, is also contributing to the promotion of agroecological practices. Finally, motivation is also stepped up by pressure from the general and professional public, the media, and end customers. Openness to agroecological research on the part of politicians and farmers in Central and Eastern Europe is additionally facilitated by the support for sustainable farming within the scope of the common agricultural policy (CAP) (Moudrý et al., 2018).

Agroecology's inputs and outcomes include deepening the knowledge of basic relationships, connections, and processes in the agricultural landscape. Knowledge of the concept of agroecology brings the following benefits:

- Makes it possible to identify problems in the agricultural landscape and propose corrective measures;
- Helps anticipate the impacts of certain measures on selected ecosystems, especially agroecosystems;
- Assists in developing conceptual proposals professionally;
- Helps estimate the quality of the environment according to the species composition;
- Favours the use and application of knowledge about wild organisms in the comprehensive care of the landscape with a special focus on agroecosystems;
- Promotes the organisation and conducting of landscape-ecological research;
- Helps orient farmers in learning about basic landscape-ecological concepts, environmental legislation and environmental impact assessment with an emphasis on the agricultural sector.

Besides these practical benefits of agroecology, its implementation in farming communities has also been documented to improve the livelihoods and empowerment of small-scale farmers. Agroecological methodologies for inclusiveness, mutual learning, self-monitoring and collective decision-making have resulted in the creation of solidary economic networks (such as Community Supported Agriculture (see more on page 179) schemes and short food chains), which often reinforce women's role in farming and food and create locally controlled food systems. Examples of successful empowerment and improvement of well-being of small-scale farming communities can be found in the report of the High Level Panel of Experts on Food Security and Nutrition (2019). Specific strategies to align agroecosystem regeneration with the promotion of well-being for vulnerable farming communities include using farmer-to-farmer learning, joint academic/farmer agroecological research focusing on accessible and job creating technologies, offering agroecology as a vocational training, using value-adding techniques such as participatory guarantee systems and the use of sustainable varieties and breeds. In short, there is enough evidence available today to support the idea that agroecology is a powerful approach for transforming food systems, not only in terms of agroecosystem regeneration but also social equity and other structural changes that counteract the power asymmetries present in modern food systems (HLPE, 2019).

There is a clear need to implement the principles of agroecology in practice and thus mitigate the effects of intensive agriculture oriented almost exclusively towards economic efficiency. The conventional approach still used by a majority of farmers is hampering the relationship with nature, especially in high production areas, and technical, technological, and biotechnological progress has so far focused more on the production side of agriculture and its intensification. Agroecological practices and principles have the potential to regenerate agroecosystems as well as bring greater justice and equity to food systems, and should be more strongly supported by national and supranational institutions if they want humanity to stand a chance in surviving the major challenges of the 21st century.

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PERMACULTURE FARM DESIGN

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2.1 PERMACULTURE IN A NUTSHELL

2.1.1 WHAT IS PERMACULTURE?

Permaculture is a set of ethics, principles and tools for designing human systems in ways that mimic natural ecosystems (see more on page 180). By working with nature instead of against her, Permaculture seeks "the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability, and resilience (see more on page 185) of natural ecosystems" (Permaculture Research Institute, 2021). It aims to preserve remaining natural ecosystems, assist in regenerating degraded land and implement efficient agricultural systems (see more on page 181) which use the least amount of land and external energy inputs, by integrating people and nature in mutually beneficial synergies.

The concept emerged in Australia in the late 1970s through the hands of Bill Mollison, university teacher and David Holmgren, his student. The term 'Permaculture' originally arises from the conflation of "permanent" and "agriculture", referring to a framework for regular farming systems (see more on page 181) based on perennial trees, shrubs and herbs. Yet, after realising the potential application of Permaculture principles to human systems, in 30 years it evolved to actually mean a system for designing "permanent cultures", including not only environmental and agricultural design but also social, economic and legal considerations — recognising that sustainability (see more on page 188) requires productive landscapes but also healthy environment, circular economies (see more on page 178) and equitable societies.

Permaculture is a design system (see detailed in next subchapter), comprising a multidisciplinary toolbox which combines agricultural and forestry techniques with ecology (see more on page page 180), hydrology, soil science, renewable energies, natural building, waste management, appropriate technologies (see more on page page 177) and community development. It does not invent new techniques but rather bridges scientific knowledge with diverse traditional practices, advancing a framework of ethics and principles which rescues ancestral modes of working in collaboration with Nature.

Nature is the great teacher as it is the result of millions of years of adaptation to the planet, which shows us how to assure life's sustainability, so Permaculture promotes thoughtful observation rather than thoughtless action for creating a truly sustainable living. Doing so, Permaculture offers holistic (see more on page page 182) solutions to both rural and urban contexts at any scale, from a single balcony or backyard garden to a whole village or for large-scale farming.

For further information about the concept of Permaculture, consult Bill Mollison's book: Permaculture, A Designer's Manual, 1988.

2.1.2 ETHICS AND PRINCIPLES

Before getting into action, applying any design tools or techniques, the Permaculture journey starts by understanding its fundamental ethics and principles. These are the philosophical guidelines which should inform every stage of the design process — the what, why and how — conveying the Permaculture design goals and opening pathways to get there.

The Three Ethical Principles: Earth Care, People Care and Fair Share

Permaculture ethics are not exclusive to Permaculture, but rather found in diverse cultures worldwide. These express an ancestral wisdom on how to live a 'good life', being the basis for more harmonious ways of living with ourselves, with each other and with Nature. Any Permaculture project should comply with these three foundational ethical principles:

Earth Care: Caring for the Earth, our home planet, means to appreciate Nature in all its manifestations, recognising her as the basis of all life, being grateful for all the abundance she provides and respecting all living beings for its intrinsic value, rather than its utilitarian value for humans. This implies reducing humans' ecological footprints (see more on page 180), minimising the land surface required to meet human needs; creating productive systems with the least impacts on natural ecosystems; and, ultimately, reducing resources used by questioning consumption patterns, adopting zero waste policies, creating closed loop systems (see more on page 178) based on reciprocity (see more on page 185), giving back or restoring what one takes.

People Care: Caring for people is about meeting people's needs "in compassionate and simple ways", by building strong collaborations, mutually beneficial exchanges and supporting meaningful personal and community development to reduce inequalities and collectively empower ourselves. It starts with the self and expands to our families and wider communities, taking care of ourselves and each other. It requires building self-reliance and taking full responsibility for our actions and surrounding contexts, recognising the greater wisdom and power that lies in a collective to co-create the best possible outcome for all.

Fair share: This means taking only what one needs and sharing the surplus, as the saying goes, "there is enough for all our needs but not for all our greed". This requires a redistribution of resources, examining our personal needs (distinguishing needs from desires), considering what is enough and sharing the surplus for the benefit of all — the Earth and people around us. It recognises there are different needs and different capacities, so everyone is able to give but there are limits to both what one can give and what one may take. By giving, one establishes reciprocity bonds, where sharing the abundance creates more abundance in ways which ultimately benefit all the involved.

For further information, consult Geoff Lawton's video on the topic: shorturl.at/ch579

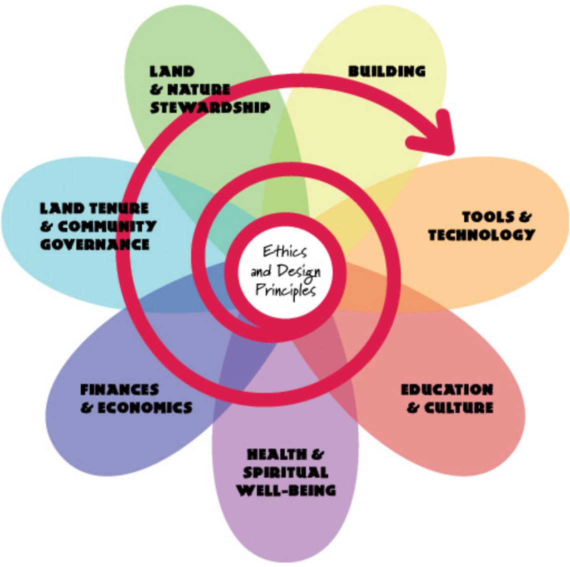


Figure 2.1: Permaculture Flower, the seven domains of Permaculture action start with its ethics and principles Source: Holmgren, 2002

THE PERMACULTURE PRINCIPLES

In addition to the ethical principles, the Permaculture approach uses a set of fundamental design principles to guide observation and intervention on site. These can be applied to any space, regardless of location or size, and offer universal guidelines mostly based on common sense. When applied correctly and effectively, these fundamental principles assist in creating permanent, diverse and productive agroecological (see more on page 176) systems.

Work with nature rather than against it: Understanding and working with natural patterns (see more on page 184) helps create both energy efficient and visually beautiful systems (see more on page 188), which respect natural energy flows through space and time. Natural patterns are forms which repeat themselves, from seasons to symmetries, spirals, fractals or waves, which may inspire designs. Additionally, by working with biodiversity, creating spaces that provide diverse habitats for insects and birds, these may assist balancing diverse ecological functions (see more on page 180), including pollination, pest control or soil fertility. For example, bees may assist pollination and provide honey while other insects and birds may help control populations of harmful species (e.g. locusts, caterpillars or aphids) and their excrements may add crucial nutrients to the soil. Ultimately, it is a basic principle that by collaborating with nature, nature will collaborate with us, offering an abundance of resources, teachings and energy sources.

The problem is the solution: Permaculture approaches problems based on the possibility of turning them into solutions. It means we try to look at the problem from a different angle and see its positives. This entails thinking, for example, on the potential uses of an excess of stones in our site, looking at their ability to absorb heat and using it to our advantage; or, transform a swamp area in a rich and biodiverse wetland garden; or, understanding a slug problem as a duck deficiency; or, using harnessing cold blowing winds to generate energy. This means understanding: first, that everything may be turned into a positive resource, depending on how we use it to our advantage; and, second, that it is not worth wasting time nor energy attempting to change something which has evolved to become as it is and therefore it is part of the system. Changing it might mean creating unexpected reactions and a bigger problem.

Minimum effort for maximum effect: This means to "make the least change for the greatest possible effect" (Permaculture Association, 2021), as small changes are easier to implement, require less energy and face less obstacles than bigger ones while may also have great lasting impacts. This is a general principle for an efficient use of energy, time and labour when planning and implementing a Permaculture design. An example is to plant salad in a balcony or windowsill, which will cut food miles, packaging and be cheaper than buying it. Another example is applying a soil protection technique where, by covering the soil around plants with straw (mulching), it will keep the soil moist, prevent weeds from growing and provide organic matter to the soil, we will end up with richer soil and spend less time watering and weeding. Thus, with a single action, we may save time and resources while obtaining multiple benefits.

A system's yield is theoretically unlimited: This does not mean resources are infinite nor that system's growth is unlimited, but rather that theoretically there are always ways to improve the benefits it can provide. As Mollison (1988) said, "the yield of a system is only limited by the information and imagination of the designer". There are always ways to observe a site and see many things that could still be done or implemented, such as introducing a new plant in between others, another animal to increase production or even a microorganism to improve soil. Alternatively, one can look at a specific resource and see different new uses for it.

Everything Gardens: This means everything has an effect on its environment, so it depends on us to understand each element's roles and optimise their benefits for our gardens. For example, the chicken scratches the ground, fertilises the soil, cleans weeds, eats insects and helps control pests while providing manure, eggs, feathers and heat. Thus, chickens support multiple ecological functions and the same may be said of other species of birds, mammals and even microorganisms. All beings have an effect on the greater environment and, in our gardens, these may provide biomass (see more on page 178), remove weeds or twigs, collect and distribute seeds, decompose organic matter or provide conditions for future generations, overall contributing to the natural balance of the whole ecosystem.

2.1.3 BRIEF HISTORY

In the 1970s, Australia conventional agriculture (see more on page 182) was already showing its negative impacts on the land. The practice of large-scale agriculture using monoculture (see more on page 184) crops, phytochemicals, intensive irrigation, deep ploughing and the increasing of big herds of cattle were resulting in environmental degradation and loss of nonrenewable natural resources. In many areas fertile soil was despairing, the deserts were growing fast and water was becoming contaminated and scarce. Observing the destruction that was going on in his country, Bill Mollison, an ecologist and professor at the University of Tasmania, decided to do something, and worked on creating a possible positive solution.

Initially it emerged as a beneficial association of plants and animals, mostly geared towards domestic and community self-sufficiency, but later he and his student David Holmgren took the concept to another level.

They realised that people, their buildings and the ways in which they organise themselves were very important and a central issue, making evident the systemic approach as interdependencies among the different sectors show that to change one element is not enough: it had to happen at all dimensions of human activity. In this way "the original Permaculture vision of permanent or sustainable agriculture has evolved to permanent or sustainable culture" (Holmgren 2002).

After spreading mainly among the English speaking countries in the 80's, Permaculture started to emerge in other countries as well during the 90's and gained its shape as an international movement. The establishment of its education scheme largely contributed to this evolution, as Permaculture Design Courses were organised in all countries to spread the idea.

2.1.4 CURRENT INTERNATIONAL AND NATIONAL STATUS, WITH NETWORKS IN RELEVANT COUNTRIES

Its ethics and principles can be adapted to any context, integrating local traditional practices and not just importing concepts/practices from elsewhere. This is why Permaculture was well accepted and integrated all over the globe. Today, within a distance of 20km we can almost certainly find someone that has already heard about Permaculture.

Permaculture associations were established to promote, teach and represent the movement in respective countries.

Permaculture associations in the trAEce countries (it is worth to consult at least your relevant association for further collaboration possibilities):

Hungary: https://permakultura.hu/
Czech Republic: https://www.permakulturacs.cz/
Austria: https://www.permakultur-austria-akademie.at/
Romania: http://www.permacultura.ro/
Portugal: there is no official institute although Portugal has one of the highest number of projects registered in the Permaculture Global website. Portuguese permaculturist refer to the British Permaculture Association (see below), which certifies the Permaculture Design Courses in Portugal.

Other wider Permaculture networks:

Visegrad and beyond Permaculture Partnership: http://visegrad.permakultura.sk/
Permaculture Network Europe: https://permaculture-network.eu/
Permaculture Research Institute: https://permacultureglobal.org/
Australian Permaculture Research Institute: https://www.permaculturenews.org/
British Permaculture Association: https://www.permaculture.org.uk/

2.1.5 PERMACULTURE AND AGROECOLOGY

Permaculture can be seen as one agroecological movement with a specific approach to design, sharing a systems view of life and of human activity. Permaculture principles and themes can complement those found in agroecology. Design principles and practices in Permaculture bring a distinctive view on agroecosystem management (Ferguson & Lovell, 2014). It offers a strong ethical base, also a very practical systems design guide. Agroecology provides the political and social movement context and is more embedded in farming communities. Both started in the 1970's from the starting point of applying ecology as a science to agriculture as a practice evolving to a more holistic approach. Agroecology has been identified currently as a key concept for the transition to sustainable agriculture (see more on page 189).

The transition pathway is well worked out for agroecology at a larger scale (throughout the whole food system (see more on page 181)) (e.g.: Tittonel 2014), Permaculture offers a lot of tools on how to design and implement the transition (see more on page 189) at farm scale. The concept of Permaculture can be applied to human systems as well, and land based designs often encounter lots of social aspects, thus Permaculture can be used as a good tool not only to transform our agriculture and landscapes but also people's thinking, attitude and eventually our culture.

Summing up agroecology and permaculture are complementary in a lot of senses, not only at the level of farming design practices, which is why permaculture has been chosen to be part of this curriculum. There are several internationally acknowledged pioneer farms where the two concepts are applied together: Ferme du Bec Hellouin in France, Ridgedale Farm in Sweden, Krameterhof in Austria.

You can consult this online article (Word Permaculture Associaton, 2021) or this scientific article (Ferguson & Lovell, 2014) or Geoff Lawton's video (Permaculture Vs Regenerative Agriculture, Syntropic Agriculture & Holistic Management?) for further information.

2.2 PERMACULTURE DESIGN

2.2.1 AIMS AND PRINCIPLES OF DESIGN

Why design? Design provides the link between our abstract idea(l)s, principles with the actual site conditions in a practical manner. It helps us to bring down to earth our dreams, needs and ideals and to transform them in a pragmatic way into reality, step by step how we are going to realize them.

The aim is to create a plan which takes us from point A - the current situation presumably unsustainable with unmet needs and/or unused resources - to point B - the ideal, sustainable and resilient system which meets both our needs and respects th site's ecosystems - . Our design will describe the plan of how to do it.

During the design we aim to create a system which can maintain its functions in a sustainable way (sustainability refers to their long term functioning — ability to sustain both now and in the future). In permaculture design we observe and use site patterns to enhance systems' overall functioning, including its resilience and productivity.

Building energy efficient systems is one of our main goals and to have it we have to consider the followings:

1. The systems we build should last as long as possible with the least possible maintenance.
2. These systems, fuelled by the sun, should produce enough to meet not only their own needs, but the needs of the people creating and managing those systems. Thus, they are sustainable, as they sustain both themselves and those who rely on them.
3. We can use energy to put together these systems, provided that in their lifetime, they conserve more energy than we use to create them or maintain them.

There are a few principles a Permaculture design process needs to observe, described in the following paragraphs:

Resources' balance: there is a statement in Permaculture design, that says we should aim to allocate 80 % of our energy and resources to design and implement the system and only 20 % to the maintenance. These magic numbers are very hard to keep in practice, but always remind us of the importance of the design. The best example for this principle is planting a fruit tree.

At the beginning we thought it through very well what fruit tree species we need and which species fits in our site, where we would like to place it, then we plant it, dig a big hole, provide compost or manure for the start. In the first years we have to water it, also prune to be more accessible and beautiful. But with time the energy needed to maintain is less and less, while the yield is increasing!

We have to put the maximum effort into the initial system's design and implementation so as to save unnecessary efforts once the system is operational. Another advice is to work with what is already there: first to see and preserve what is there, secondly to enhance what is there, and last to introduce new things.

Specificity: Permaculture does not bring an ultimate recipe for what or how to do things. Design means that we have to identify the special characteristics of our site and build our own design based on those features, instead of trying to replicate another example previously seen elsewhere. Although we can adapt them as patterns for our design. In Permaculture design it is said that every situation is unique, thus every design should focus on the special aspects of the site and its social context; these unique aspects may lie in the singular conditions of existing buildings, vegetation, soil type, or in the social and market features of the region.

Consequently, the principles and methods that we apply to our design should be in tune with the unique characteristics of an individual place, and of the people who live and work there. In other words, we have to use the land for what it's best suited to, but we also have to consider the people's needs with equal weight.

Multifunctionality: Every element in a design should have more than one function, to maximise efficiency (see more on page page 180); and each function should be supplied by multiple elements, to increase the resilience of our farming system (see more on page 181).

2.2.2 THE DESIGN PRINCIPLES

We often look at design principles as supporting structures which can assist us during our design practice and we aim to apply all these principles at the same time in a holistic manner and not only selected ones.

Permaculture design principles can be applied to social designs as well, not only to farm design, although below we describe the latter in detail. If you are interested in social design, consult MacNamara's People & Permaculture book (Macnamara, L. (2012). People & Permaculture: Caring and Designing for Ourselves, Each Other and the Planet. Permanent Publications).

1. OBSERVE & INTERACT

By taking the time to engage with nature we can design solutions that suit our particular situation. For this we need to allocate enough time for observation, to recognise patterns and ecological principles in our systems, so that we can work with them not against them.

If we have a site with an established shrub layer, it is worth first observing and identifying the plant species before acting. Plants can indicate soil properties (e.g. acidity, lack of nutrients, excess of substances), also we might observe signs of damage by wild animals etc. We can find wild fruit tree seedlings (e.g. hawthorn) that are suitable for grafting new cultivars on them. This is how we interact with what is already there. Wild stocks will likely be more vigorous, locally adapted and provide healthier trees.

Figure 2.2: Sour cherry and cherry cultivars grafted on a wild sour cherry stock. This is how acting was based on thoughtful observation first. Credit: Alfréd Szilágyi

2. CATCH & STORE ENERGY

By developing systems that collect resources when they are abundant, we can use them in times of need. Energy is understood here widely, e.g. building our soil with available organic matter, or developing complex perennial systems are both good ways of catching and storing energy.

By collecting rainwater to water reservoirs we can reserve it later in the season when it is less abundant. We can use it for passive irrigation, and a water body has a lot of other benefits like creating microclimate, providing habitat etc.

Figure 2.3: Water reservoir built to collect rainwater from the roof of a greenhouse, it reflects sunshine on the glasshouse and it is used for passively irrigating vegetable beds. Credit: Alfréd Szilágyi

3. OBTAIN A YIELD

Ensure that you are getting truly useful rewards as part of the work that you are doing. We have to create independent and regenerative systems that can sustain not only themselves but those who maintain them.

It is always important to be conscious about the diversity of benefits we gain from our site. There are many forms of profit which cannot be expressed monetarily but also contribute to our welfare. On the other hand we have to be careful also about our own sustainability and to not exploit ourselves.

Figure 2.4: Yield in its wide sense is important for our well being. Credit: Alfréd Szilágyi

4. APPLY SELF-REGULATION & ACCEPT FEEDBACK

We need to discourage inappropriate activity to ensure that systems can continue to function well. Self-regulation here implies allowing the system to find its balance, while feedback means reinforcing positive outcomes while adjusting to negative ones (everything is connected, so one activity or element may reinforce or constrain certain functions).

Good pasture management and grazing regime require adequate animal stock density (adjusting livestock populations, so both livestock and pastures are healthy). If stock density is not planned adequately (see more on page 182), shrubs and weeds can grow and invade our pasture, or overgrazing can cause erosion and loss of plant vegetation. In this case, animal stock and pasture form a self-regulating system where we look at the feedback and adjust and interact when needed by controlling herd size.

Figure 2.5: The length of time animals stay on a pasture is a key factor in maintaining it in a good condition. Credit: Alfréd Szilágyi

5. USE & VALUE RENEWABLE RESOURCES

Make the best use of nature's abundance to reduce our consumption behaviour (footprint) and dependence on non-renewable resources. A Permaculture system endeavours to rely as little as possible on outside energy sources and to maximise the use of renewable resources available within the system.

We can use fresh manure from the stall to make a hotbed underneath our seedlings. The manure will heat the polytunnel while decomposing instead of using external energy. After there is no need for heating it will become good quality compost.

Figure 2.6: Fresh manure bed for heating polytunnel for seedlings. Credit: Alfréd Szilágyi

6. PRODUCE NO WASTE

By valuing and making use of all the resources that are available to us, nothing goes to waste. In a good functioning system every output (by-product) of an element is used as an input for another element instead of becoming a pollutant.

Green wastes (leaves, branches after pruning etc. also kitchen wastes) from gardens can be used as biomass for covering soil. It provides protection for the soil, stores nutrients and water and also suppresses weeds. Green waste is a valuable biomass source which is still a lot of times not managed in a responsible way (often burnt, disposed of in the garbage container etc.).

Figure 2.7: We can make wood chips from branches after tree pruning with the help of a shredding machine. Credit: Balázs Kulcsár

7. DESIGN FROM PATTERNS TO DETAILS

By stepping back, we can observe patterns in nature and society. These can form the backbone of our designs, then working with nature and filling the details as we go to meet both our own needs and enhance ecological functions. Patterns occur in time e.g. seasonal or daily changes of the sun) and also space wise (e.g.: structure of the root system of the trees).

It is suggested to observe and design the water management of the site first and then the plant and animal systems. Contour lines show us patterns in the topography of our site. We can design our water systems around them using swales to collect and retain water in the landscape.

Figure 2.8: Swales on a steep site along contour lines. Credit: Etelka Kardos

8. INTEGRATE RATHER THAN SEGREGATE

By putting the right things in the right place, relationships (positive synergies) develop between those things (eg. plant and animal species or landscape features such as water sites) and they work together to support each other.

Integrating animal and plant systems raises several beneficial relations. Chickens in the orchard supply soil nutrients, control weeds and pests, while they can cover their feedstuff partly and also express their natural instincts.

Figure. 2.9: Chickens are good complementary elements in the orchard. Credit: Anett Póss

9. USE SMALL & SLOW SOLUTIONS

Small and slow systems are easier to maintain than big ones, making better use of local resources and producing more sustainable outcomes. We can adjust small scale and slow processes to our conditions thus successfully adapt to changes.

Small scale and simple solutions are often the most resource efficient tools and technologies. We always have to seek to find the most appropriate technologies for our contexts. Animal traction and small farm machinery are good examples for this principle.

Figure 2.10: Using animal traction for soil cultivation. Credit: Dániel Valkó

10. USE & VALUE DIVERSITY

Diversity reduces vulnerability to a variety of threats and takes advantage of the unique nature of the environment in which it resides, thus it increases redundancy and resilience.

In permaculture we aim to establish complex plant assemblies (we call it guild (see more on page 182) with perennial plants in the center. The different plants have different needs for space and resources thus they can thrive together and positive synergies can arise.

Figure 2.11: Complex plant assembly with apple tree, black currants and perennial herbaceous plants. Credit: Alfréd Szilágyi

11. USE EDGES & VALUE THE MARGINAL

The interface between things is where the most interesting events take place (this what we call edge-effect (see more on page 180) **in ecology). These are often the most valuable, diverse and productive elements in the system. Thus we aim to create and increase edges in permaculture design.**

Trees provide good microclimate for several plants while forest openings allow smaller trees, shrubs and herbs to thrive. On the site below, raspberries were planted along the forest border creating a more productive edge.

Figure 2.12: Raspberry in the forest edge. Credit: Csaba Centeri

12. CREATIVELY USE & RESPOND TO CHANGE

Changes can have a positive impact and we can work with changes to potentiate reorganization and adaptation by carefully observing, and then intervening at the right time.

Collecting, conserving and reproducing traditional varieties can assist us to better adapt to changing environmental conditions. We can use the genetic diversity they provide to find the best cultivars to our site while allowing diversity to create options in case of disturbances and increase system resilience in case of pests or extreme climate events (eg. varieties resistant to drought or flood). Seed swaps and seed banks initiatives are getting more and more popular today.

Figure 2.13: Centre of the hungarian civil seed bank. (Magház- Seedhouse) Credit: Alfréd Szilágyi

For further information and examples of Permaculture principles in practice, you can consult David Holmgren's book, Permaculture: Principles and Pathways Beyond Sustainability (Permanent Publications, 2002) (this book is the source of the above graphics of permaculture principles) or https://permacultureprinciples.com/ or you can also consult this online OSU video (The Permaculture Principles).

2.2.3 DESIGN PROCESS FRAMEWORKS & STEPS

There are diverse methods and frameworks on how to build up the design process. We can find several design techniques like SADIMET (**S**urvey, **A**nalysis, **D**esign, **I**mplementation, **M**aintenance, **E**valuation and **T**weaking), OBREDIM (**O**bserve, **B**oundaries, **R**esources, **E**valuation, **D**esign, **I**mplement, **M**aintain), CEAP (**C**ollect site information, **E**valuate the information, **A**pply permaculture principles, **P**lan a schedule of implementation, maintenance, evaluation and tweaking), etc., but all of these are composed of the following main steps:

- **Preparation**: defining roles (who does what?), key aims of the design (what are we planning for?), main features/desired outcomes of the project (what are the expected results of a successful implementation of the plan?), time scale (when is short-term, medium-term and long term in months/years? How much time for each phase of the design process? How much time do I have to dedicate to it?) , energy and resource needs of the design process (what kind of energy and resources do I need for the design process?), financial conditions (how much money do I have, how much do I need and how can I get the difference?). In the case of an external designer it is also important to set a common language and understanding of Permaculture between designer(s) and clients.

- **Survey**: gathering information about the site (detailed in next section) and also people's needs (goals, needs, desires, life situation, personal resources and limits, site related information like ownership, their farming practices, etc.). We create a base map and use layers to represent information space-wise.

- **Analyses:** evaluation of the gathered information to understand the actual and the desired situation, here we can set SMART goals, use SWOT/SWOC analysis (see in the next section). At the end of the phase we should determine the desired functions of the foreseen system assigning strategies and elements to each function, resulting in a list of all possible elements.

- **Design:** The first step is to choose the elements for the functions while considering what the site is able to provide and how to fulfil its needs. After we have our elements we have to place them on the site and integrate them in a coherent pattern. By building up subsystems we aim to raise positive relationships between elements and reduce the risk of negative impacts. We use map overlays for the different phases and create a final design map showing the desired system at a later stage of the succession. At the end of the design phase it is always worth going back to our initial principles and ethical considerations. By analysing where we could correspond to them and where there are missing points, how we can find ways to ameliorate our final design which is truly in line with the goals and principles of Permaculture.

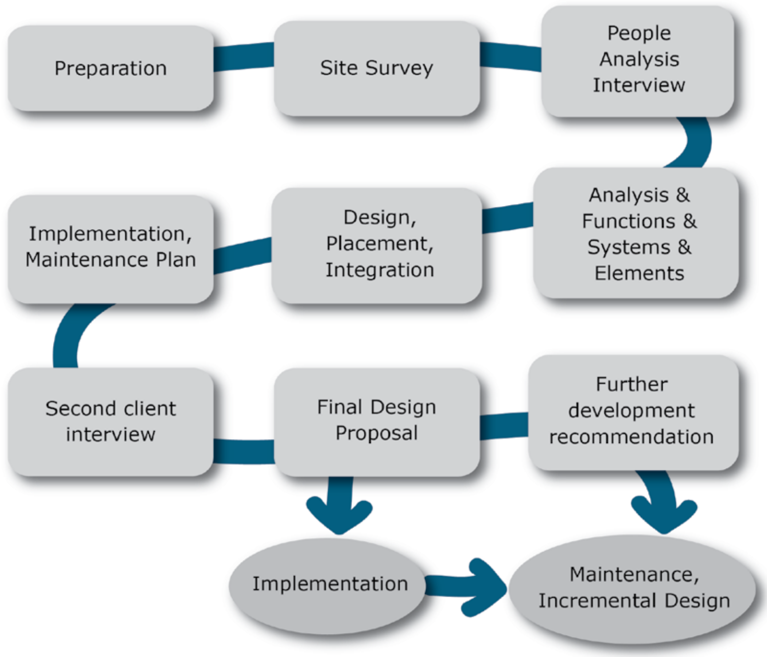


Figure 2.14: Simplified flowchart of Permaculture design. Source: Alfréd Szilágyi, adapted by Júlia Csibi

- **Implementation and maintenance:** When we have our final design (future layout of the site) we have to work out how we will implement changes, broken down to smaller steps within a reasonable timeline. We also have to consider how the system will be maintained and work out strategies to keep it on a sustainable level.

- **Evaluation and tweaking:** On one side it means that in view of the energy requirement for implementation and maintenance we might need to go back to a previous stage of the design process to redesign our system and apply tweaks. This shows that the design process is not a linear but rather an iterative process. Secondly after implementing the design we will probably find new aspects, new conditions and also mistakes in our previous design, these give again opportunity for evaluation and redesign.

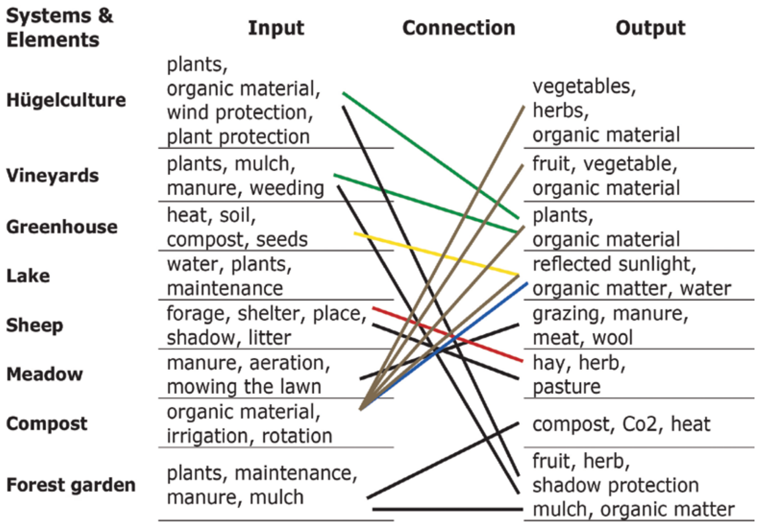
Observation has key importance, it is advised to allocate at least one year if possible to site observation so that we can assess seasonal changes (patterns in time), surveying the site is more detailed in the next section.

Some people prefer numerical values and structured tables, others prefer more graphical illustrations (pictures, charts etc.) while the rest understand better text descriptions. Whatever data we choose to record and register during the design, this information can be organised in a way that helps us in constructing systems and strategies and a final design that is understandable, also for external people. We can go back at a later stage to our initial design steps making possible better monitoring and evaluation of our work.

2.2.4 DESIGNING TOOLS

There are thinking tools that help us reorganise information in a structured way. By using them we can extract conclusions, highlight key points in our design and also graphically illustrate our design concept in ways which better helps our understanding. They can be applied in the different design phases but mostly during the first phase, when evaluating the survey data, to understand the actual situation, and during the design and integration phase, to construct the best adapted solutions and elements.

- **Input-output analysis:**



By listing the input of the elements and systems on one side and then doing the same with their output on the other side, we can make connections among them, so that the inputs of one are satisfied by the outputs of others. By doing so we can try to avoid the dependence on external inputs and the production of waste: the aim is to have no unused output and unfulfilled input.

Figure 2.15: This and the following diagrams are simplified flowcharts for Permaculture design. Source: Alfréd Szilágyi, adapted by Júlia Csibi

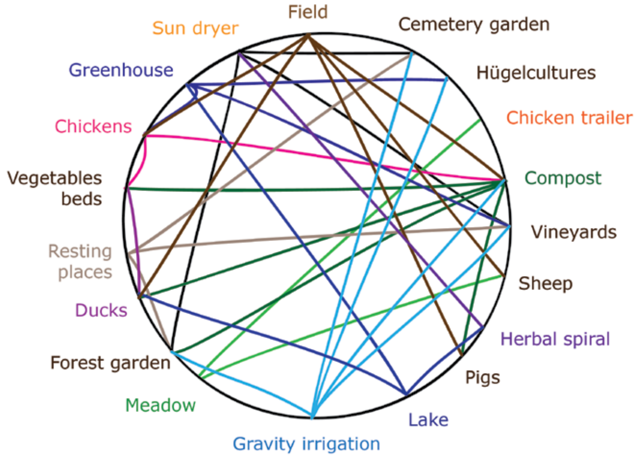
- **Functions & Subsystems, strategies & Elements:**
  This is a table structuring our ideas about the system we design in this order: Functions in the left column, the strategies and subsystems that will provide the specific function fall in the middle column while the elements that we determined which will compose the subsystem/strategy are placed on the right. After composing this table we can assess to what extent we managed to establish multiple functions with multiple elements.

- **Sit spot:**
  Sit spot is a spot on the site where you sit and observe. It is in this place where you start your observations. But also useful when we do the placement of elements, to go back to this spot and give time to imagination. It is important that we do not only use visual sense but also all other senses!

- **McHarg's exclusion method:**
  The designer can go about the task the other way around looking at first where the element surely cannot go and disclose those areas on the design map.

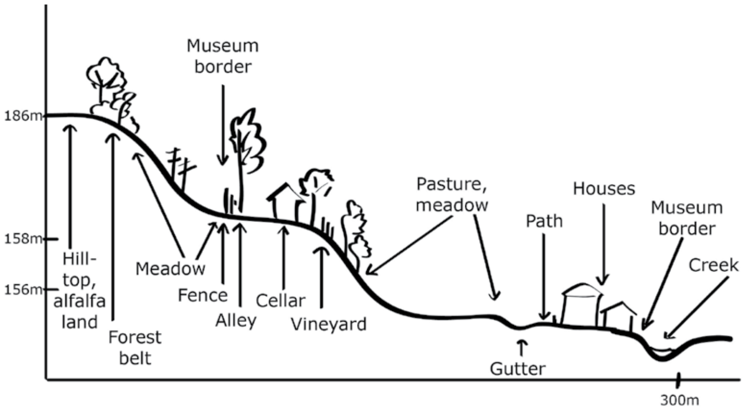
- **Random assembly:**

When we list the elements of our system and then connect them randomly (by using cards and connecting words and assemble elements with closed eyes), we can notice unexpected and beneficial relationships that we are likely to miss otherwise.



- **Web of connections:**
  By making a circle of the elements and sub-systems and connecting them on the basis of the relationships between them (or based on the time scale), we can analyse how connected our system is, and which elements have to be placed close to each other depending on the number of connections.

- **Elevation planning:**



Analysis of topographic features of the site by transect profile, which helps us to design and place elements along the slope. (e.g: buildings are least exposed to the environment (wind, frost etc.) on the middle of the slope) This is a matter of placing components in relation to the topography, including the degree of slope, the direction which the slope faces (its aspect), its height above sea level and its height relative to the surrounding land.

Other tools that we often use in Permaculture design are **SWOT/SWOC** (strengths, weaknesses, opportunities and threats or constraints) analysis, which can help us to simplify the information and find the key points of our design; **PNI**, a decision tool listing all positives, negatives and interesting features of a possible element; **SMART** (Specific, Measurable, Attainable, Relevant, Time-bound) goals which help us to clarify aims of our design and **Mind maps**, which are a type of diagram used to represent the connection between different ideas, copying how our minds connect ideas to create understandings.

For more information on design tools and practical considerations, you can consult Aranya's Permaculture Design book (2012) or you can consult these online OSU videos (The Foundations of Permaculture Design) by Andrew Millison.

2.2.5 EXAMPLE OF PERMACULTURE DESIGN

Valaha farmstead is one of the Permaculture demonstration sites (https://permakultura.hu/terkep/)of the Hungarian Permaculture Association. It is a certified organic farm with a total 12 hectares of land. Fruit production is the main focus of the farm, they process the fruits to syrups. Animals (cattle and sheep) are also kept for making cheese and grazing the land. For the design, the idea of Zoning was used, as a tool to decide where to place what, which is further described in section 3.5.

The farm is composed of the following zones (see the map):

Zone 1: Farm buildings, family house with the processing unit in the basement, chicken range
Zone 2: Vegetable beds and greenhouse to supply the family, also to grow herbs for the syrups. Open space in this zone for events.
Zone 3: Animal stock pen and orchards
Zone 4: Grasslands and arable land to produce feedstuff for animals
Zone 5: Hedge around the farm (several species but dominated by acacia) and pine tree plantation

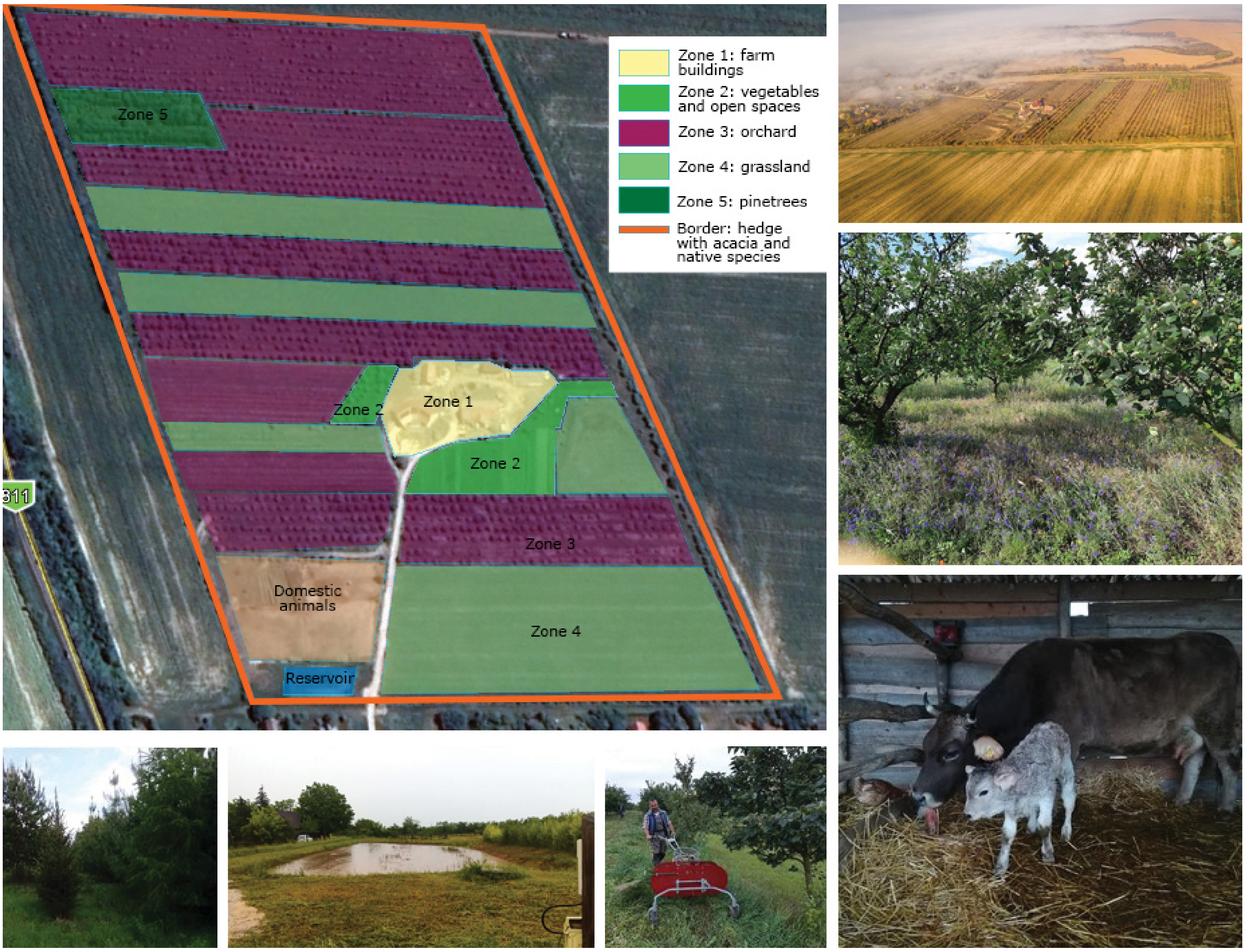


Figure 2.16: Zone map of the Valaha farmstead. Credit: Alfréd Szilágyi. Photos: Balázs Kulcsár

There are several Permaculture principles and practices that are demonstrated well here. It is a very complex, integrated system that needs few external inputs. The farmer builds on biodiversity, including genetic diversity, the name of the farm means "once upon" which indicates that they grow and keep traditional varieties and cultivars (animals and plants as well).

See trAEce video for more examples for Permaculture principles on this farm https://www.youtube.com/watch?v=AUOPcxoxRbs, also the other trAEce video on designing self-sufficient Permaculture farming https://www.youtube.com/watch?v=mV4ZWx1kBfg and this OSU video (Permaculture zones) by Andrew Millison.

2.3 PERMACULTURE FARM ELEMENTS AND RESOURCE MANAGEMENT

2.3.1 READING THE LANDSCAPE

Before starting any farm design process, the first step is to carefully observe the site and its connection to the wider landscape — preferably for at least one entire year to account for seasonal changes. One must pay attention to both spatial and temporal variations when considering the site's topography, slope's orientation, dominant winds, main water sources, different soil types, distinct habitats, macro and micro climates and current fauna and flora diversity throughout the landscape. But also previous human influences, built infrastructures, possible resources and potential extreme climate events (e.g. floods, droughts or fires). Site observation may be complemented with information provided by the local community (e.g. elders) about past site conditions, previous activities, who may also give important clues about relevant weather and biodiversity patterns, local livelihoods and main agricultural activities.

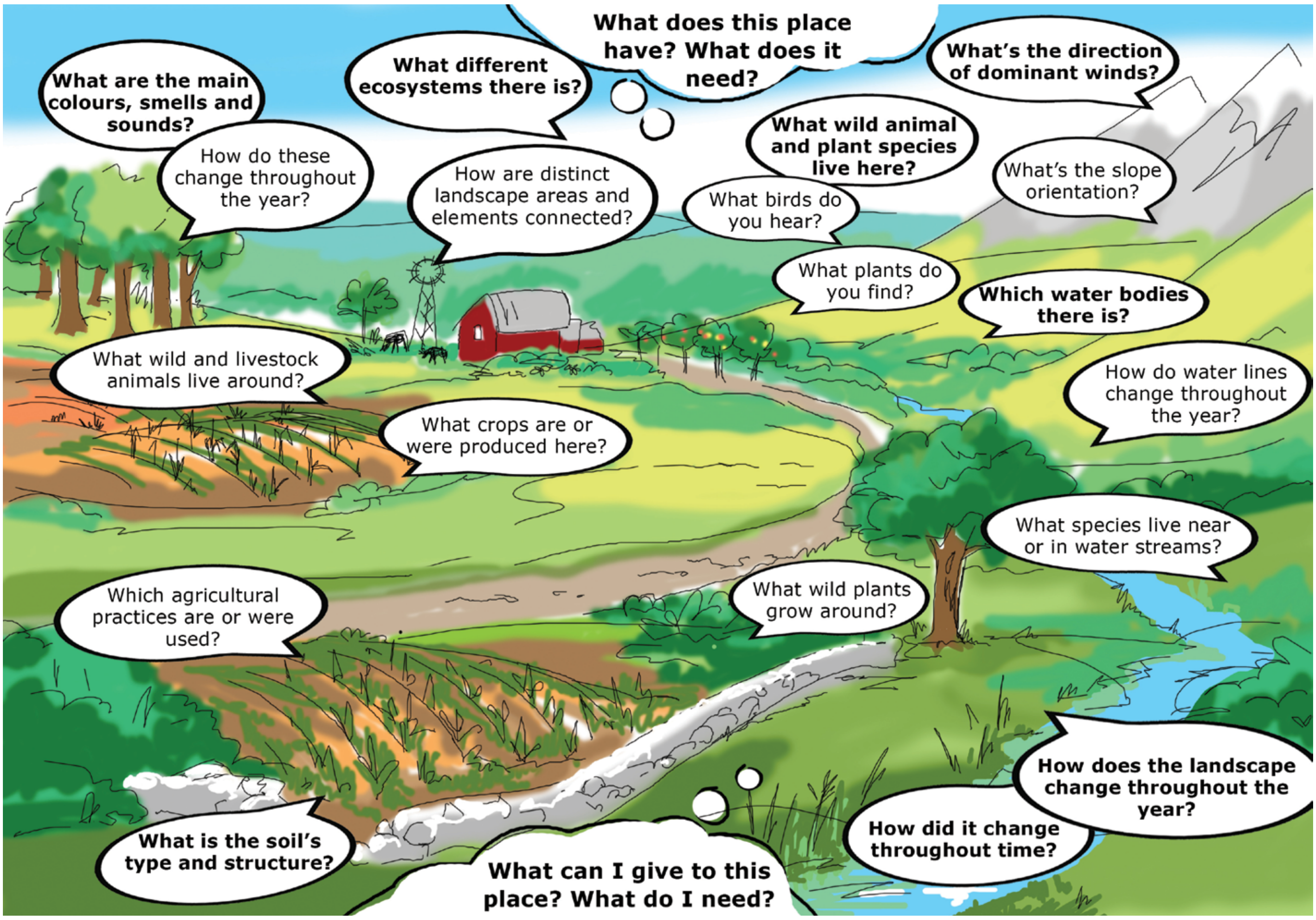


Figure 2.17: Reading the landscape. Source: Joana Canelas, adapted by Júlia Csibi

This observation period will yield valuable information that may avoid great surprises or missed opportunities later on. Working with the land requires working with what is there already, and understanding what is missing to enhance ecosystem functioning, ecosystem connectivity (see more on page 180) and productivity. Simultaneously, it requires understanding how our own skills and resources may engage with current natural cycles and surrounding social contexts (local community) to meet both our own needs and those of the place. This two-fold understanding is the basis for a successful management of social and ecological resources, including people, water, soil and biodiversity, enabling to also establish good relationships with the local community.

You can consult Andrew Millison's Oregon State University video (Introduction to Permaculture Site Analysis) on site analysis for further info or Aranya's Permaculture Design book.

2.3.2 WATER MANAGEMENT

Water is a critical resource in any farm, so its effective management is fundamental to ensure the productivity and functioning of the whole system for both current and future generations. Four distinct water sources must be considered in design: rainwater, groundwater, wastewater and water runoff within and around the farm. The aim is to capture water by holding it on site, preserving its quality and assisting its infiltration in the soil, so it reaches plants' roots and groundwater reservoirs: we should assure to replace more than what we take. This requires understanding precipitation patterns as well as surface water movements, by considering the land topography and identifying contour lines (see more on page 179), so one may slow down water runoff, channel it through the system and/or create ideal soil conditions for water infiltration. Additionally, it is necessary to preserve water quality, recycling and purifying water by integrating biological water treatment systems (e.g. plants that remove toxins from water) while avoiding leaching of nutrients (see more on page 183) and chemicals. Identifying water patterns and protecting water quality will allow the creation and maintenance of diverse habitats, including polyculture lakes, which sustain both local biodiversity and farm productivity.

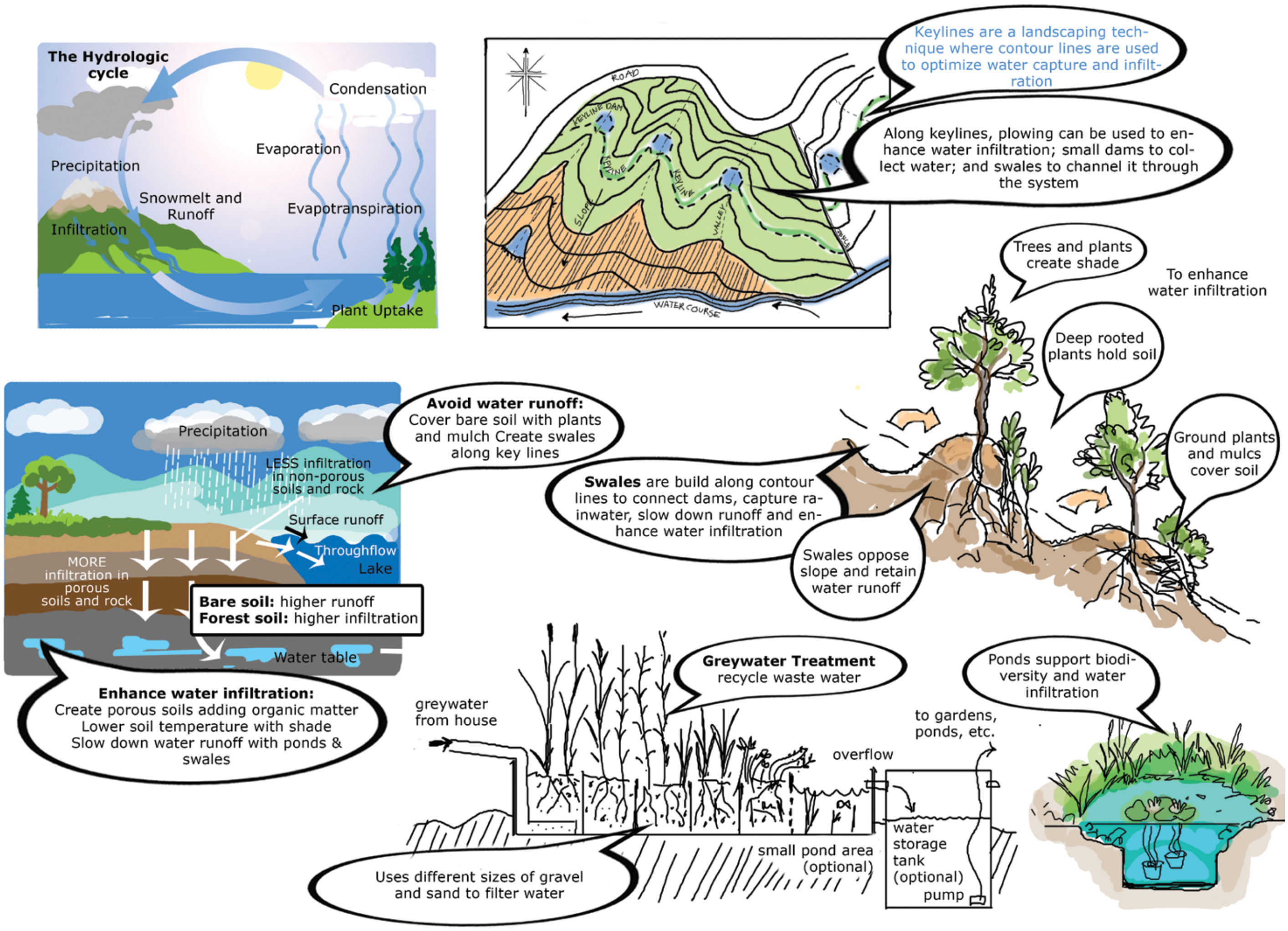


Figure 2.18: Water management. Source: Joana Canelas, adapted by Júlia Csibi

For an effective water management one must consider how to best: (1) capture and store water, for example by building small dams to create natural water reservoirs in strategic places and harvesting rainwater from roofs; (2) effectively channel water, for example by creating swales (see more on page 188) along keylines (see more on page 183), which retain and lead the water through the site, including biological water treatment systems to recycle and clean wastewaters; and (3) enhance water infiltration in the soil, by slowing down water runoff, retaining water in swales and ploughing along keylines. Ultimately, water infiltration will determine water availability in the long-term and it largely depends on soil type and temperature, so it is important to add organic matter to the soil and provide shading with trees and plants or, if this is not possible, cover soil with mulch to aid infiltration. Always avoid bare soil!

You can consult Andrew Millison's Oregon State University video (Open Oregon State | Drought Proof Farms Course Intro) on Permaculture water design & management or the Permaculture Research Institute's site.

2.3.3 SOIL MANAGEMENT

The second most critical resource in any farm is soil, the basis of all above and underground life. Three fundamental ecosystem functions of soil include nutrient cycling, by transforming organic matter and making nutrients available to plants; sustaining biodiversity (see more on page 177), by supporting microbial and plant life; and climate and water regulation, determining water infiltration rates, potential risk of droughts and underground carbon storage. Good soil management aims to support soil functions by working with physical, biological and chemical indicators to understand soil characteristics, identify imbalances and design effective strategies to enhance soil quality, health and fertility while minimising soil erosion.

Soil physical indicators convey the soil structure, composition and porosity, providing insights into soil profile and water infiltration rates. Chemical indicators give information on soil pH and nutrients available, including carbon, nitrogen and phosphorus. And, finally, biological indicators disclose soil biomass content, enzymatic activity and biodiversity, including micro-organisms, earthworms and nematodes, responsible for organic matter decomposition and nutrient availability. Notably, observing plant distribution and characteristics, including morphology, abundance and overall health may provide important physical and biochemical indicators. Certain plant species can be marvellous soil indicators, assisting to identify the soil profile, pH, water availability and nutrient deficiencies.

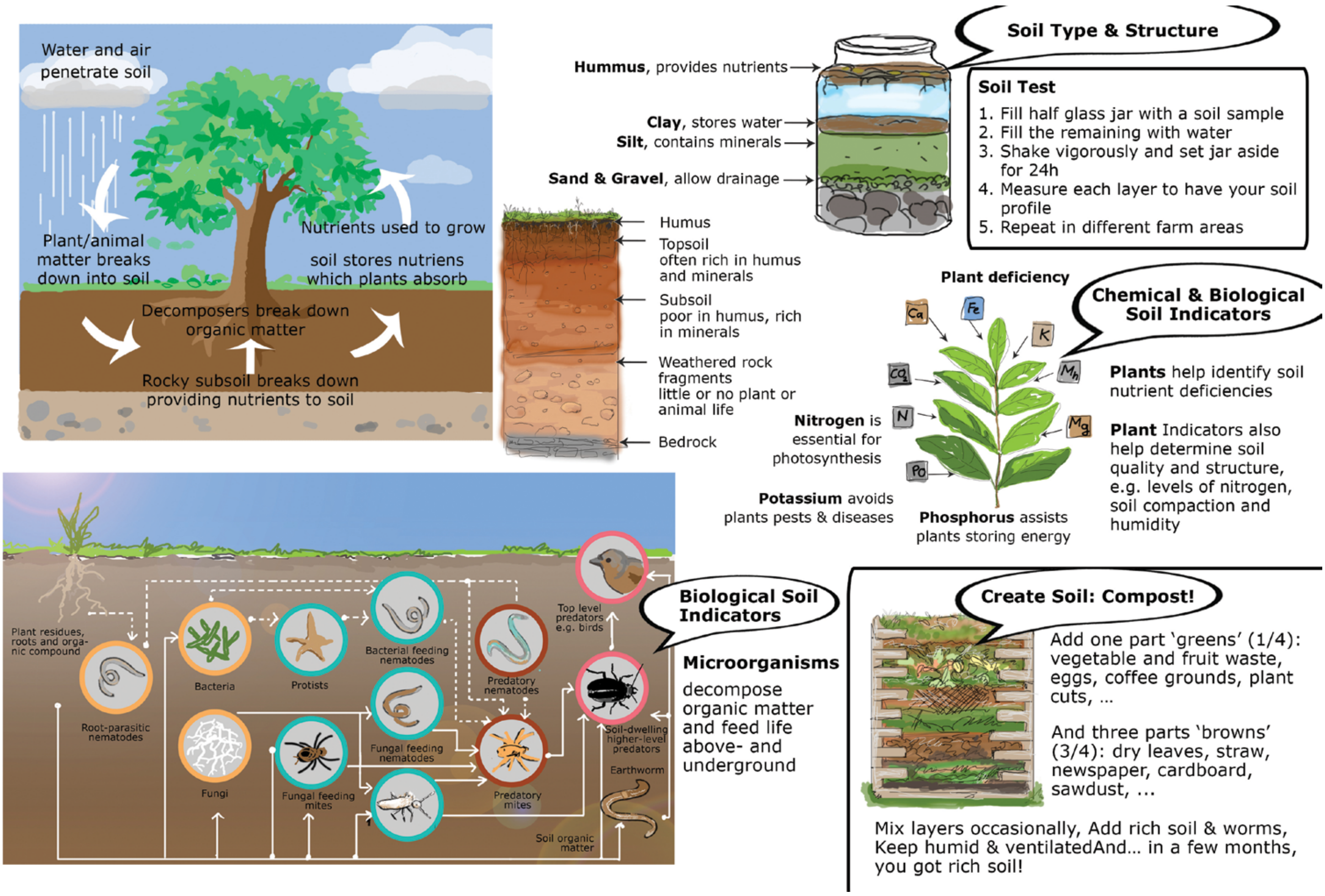


Figure 2.19: Soil management. Source: Joana Canelas, adapted by Júlia Csibi

Sustainable soil management strategies should always try to minimise soil disturbances, preserving soil structure by reducing tillage; increase nutrients availability, by supporting microbial life and maintaining or adding organic matter; and reduce soil erosion, by conserving living roots in the soil and always covering soil with plants or mulch. Strategies to enhance soil quality and minimise erosion may pass by introducing certain plant species, such as nitrogen fixing plants (e.g. in Fabaceae family) to improve nutrient availability or deep rooted plants (e.g. trees and shrubs) to increase soil porosity and water infiltration. Adding kitchen compost, animal manure or other organic mulching to the soil will also significantly improve its biomass content, nutrient availability and microbial life while enhancing soil insulation and water infiltration. Healthy soils provide for healthy plants and happy farmers!

Some further resources on soil management: Tobias Roberts's article (A Primer on Creating Soil) on the PRI site, article on Permaculture Apprentice site on building deep, rich soil, and Geoff Lawton's video on soil fertility management.

2.3.4 ECOSYSTEMS, BIODIVERSITY & HUMANS ROLE

Ecosystems are complex webs of interdependent species, where each ecological function is maintained by several elements and each element performs several functions. Species diversity, or biodiversity supports ecosystems' redundancy (see more on page 185) and multifunctionality, being crucial for its adaptation to disturbances, such as pests and extreme climatic events. When disturbances occur, complexity is broken and diversity will increase the options to maintain ecosystems functioning. Disturbances lead the ecosystem to reorganise, gradually integrating new elements to fully restore ecological functions and increase diversity again (e.g. through forest succession). Designing farms to mimic nature means reproducing redundancy and multifunctionality, embracing the humans' role sustaining ecosystems by adopting strategies to accelerate ecological succession (see more on page 188), increase site biodiversity and support species interdependence. By respecting abundance (i.e. use what is already available), diversity (i.e. everything has its function) and reciprocity (i.e. taking requires giving back), we are recognising human's ecological roles while, ultimately, sustainable farming (see more on page 188) is about creating resilient and productive ecosystems!

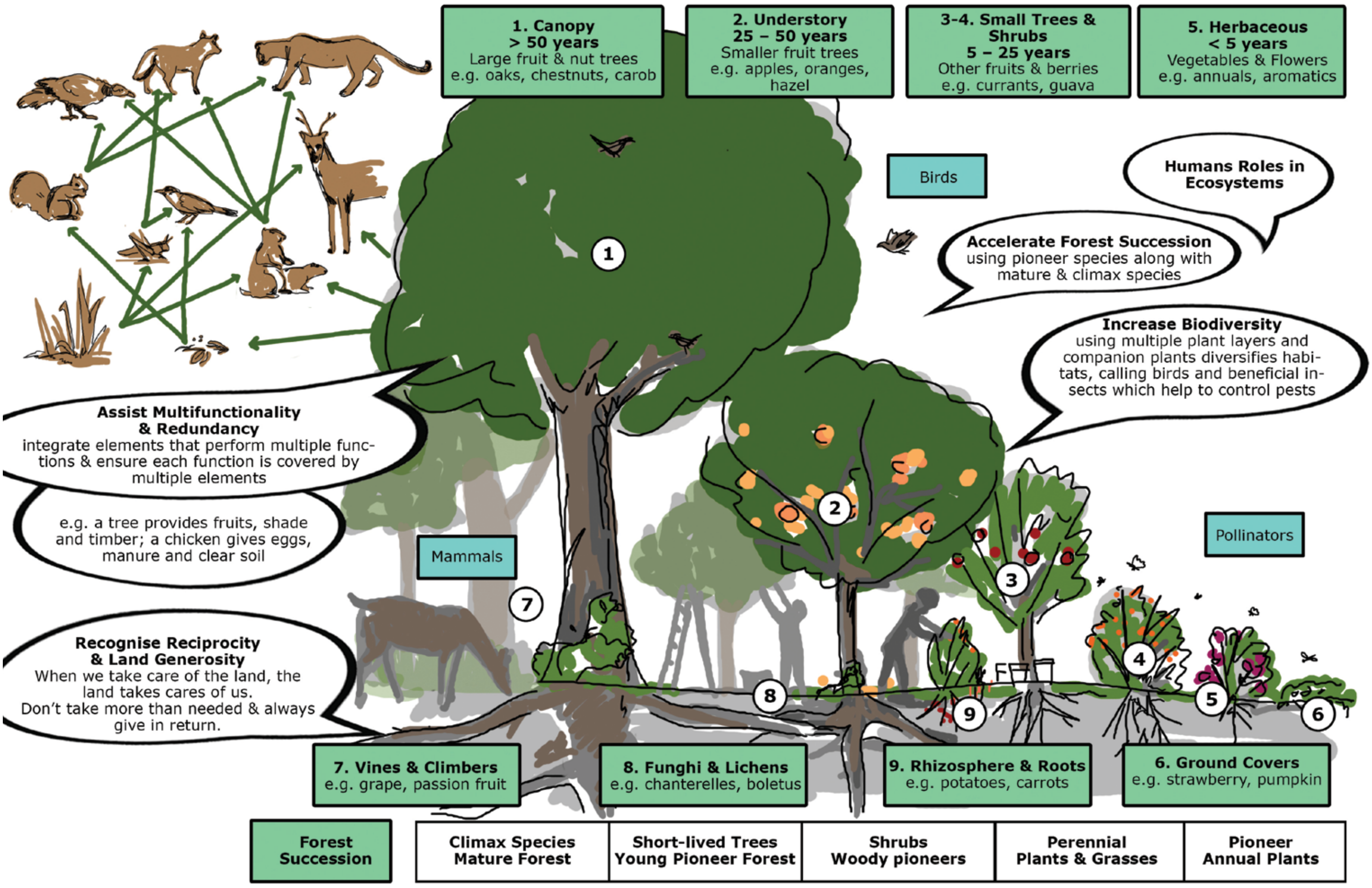


Figure 2.20: Ecosystems, Biodiversity & Human Role. Source: Joana Canelas, adapted by Júlia Csibi

The farm's sustainable management requires working effectively with time, space and energy inputs to foster resilient ecosystems, increase productivity and support biodiversity. A good strategy is to choose polycultures and implement agroforestry or forest garden systems. Integrating the nine layers of an agroforestry ecosystem, from the canopy to the rhizosphere (see more on page 186), enables the intensification of production by optimising spatial use (both vertically and horizontally) while increasing redundancy, diversifying habitats, minimising pests and reducing energy and labour requirements over time. Yet, such systems require understanding how each plant interacts with others, providing nutrients, creating microclimates and attracting pollinators. Introducing plant guilds, where each plant uses distinct resources so they may fit in the same area, or companion plants, which enhance each other's growth and health by providing complementary nutrients, are great strategies. Here, aromatic plants may also play a role by inviting beneficial insects and pollinators while some may be useful to repel pests. A key example of plant guilds is the three sisters, a traditional polyculture strategy combining the production of corn, legumes and pumpkins, where corn provides structure for beans to climb and the squash covers the soil, preserving its moisture and suppressing weeds. Diversifying cultivars, including both perennial and annual plants, assists good soil and water management strategies, while fostering biodiverse ecosystems that are resilient to disturbances and may be designed to produce different foods all year-round.

2.3.5 INTEGRATED EXAMPLES OF PERMACULTURE PRACTICES: FARM ZONES & SECTORS

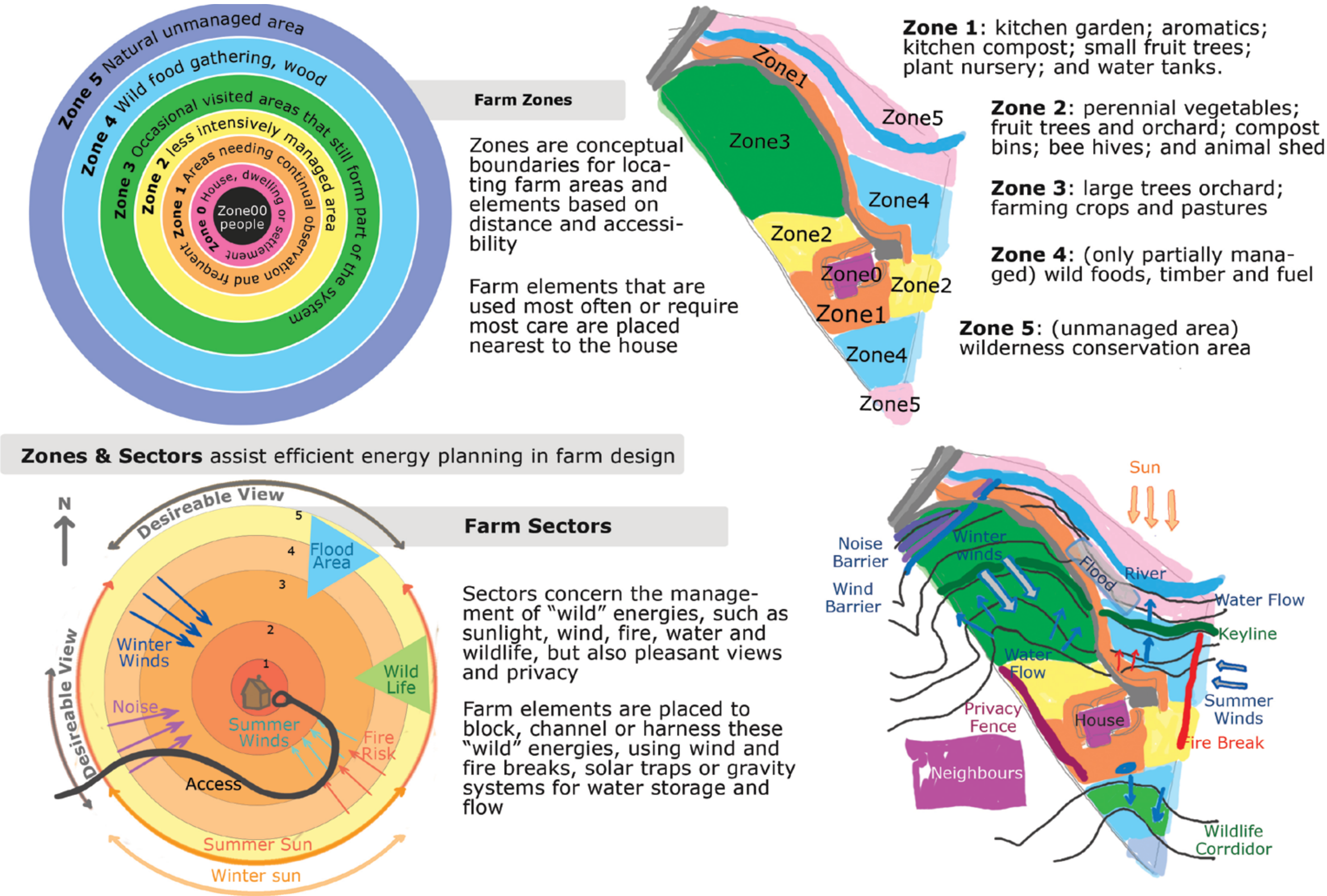


Figure 2.21: Integrated Examples of Permaculture Practices. Source: Joana Canelas, adapted by Júlia Csibi

Integrating the human element in the farm's design, considering both our own needs and those of each farm element, entails recognising farm sectors and defining farm zones. These are management areas, with conceptual boundaries, which take into account internal (e.g. human labour) and external factors (e.g. incoming energies) to optimise the farm design and minimise potential risks. First, identifying farm sectors requires analysis of external environmental influences, locating main energy flows through the site and incorporating strategies to deal with these 'wild energies' (e.g. wind, sunlight, fire, flood or wildlife) in order to avoid their hazards or harness their opportunities. Farm sectors convey the site's relationship with these external influences, assisting the management of water, soil and biodiversity by informing where key farm elements may be located to avoid major risks (e.g. house location), block undesirable factors (e.g. placing fire, wind or noise breaks), work with natural energy flows (e.g. topography and water gravity systems) and channel or store beneficial energies (e.g. creating sun traps and water storage facilities).

Second, farm zones are designed according to their use and management intensity, such that distinct farm elements' are located considering their distance to centres of human activity (d) and the frequency of their use or labour requirements (f). One may distinguish 6 zones in design, namely: zone 0, as the people and housing structures; zone 1, easy access areas which demand continuous attention or daily use and maintenance (e.g. kitchen and aromatics garden, greenhouse and worm farms); zone 2, frequently used areas which require slightly less attention (e.g. orchards, beehives and poultry sheds); zone 3, farmland areas with only minimal maintenance (e.g. farming crops, livestock pastures and larger trees orchards); zone 4, area only partially managed and used to collect timber, wild foods or animal forage (e.g. coppicing forest); and zone 5, unmanaged area allocated to nature which serves as wildlife conservation area and source of inspiration (e.g. forest and wildlife corridors). Thus, farm areas able to self-maintain themselves tend to be located further away from the house while, to optimise energy requirements, the total area allocated to them is usually inversely related to their management needs (i.e. less managed areas are larger).

For further info on zoning & sectoring you can consult Oregon State University Andrew Millison's video (Permaculture Design by Sectors), also Geoff Lawton's video on Integrated System Design.

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ECONOMIC STRATEGY AND BUSINESS MODEL

Authors:
Paulina Jancsovszka, Csaba Szűcs, Gergely Rodics

3.1 INTRODUCTION

Although agroecology (AE) is perceived mainly as a means of strengthening the environmental function of agriculture, the economic reality cannot be ignored. The farmer is usually the one implementing agroecological measures, whereas the agricultural farm or agricultural landscape are usually the environment where these measures are implemented. Farmers working according to the principles of agroecology must also be economically efficient and sustainable. However, the emphasis on environmentally friendly approaches and a holistic approach to farming in general sometimes appears to slow down or complicate the achievement of economic efficiency through conventional methods. It is necessary to incorporate elements of agroecology into the economic side of an agricultural business and use them in all possible aspects of the business whenever achievable.

However, the farmer is often tied to activities and duties that are directly related to farming and agricultural activities, and it can be difficult for a farmer to devote a lot of time and effort to creating classic business plans (see more on page 178). This also applies to farmers who are engaged in agroecological approaches to farming, perhaps even more so because, in addition to the agricultural pillar, they also pay attention to the environmental and often social pillars within agroecology. At the same time, agroecological forms of farming are more often implemented by smaller agricultural units such as family farms, where personnel issues further limit the possibility of devoting too much time to creating and modifying classic business plans. Alternative models, such as the Business Model Canvas (BMC) (see more on page 178), can be a suitable solution.

Agricultural entrepreneurship requires innovative solutions in many fields - designing a business and developing a strategy is no exception to this. Business strategy (see more on page 178) can be defined as a long-term plan facilitating the achievement of the enterprise's goals and objectives. For the sake of the achievement of the business goals, every entrepreneurial activity has to create and deliver value in the economic, social, cultural, or other context. As part of strategy development, a concrete business model (see more on page 178) defines the value proposition for customers.

The aim of the "Economic strategy and business model" module is to provide farmers and rural entrepreneurs with a simple tool that helps them visualise the structure and main features of their organisations. Using the Business Model Canvas (BMC) methodology, learners can be enabled as decision-makers to have a transparent view of their business/project and to be able to identify the interrelations between its different elements, while detecting the possible weaknesses of their business model. This process aims to complete and clarify in detail a working business plan, simply and effectively. The BMC is especially applicable to a comparative analysis of the impact that investment increases may have on contributing factors. Using the canvas, farmers can evaluate traditional processes and bring agroecology-related innovation into their business models. The canvas can be quickly prepared, easily extended, flexibly shaped and used by start-ups (see more on page 186) as well as non-profit organisations. It is possible to adapt the BMC to different types of farmers and settings. For farmers willing to apply AE practices, the usefulness and necessity of the BMC should be made clear. Accordingly, the module exemplifies the building blocks of the Canvas through different business situations in terms of agricultural production and marketing - with the agroecological approach as one of the most important value-adding factors.

The BMC presented in this chapter allows farmers as well as other actors to create a business plan with a clear presentation of the added values of agroecology. At the same time, if we sufficiently take into account the elements of agroecology in the creation of a business plan, we reduce the risk that an excessive focus on economic efficiency will begin to suppress the environmental pillar of farming and weaken the environmental benefits of agriculture based on agroecological principles.

3.2 BUSINESS MODEL CANVAS

A business model describes the rationale of how an organisation creates, delivers and captures value in different aspects (economic, social, cultural, etc.).

The Business Model Canvas (BMC) is a strategic management tool that helps organisations to design, overview, analyse and understand their business models. BMC aims at visualising and assessing the business idea of the entrepreneur. Osterwalder and Pigneur (2010) define the BMC as "the most common and widespread tool for business model innovation". BMC is a simple, one-page template that contains nine building blocks representing the essential elements of the business. The value proposition occupies the centre of the canvas. The right side of the canvas focuses on choosing, delivering and capturing value, while the left side emphasises value creation. (Figure 3.1)

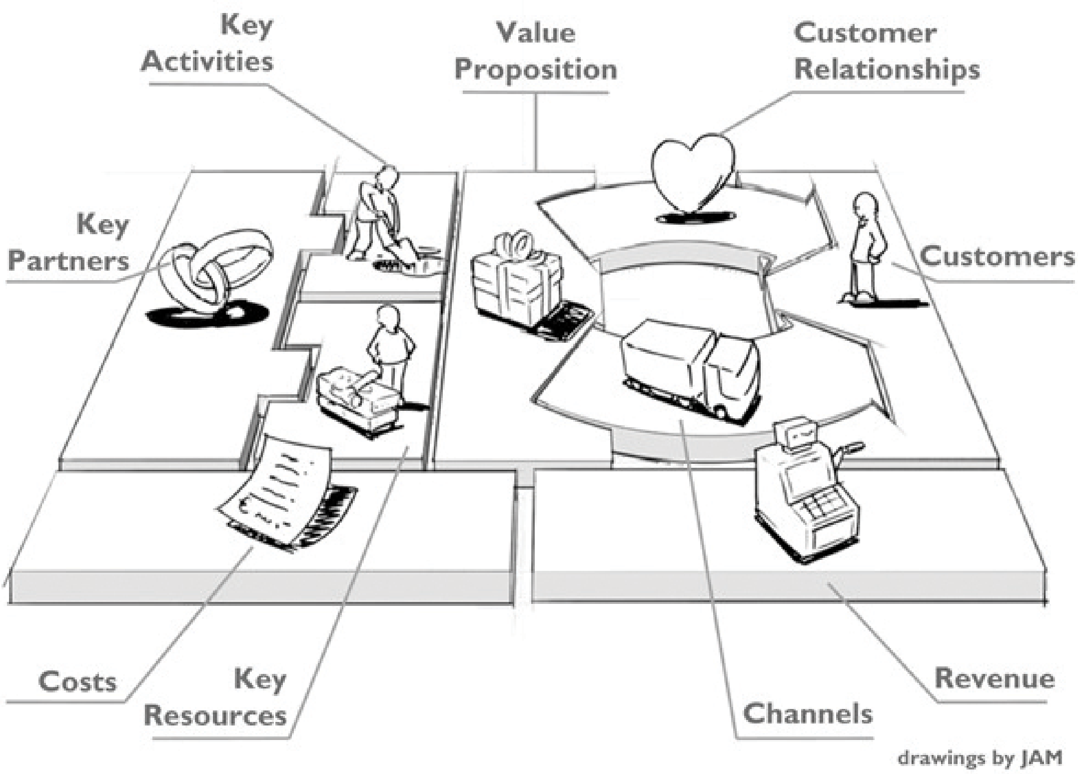


Figure 3.1: Business Model Canvas. Source: Osterwalder & Pigneur, 2010

Brief explanation of the BMC can be found at the links below:
BMC basic introduction video: Business Model Canvas Explained
BMC introduction through the example of LEGO (video): Design and innovation tool: the Business Model Canvas, how does it work? (e.g. LEGO)

Due to the universality and non-industry specificity of BMC, currently, it is widely applied. Therefore, this tool can also be used in agriculture by farmers who already operate or are willing to operate their farms following agroecological principles. While designing the canvas, farmers can evaluate traditional processes and bring agroecology-related innovation into their business models. Beside the for-profit business goal, these farms also have important environmental and social functions, thus resonating with the Triple Bottom Line (TBL) approach. The latter term, created by John Elkington in the 1990s, refers to a sustainability framework evaluating (measuring) the performance of organisations. The TBL approach consists of social equity, economic benefits, and environmental quality. Its three elements: people, planet, and profit, commonly called the three Ps, represent the three dimensions of sustainability. (Figure 3.2.)

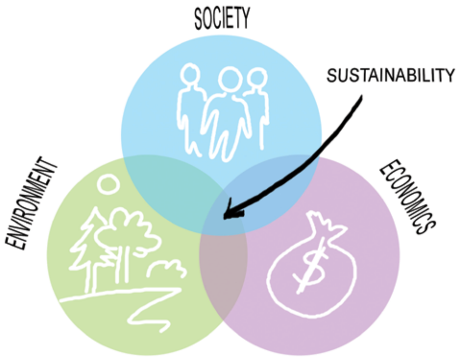


Figure 3.2: Triple Bottom Line Approach: People, Planet, Profit. Source: Romdhani et al., 2018. Adapted by Júlia Csibi

Therefore, for agroecological farms an enhanced business model inspired by the "triple bottom line model" - called the "sustainable business model" (see more on page 188) - can be applied. Both names take into account the environmental and social aspects of the business in addition to the financial ones. (Figure 3.3) This is done by extending the canvas with two new building blocks or two extra layers: social and environmental.

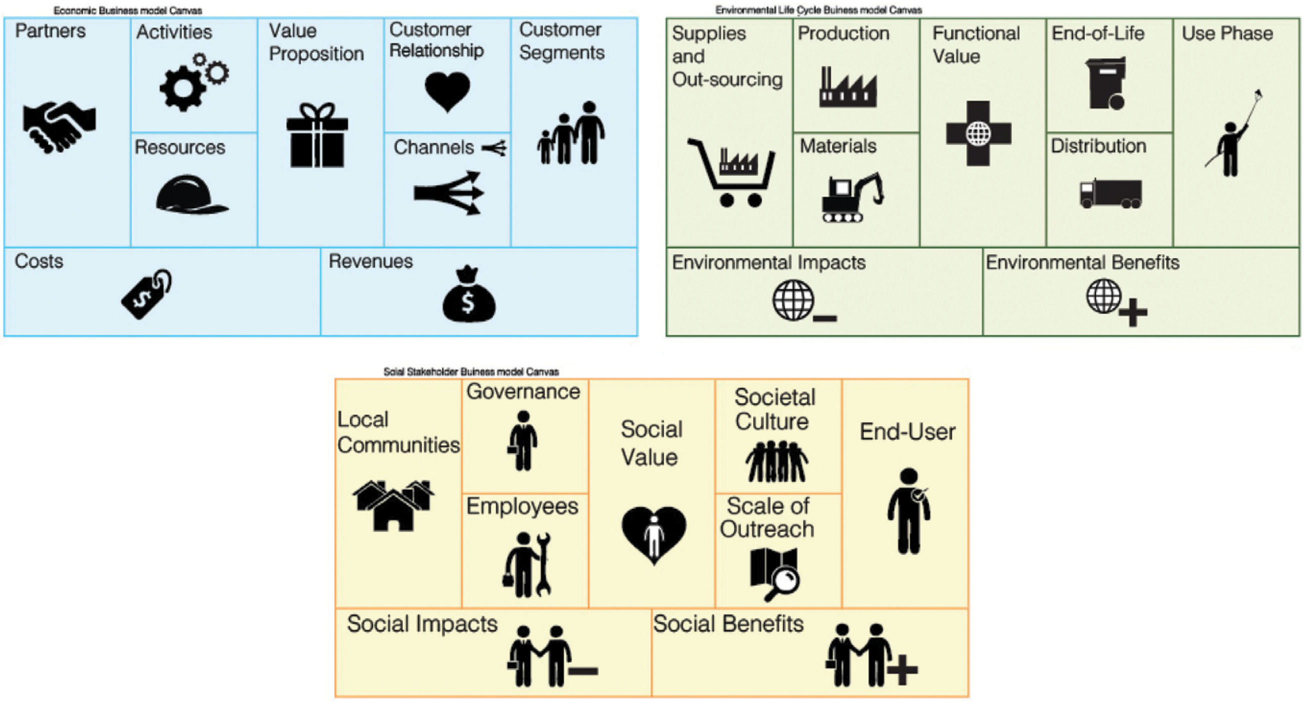


Figure 3.3: Triple Bottom Line Business Model Canvas. Source: Joyce et al., 2015

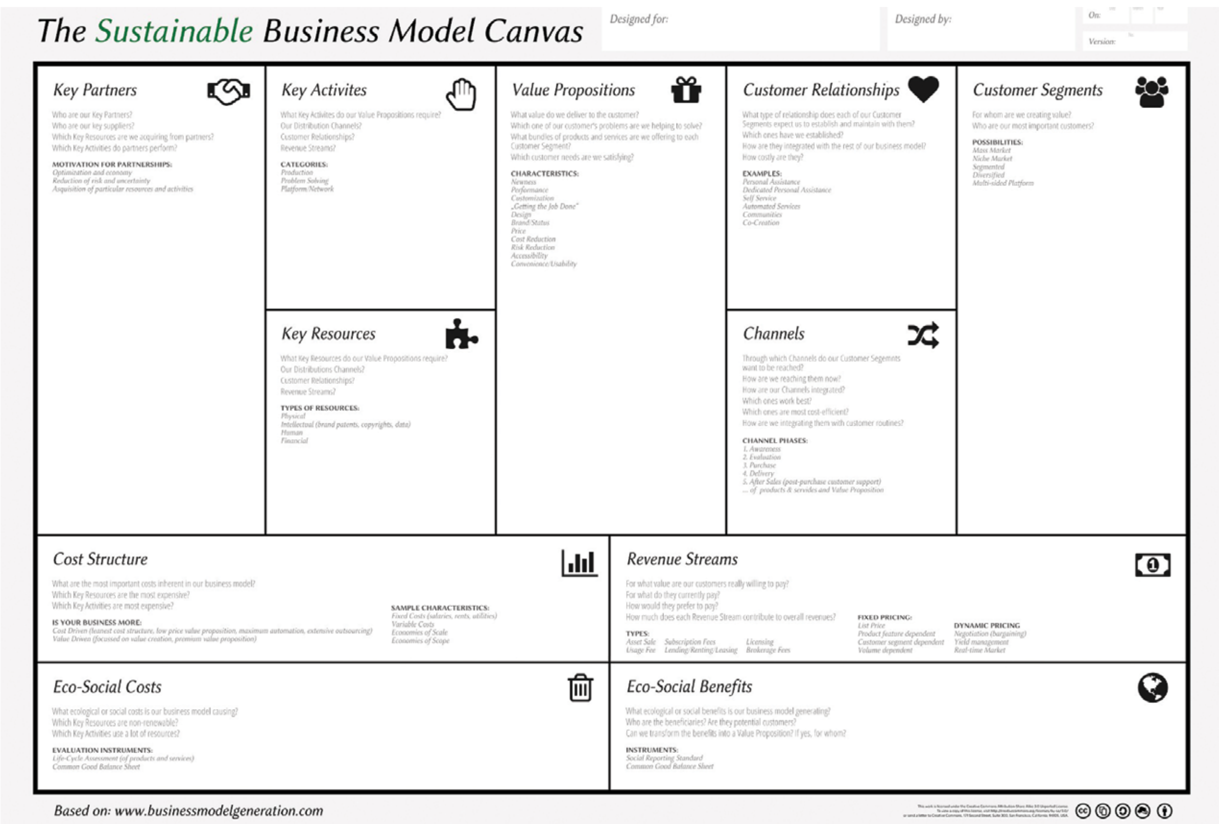


Figure 3.4: Sustainable Business Model Canvas. Source: https://www.strategyzer.com/canvas

For further details please go to:
Sustainable BMC introduction video ("extra blocks"): The Sustainable Business Model Canvas, 11 Steps to designing a successful sustainability strategy
Sustainable BMC example video ("extra blocks"): Business Model Canvas Example, Interface Case study on Sustainable Business Model Innovation
Triple-layer BMC - ("extra layer"; starting at 32:07): Lecture Triple Layer Business Model Canvas and Circular Economy

3.2.1 CUSTOMERS AND VALUES

CUSTOMERS

Customer Segments refer to groups of individuals or businesses that an organisation aims to reach and serve. The **important questions to ask concerning** this block are:

- Who is the value created for?
- Who are the target customers?
- Who may be the most important users or customers?
- Are the aims focused on mass markets or niche markets?
- How to deal with negative buyers?

It must be understood from the very beginning that no business can survive without customers, thus properly satisfying their needs is indispensable. In order to do so, segmentation should be done for example on the basis of common needs or common behaviour of the distinct groups. Groups can be considered distinct if:

- an individual Value Proposition is required to satisfy their needs,
- these groups can be reached by means of different Distribution Channels,
- different types of relationships are necessary,
- profitability is fundamentally different,
- they are interested in different aspects of the Value Proposition.

Not all segments are equally important, some can/must even be ignored. ABC analysis is a possible tool to assess the segments. The business model can only be designed properly if we are aware of the specific customer needs and know how to satisfy them. There are a number of different types of customer segments, for example:

When the Value Propositions, Distribution Channels, and Customer Relationships consider only one large group of customers whose needs, expectations, problems, etc. are somewhat similar, it indicates the mass market business model.

On the other hand, a niche market serves specific, specialised Customer Segments. In this case, the Value Propositions, Customer Relationships, and Distribution Channels are adjusted to the special needs of the niche market.

There are certain market segments for special products that few producers grow, partly because of the risk of production and partly because of export opportunities. Within these niche markets it is possible to obtain remarkable profit if production is organised properly. Producers must have a solid background, as it is not easy to produce in harmony with AE principles: they need to be aware of ever-changing conditions and of how production itself can run into difficulties.

Producers who apply AE principles create value for customers who are health-conscious, want to protect biodiversity, seek excellent products, and have high expectations. The target groups for agroecological farming are growing. It is important that the target group has an adequate income, because goods produced in harmony with AE principles can be more expensive than conventional goods. According to research conducted by Loconto et al. (2018) the main market forms of AE farms are direct sales, farmers markets, eco fairs, open-air markets, restaurants and hotels, and one of the greatest obstacles AE farms face is logistics, which indicates that the potential customers of agroecological farms are also local. This, however, depends on the development of suitable distribution channels.

According to the Agricultural and Rural Convention (2018) consumers are increasingly aware of the negative impacts of conventional farming. They can become "co-producers of the food they eat" and "are not just consumers but also food citizens operating on the local, regional, national and international levels".

However, there can also be negative buyers in the market who bargain, criticise and belittle the goods. They must be convinced with facts and educated to be good buyers, including by the farmers themselves - after all, it is in the interest of producers to have a solid customer base.

VALUE PROPOSITION

According to the definition of Lanning and Michaels (1988) the Value Proposition is „a clear, simple statement of benefits, both tangible and intangible, that the farm will provide, along with the approximate price it will charge each customer segment for those benefits." Therefore, the Value Proposition identifies the benefits that the farm's product(s) or service(s) will deliver to the customers. It can be considered as an opportunity to inform customers why the farm/organisation, its product or service is the best one to purchase and why it can meet customers' needs in the best way. A well-designed Value Proposition will differentiate the company, its product or service in the market. It needs to be crafted so as to be memorable and work on various platforms, from company websites to promotional materials.

The Value Proposition should be easy to understand as this helps customers to remember it. Accordingly, the Value Proposition can be interpreted as a way to gain competitive advantage by winning customers, building loyalty, and boosting sales.

While some Value Propositions may be related to existing products or services with added attributes, others could be innovative, representing a new offer. The key is to identify the customers' needs and to find ways to satisfy these needs.

Even though each Value Proposition has to be unique, it usually contains many of the same key elements: headline, sub-headline, and text paragraph (with a visual).

- **Headline**: What is the end benefit offered in one sentence? (N.B. the Value Proposition is not a slogan, catchphrase, or positioning statement!)
- **Sub-headline**: or a short text: A specific explanation of what is offered, for whom, and why it is useful.
- **Bullet points**: List of the key benefits or features.
- **Visual** (photo, graphics): in order to reinforce the main message.

A good Value Proposition is clearly defined, quickly and intuitively understandable and avoids hype, superlatives, and business jargon.

Key questions to check:

- What value is delivered to the customer?
- Which of the customers' problems are dealt with?
- What bundles of products and services are offered to each Customer Segment?
- Which customer needs are the focus on?

It is important to emphasise that the Value Proposition may induce changes in the other building blocks (e.g., in Key Activities in order to adjust to a newfound Value Proposition).

For farms already applying or willing to apply AE principles in the future, most values are related to public benefits, including healthy and high quality food, social and environmental benefits, as well as close relationships with consumers. Consequently, the Value Proposition needs to focus on added environmental, social, and ethical values of agroecological farming.

In this case, although the Value Proposition is mainly qualitative (related to the social and environmental performance of the farm), it could also be quantitative (e.g., cost reduction when using their own seeds or compost) or innovative (e.g. human-centred innovation – social farming).

Value Proposition - example

Quality of food
Newness of the concept
Sustainability
Access to local products
Environmental benefits (positive externalities/public goods)
Social benefits
Fashionable lifestyle
Competitive price
Good relationships with customers

How to create a value proposition canvas, please view the following video: Strategyzer's Value Proposition Canvas Explained

CHANNELS

Channels (categorised as communication, distribution, and sales channels) are an organisation's (e.g. farm's) interface with customers. Channels serve as key touchpoints determining the customer's satisfaction. They play an important role in defining the customer experience.

The Channels building block of BMC outlines how a company communicates and reaches its Customer Segments to deliver the Value Proposition. It is indispensable to understand which channel is the best to reach the different customer segments.

Communication channels (traditional and social media, website, communities) aim to:

- raise awareness about your business and product or service,
- communicate the Value Proposition,
- influence customers to buy the product,
- persuade customers,
- maintain a relationship with customers after purchasing the product or service,
- tell your customers why you do what you do and why it makes so much sense

Please visit the following video for more details on the Golden Circle by Simon Sinek: https://www.ted.com/talks/simon_sinek_how_great_leaders_inspire_action?language=hu.

A **distribution (marketing) channel** is the link between production and consumption. It can be defined as a network through which the end consumer gets the product or service from the producer. An organisation can reach its customers through its own channels, partner channels, or through a mixture of both.

Own Direct Channels can be the sales force or website, or a farm shop owned or operated by the organisation. This type of channel provides a direct relationship with customers that results in higher profit margins. At the same time, in terms of infrastructure development, more investment is needed and their operating costs could also be high.

Partner Channels are indirect and cover a number of options, such as wholesale distribution, retail, or partner-owned websites. They result in lower margins, but an organisation can benefit from partner strengths and expand its reach.

Choosing the right Channel or Channel mix is essential for bringing the Value Proposition to market. While deciding about the appropriate channel, several factors have to be taken into account, such as number of customer segments, investment required, and whether the product is standard or not (e.g. a non-standard product would more likely be sold through a direct channel).

Five Channel phases can be distinguished:

1. **Awareness**: How / where / when do customers get to know about the products / services? How can awareness be raised about an organisation's products and services? (Advertising e.g. Word of Mouth, Social Media, Newspapers)
2. **Evaluation**: How do customers make up their mind? What assistance can be provided for customers to help them evaluate Value Propositions? (e.g. surveys, reviews)
3. **Purchase**: How do they buy? How do they pay?
4. **Delivery**: Where do they prefer to buy?
5. **After sales**: How can customers be assisted after sales? (post-purchase customer support)

Key questions to check:

- Through which Channels do Customer Segments want to be reached?
- How can they be reached?
- Which ones work best?
- Which ones are most cost-efficient?
- How can they be integrated into customer routines?

Both long and short food supply chains can be considered in agroecological farming. Since short food supply chains represent traditional and/or alternative ways of producing, distributing, retailing, and buying food, they are a great pathway and target for agroecological farmers.

Both direct and indirect channels where online, offline, and community marketing may come into play can be chosen.

Direct channels: on-farm sales, door-to-door sales (online sales, orders via telephone or permanent orders like box schemes), farmers markets, fairs, farm shops. Thus, traditional (e.g. farmers markets, farmer halls, farm shops) as well as new forms of traditional short food supply chains (box schemes, community supported agriculture schemes, webshops, consumers groups) are applicable.

A farmer willing to engage in direct sales has to take into account that an investment in processing, storage, and distribution facilities will be needed.

Indirect distribution channels: wholesale and retail (super- and hypermarkets, specialised health food stores).

It appears that small-scale farmers mostly prefer direct channels.

CUSTOMER RELATIONSHIPS

This building block of Customer Relationships (CR) describes the types of relationships a company can establish with specific Customer Segments. The type of relationship the company intends to establish with each of its Customer Segments should be clearly identified since there is a variety of options ranging from personal to automated ones or from transactional to long-term options, which may be driven by motivations such as:

- Customer acquisition,
- Customer retention,
- Boosting sales (up-selling).

There are a number of **key questions** that may be asked:

- What type of relationship does each Customer Segment expect?
- Which ones have been established?
- How costly are they?
- How are they integrated into the rest of our business model?

Customer Relationships are established through different Channels and it is important to understand that the overall customer experience is influenced by the type of Customer Relationship applied.

For farms that are already involved in or are planning to get involved in agroecological farming this means that they must create close connections with existing and potential consumers in order to be beneficial for the local economy. This can be achieved through reliable links between local farmers, local retailers, and local consumers, short supply chains such as farmers markets where producers can meet consumers, which creates stronger relationships between producers and consumers as well as a strong commitment to the local economy.

For each particular Customer Segment different types of CR may be distinguished that often co-exist. Customer Relationships can be:

- Transactional,
- Long-term,
- Personal assistance,
- Dedicated personal assistance,
- Self-service,
- Automated services,
- Communities,
- Co-creation.

If a Customer Relationship is Transactional, the interaction between a company and its clients takes place on a transactional basis, which means that there is no real opportunity to create a meaningful relationship, at least in the short term. Nonetheless, it may serve as a basis for improved relationships. If a stand at a market is considered, it can be understood that a transactional based relationship will be a shallow one.

When interaction is more developed and takes place repeatedly, long-term and more thorough relationships may develop.

The situation when customers are offered the chance to communicate with real customer representatives before, during, or after the transaction takes place, can be referred to as Personal assistance. Personal assistance does not necessarily have to happen in person at the point of purchase (POP) as help may be provided through e-mail, telephone, or any other forms. For applying AE principles, however, personal communication should be preferred.

A higher level and more committed form of CR is called Dedicated Personal Assistance, which involves a customer representative specifically dedicated to an individual client. This type of relationship may need an extensive period to develop and is usually offered to high value, important customers.

It may happen that a company does not have any direct contact or relationship with its clientele but provides all the necessary help for its customers to serve themselves. This type of relationship is called Self-service.

Automated services combine semi- or fully automated services with self-service, which requires sophisticated technology since the profiles of individual customers are automatically recognised. As a result, information on previous orders and/or transactions are revealed and on the basis of that offers and recommendations can be made concerning future purchases.

Communities enable companies to have better connections with the members of these communities and also to better understand their existing or potential customers. Community members have the possibility to exchange information, gain knowledge, provide feedback, express requirements, and if necessary, have their voice heard. These days, communities are often organised online.

An increasing number of companies invite their customers to co-create value through for example reviews and feedback for product development or improvement.

Apart from the above-mentioned traditional methods there are more modern solutions that may be worth considering for companies working in agriculture.

Online Communities can be created by companies so that the members can get involved in creating and facilitating connections among the members, exchanging information, or solving problems. The real benefit of these communities is that companies can have better knowledge of their customers and also that customers can feel connected to the company.

An even further step can be Co-creation, by which customers are enabled to get involved in for example designing new and innovative features of products (or new and innovative products), in this way value is created with the help of customers.

Producers create products and pass them on to consumers who may include other producers and end-users. The role of customers is decisive. After taking into account a lot of information, the customer's decision is ultimately made in the customer's "black box".

EXTERNAL STIMULI		BLACK BOX OF CUSTOMERS		PURCHASE DECISION
Marketing	Environmental factors	Buyer features	Purchase decisions process	
Product Price Distribution channel Sales promotion	Economic Technological Political Cultural	Cultural Social Personal Psychological	Problem recognition Collection of information Evaluation Decision Post-purchase behaviour	Product selection Brand selection Dealer selection Timing Determining the amount spent on purchases

Table 3.1: A model of purchasing behaviour. Source: Kotler, 2004

Marketing stimuli are generated by companies and the sales of their products are influenced by prices and incentives. External stimuli and environmental effects are important.

The environmental impacts include, but are not limited to:

- economic framework conditions,
- price and income conditions of the national economy,
- social and demographic characteristics,
- political and legal context, and
- the infrastructural conditions.

Buyers have cultural, social, personal, and psychological characteristics. Cultural characteristics influence shopping. Culture is a set of learned beliefs, values, and habits that guide consumer behaviour in a given society. Therefore, it is important to know the process of purchasing decisions in order to build a strong relationship with our target audience.

The purchase decision process is as follows:

1. Problem recognition,
2. Collection of information,
3. Evaluation of alternatives,
4. Purchase decision (or rejection of the decision),
5. Post-purchase behaviour.

The behaviour of the buyers is shaped by external and internal influencing factors. In the consumer market the decision-making process is divided into five distinct stages:

1. Problem recognition means bringing a need to the fore.
2. The consumer strives to obtain as much information as possible to make a good decision.
3. It is advisable to systematise information about the product, brand, or related services. The decision is often made on an emotional basis, with habits playing a key role.
4. The decision applies to the selection of the product or service, the choice of brand and the place of purchase.
5. In the final phase (post-purchase behaviour), the consumer evaluates the purchased product (usefulness of the product, satisfaction delivered from the product, value of the product with respect to the need fulfilment of the consumer).

Due to a high price or an unexpected event, the buyer may cancel the purchase. After the purchase, buyer satisfaction can result in an enhanced relationship.

When examining the specifics of the consumer and organisational markets, a number of differences can be observed based on the elements of demand, purchasing decision, and the marketing mix.

CRITERIA	CONSUMER MARKET	ORGANISATIONAL MARKET
Buyers	Final consumers, individuals, households	Companies, enterprises
Buyers Purchase decision	One person decides	Group decision
Number of customers	Lots of big mass markets	Few customers
Price of the products	Prices set by the market	Cost-oriented price negotiations
After-sales services	Rarely needed	Indispensable
Promotion	Advertising and sales promotion are typical	Personal sales are typical

Table 3.2: Consumer and Organisational Markets. Source: Domán, Sz., & Tamus, A., 2009

Relationships with customers are essential from the point of view of a financially successful operation. Buyers can be individuals or smaller groups, but they can also be intermediary companies. The level of costs also depends on this, but it should always be considered on an individual basis.

Strengthening Customer Relationships also requires personal competencies, namely:

- independence,
- commitment,
- diligence.

Social competencies also help Customer Relationships. The following aspects may play a role here:

- motivation,
- determination,
- willingness to compromise.

It is important to apply methodological competencies as well:

- production,
- problem solving,
- platform/network.

Types and value of brands

Manufacturing and trading companies can choose from a variety of branding (see more on page 178) options. Building an individual brand is a significant additional cost compared to using a corporate brand. Individual brands, on the other hand, are able to differentiate a product more strongly with their uniqueness than a corporate brand.

A brand is a name, phrase, sign symbol, design, or a combination of these. It aims to identify a particular product and service in order to differentiate it from competitors. A brand can add significant value to a product. Brand value means "added value" resulting from some past marketing investment.

It is important for the brand to lead consumers to positive associations. In the current economic environment the brand name is a primary capital asset of marketable, efficient companies. Branding is a tool for quality comparison and highlighting differences. Branding promotes market competition by facilitating consumer choice.

Benefits of brand value:

- brand loyalty (high repurchase rate),
- higher price / surcharge (for brands with high brand value the buyer is willing to pay more),
- better cooperation with traders (a brand with a good image is more likely to apply for a favourable treatment from traders),
- brand extension (a well-established brand makes it easier to introduce new products to new markets),
- more effective marketing communication.

The measure of a brand's success is brand awareness and brand image. The company's brand name also conveys an image that is closely related to the company's internal culture. The consumer's decision is made more and more difficult by the proliferation of signs, brands, and slogans.

In order to promote organic goods and agroecological farming in the near future it is necessary to determine:

- the product structure,
- production integration strategy,
- quality assurance.

Branding is a significant additional cost for the company. The brand needs to be created, introduced to the market, communicated to consumers and constantly advertised. The brand carries quality and therefore requires increased quality control. The price of branded products is usually higher. This higher price is paid by the consumer to reduce the risk of purchase.

Mention should also be made of the concept of a trade mark, which is a distinctive sign providing legal protection. This protects the owner's right to use the brand name or trademark exclusively.

3.2.2 KEY FACTORS

KEY ACTIVITIES

The most important activities an organisation has to do to make its business model operate successfully are described in this part.

Key Activities are similar to Key Resources in that both are needed to create Value Proposition, maintain Customer Relationships, reach markets, and earn revenues.

Key Activities are also similar to Key Resources in that they differ depending on business model type.

This block is meant to connect the Value Proposition with the needs of Customer Segments.

Some of the **most important questions** to ask may include:

- What Key Activities are required by the Value Propositions?
- What Distribution Channels could work best?
- What Customer Relationships are needed?
- What are the Revenue streams like?

Key Activities usually include:

- production,
- problem solving,
- platform/network.

It is production that mainly governs the business models of manufacturing firms. Production may manifest itself in activities such as designing, manufacturing, or delivering goods competitively. Key activities related to production in a farm are, among others:

- soil preparation,
- sowing,
- maintaining soil fertility,
- plant care,
- harvesting,
- soil and plant testing,
- meteorological and plant protection forecast.

These activities must be carried out continuously during cultivation. Additionally, producers involved in agroecological farming must be aware of the principles of agroecology so that the key activities can be harmonised with the principles themselves.

KEY RESOURCES

This building block describes the most important resources that may enable a business model to operate successfully. Key resources also enable businesses to:

- create and offer a Value Proposition,
- reach markets,
- maintain relationships with customers, and
- earn revenues.

There are a number of **questions that may be asked** in connection with this building block such as:

- What Key Resources are needed on the basis of the Value Propositions?
- What may be the most suitable Distribution Channels?
- What Customer Relationships should be created?
- What are Revenue Streams like?

Key resources can be placed in the following categories:

- physical,
- intellectual,
- human, or
- financial.

Physical assets may include tangible resources such as:

- manufacturing facilities,
- buildings,
- vehicles,
- machinery,

or intangible ones like:

- processes,
- point-of-sales systems, or even
- distribution networks.

Businesses have to be aware whether they rely more on capital-intensive resources or labour intensive ones. For agroecological farming it may be both, with key resources of the following sets:

- Land managed in harmony with AE principles, reliable machinery and modern technology, building, structures, as well as livestock.
- The required knowledge and experience that must be constantly updated, and of course the well-trained, innovative labourers who are needed for farming, to implement activities, and to achieve the targets set.
- Capital, the possibility of borrowing, to get bank loans, and to apply for grants and subsidies.
- Business partners can also prove to be invaluable as they can contribute to networking and possible clustering.

Although intellectual property resources are challenging to develop and are usually utilised by global companies, once they are available, they can create enormous value for an enterprise.

Intellectual property resources may include:

- brands,
- specific knowledge,
- patents,
- copyrights, as well as
- partnerships, and
- customer databases.

Businesses require suitable Human resources, which on the one hand are becoming increasingly hard to acquire, not only in knowledge-intensive and creative industries but also in labour-intensive industries. On the other hand, human resources may be considered a great financial burden and therefore special attention must be paid to their selection and training.

Businesses may call for financial resources and/or financial guarantees, such as cash, credit, or a stock option pool for hiring key employees or other purposes.

It is important to know that key resources do not have to be owned by a company, they can be leased or acquired from other companies or partners. Key resources can be identified and prioritised by means of a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis which is based on facts concerning which resources can be organised and evaluated.

Inputs to AE crop and livestock production should include labour, arable land, buildings and structures, machinery and equipment, materials needed to produce the product, as well as capital available in the means of production and funds. These resources have common features such as the following:

- their use is limited in time, quantity, quality, and composition and must therefore be managed in a predictable manner,
- the resources have proportions that have developed in the given economy as a result of previous circumstances, the change of which is time-consuming and limited,
- both plants and animals have species-specific biological characteristics and limitations.

Human resources and thus human capital is the first and most important resource. Generally, a permanent workforce is employed which may be supplemented by temporary workers. Depending on the form of the firm, there may be owner (family) labour and employee workers.

Agroecological farming can only be successful with sensible and conscientious work. An organisation is adequate if the necessary and well-prepared workforce is available at the right place and time. To this end it is essential to ensure the recruitment and employment of the workforce required for extra work, the regulation of working hours, and the training and development of the workforce.

The success of a business significantly depends on the expertise and managerial skills of the owners. Agroecological farms are usually small, which means that the individual ability, knowledge, versatility, cooperation and positive human qualities of the contributors are important. Larger farms can also employ workers skilled in specialised areas of work.

Strengthening Customer Relationships requires entrepreneurial spirit, a risk-taking attitude (within a reasonable framework), openness, and trust. In order to expand the sources of revenue, first and foremost the right products must be produced. Buyers are aware whether sellers have the right values and respectfulness and that holds true in the long run. Additionally, patents and brand names help increase the confidence of customers.

Land, which for instance in Latin America means self-sufficiency and autonomy, is a basic resource for agroecological farming since it is a:

- converter and buffer of harmful substances,
- source of raw materials and water,
- factor of production that produces food.

Land, in the sense of agricultural soil, can be considered a renewable resource, the productivity of which should be sustained and managed. Adaptation to the natural properties of arable land is the basis of profitable farming.

Capital is needed to start and run eco-businesses, which is often a problem for these types of enterprises. Capital can be divided into two main groups according to its role in the processes:

- fixed assets over a period of one year that are involved in production (machinery, vehicles, real estate, buildings, licences, know-how),
- current assets required for continuing operations (cash, inventories, receivables, securities).

KEY PARTNERSHIPS

This Building Block of Canvas describes the network of suppliers and partners that help the business model operate successfully. It is easy to recognise that without partners, a successful operation is hard to imagine. Partnerships are formed for a number of reasons, either because no company can own all resources or perform all activities on its own, or to reduce risk, to have a larger pool of resources, to better and more successfully serve customers, etc. The three types of Key Partnerships are:

- optimisation and economy of scale,
- reduction of risk and uncertainty,
- acquisition of particular resources and activities.

The first type, namely the optimisation and economy of scale partnerships are typically created to reduce costs by optimising the distribution of resources and activities.

Risk and uncertainty can be reduced in a competitive environment by forming partnerships or acting as a part of networks or clusters. A strategic alliance in one area does not exclude competition in another.

Specific needs and motivations such as acquiring specialised expertise or penetrating markets may help form partnerships. It is easier for a company to cooperate with other firms than to have all the resources or to perform all the activities that its operations require.

The most **important questions that may be asked** include:

- Who are the Key Partners?
- Who are the Key Suppliers?
- Which Key Resources are acquired from partners?
- What Key Activities can partners perform?

In agroecological farming the most important business partners are suppliers and customers, input and service providers. The selection of partners must be based on trust and if possible they should belong to the same network, supply chain, or perhaps cluster. Ongoing contact with them, based on trust, is essential. Activities may be outsourced but the business partner must - as much as possible - be experienced, aware of AE principles, local, environmentally conscious, and have references.

3.2.3 COSTS AND REVENUES

REVENUE STREAMS

This building block of the Canvas, Revenue Streams, shows how a company can generate income from its Customer Segments. It is possible to generate more than one Revenue Stream from the existing Customer Segments on condition that it is clear what customers are willing to pay for. Therefore one must always remember that the business revolves around satisfying customer needs.

The **key questions to ask** include:

- What values are customers willing to pay?
- How would customers prefer to pay?
- How much does each Revenue Stream contribute to the overall revenues?

On the one hand, farms applying AE principles must thoroughly calculate both revenues and expenditure because fairness and the maintenance of fair prices and affordability is an underlying principle of AE. On the other hand, however, the price of goods must reflect the positive externalities of agroecology, such as alternative pest control, better pollination of plants, carbon sequestration, thoroughly observed animal welfare, and nutritional benefits compared to non-AE farming.

Once it is clear what products or services customers desire and are willing to pay for, pricing comes into consideration. It is possible that different pricing methods have to be applied with different Revenue Streams. The pricing may be on the basis of fixed prices (list prices), bargaining and auctioning, it may depend on the volume of sales or specific market conditions. Furthermore, in the case of sales, customers may pay on a one-time basis, but in the case of for example a subscription, the Revenue Stream is continuous.

Producers receive the highest income after selling their products. It is possible to sell the product for export, which usually means increased revenue.

Revenue sources are generated after each sales transaction. In many cases, agroecological farmers may have income from other areas such as:

- hospitality,
- rural tourism, accommodation,
- horse riding,
- wine tasting, etc.

There may be other sources of income, such as:

- asset sale,
- device usage fee,
- asset rental,
- leasing, e.g., cars,
- revenue from an invention,
- licence fees.

These revenues can be accounted for individually. Pricing can be fixed as follows:

- by list price,
- depending on the characteristics of the product, for example, domestic strawberry prices are high, and in case of dumping the price decreases,
- long-term and reliable customers can get a discount,
- high-volume buyers can get a discount.

These discounts are intended to increase sales volume. In many cases, resellers can also come into play, in which case pricing is a matter of negotiation (bargaining). The price may depend on the rate of yield: for example in the case of a surplus product, the price may decrease.

Selling at real-time markets, where buyers pay the advertised price, can be more reassuring. Additionally, some circumstances (such as quality) may cause the price to drop or increase.

BUDGET PLANNING

This building block of the Canvas describes the costs that make the operation of the business model possible. Activities performed by a firm, whether it be production or Customer Relations not only contribute to revenues but also create costs. Most businesses aim to decrease or minimise costs regardless of their business models. Business models can focus on lowering costs as much as possible (cost-driven business model) or to create excellent value (value-driven business model).

There are **important questions that must be considered** in this building block, for example:

- What are the most important costs for our business or business model?
- What Key Resources are the most expensive ones?
- What Key Activities are the most expensive ones?
- How to reduce costs?
- What to focus on: cost reduction or value?
- Can value increase in parallel with cost reduction?

For farms applying AE principles, not only environmental sustainability but also economic sustainability must be considered. Therefore not only production but also processing, marketing, promotion, storage, transportation, etc., cost depending on the actual activities must be taken into consideration.

There have been no significant changes in the average purchase price of the main products in the last 5 years. In the case of cereals and industrial crops, one can talk about a well-established average purchase price.

Producers may receive significant subsidies, which means that costs can remain below production price. This is also true for agroecological farming.

Income is based on the average annual return. Land rents can be significant in terms of costs, but these days many producers work on their own land. The cost of seed, fertiliser, and pesticide is also considerable in conventional farming, but the costs of machinery and automation can easily exceed that.

Costs associated with soil fertility and plant protection management such as manure, compost, soil bacteria, etc., occur in agroecological farming, however, these may remain lower than the costs of fertilisers and pesticides used in conventional farming.

There are also costs of wages and public charges. According to the above-mentioned facts revenues can be higher and the possible state subsidies can be significant. The cost of pesticide and machine work may be reduced.

There are cost-driven but also value-driven businesses. Firms that have cost-driven business models aim at cost minimisation with focus on lean Cost Structure and low price Value Proposition. They also preferably apply outsourcing and automated solutions. On the other hand, companies with a high Value Proposition aim at value creation through, for example, personalised tailor-made services. In the case of agroecological farming costs can be partially reduced, but no significant reduction can be expected.

Automation is still a great opportunity for the future, currently its use in agroecological farming is unlikely except perhaps in the case of vegetable production. Outsourcing is not typical in stable farms, and although the number of people employed in agriculture is constantly decreasing, the work can still be done by producers. In many cases, besides profit, the main goal is to obtain healthy products. In industrialised farms crops with higher yield rates are favoured but the intrinsic values of the products thus obtained are often incomplete.

There are fixed costs such as wages, rents, utility costs, depreciation and there are variable costs, for example the cost of seeds, fertilisers, plant protection products, irrigation, drying, and so on. These account for about 40% of the costs.

Some plants cannot be planted in the same field in successive years as they do not give a good crop (e.g., sunflower), but for others it matters little (e.g., wheat). Today a wide range of hybrids and varieties are available and it may be a challenge to choose the most suitable ones. Economies of scale can also affect production, in the case of larger sizes the unit costs are lower, and discounts are often offered on purchase.

3.2.4 ADDITIONAL BLOCKS

The environmental impacts (see more on page 181) of the business model (BM) are defined based on Life Cycle Assessment (LCA) (of products and services). It should be mentioned that the LCA used here is not the formal one that evaluates the impacts by using a number of indicators. The aim is to understand the main environmental issues and sustainability practices.

The determination of social impacts of the BM builds on a stakeholder management approach (Freeman, 1984). Stakeholders are, among others, employees, shareholders, community members, customers, suppliers, governmental bodies, and interest groups. Related to the stakeholder perspective, the Social Life Cycle Assessment is a tool for identifying the social impacts (Jørgensen et al., 2008).

ENVIRONMENTAL AND SOCIAL COSTS

Questions to be asked in order to determine the environmental and social costs of the business model are the following:

- What environmental and social negative impacts (costs) is our BM causing?
- Which are the non-renewable Key Resources?
- Which are the Key Activities using a lot of resources?

Agroecological systems produce a small number of negative externalities: for example, organic fertilisers can also pollute the environment (nitrogen leaks or copper issues) and there are impacts from contested but still used additives such as nitrite (in cured meats).

ENVIRONMENTAL AND SOCIAL BENEFITS

BM's environmental and social benefits can be determined by **answering the following questions**:

- What environmental and social positive impacts/benefits (revenues) is our BM generating?
- Who are the beneficiaries? Are they potential customers?
- Can we transform the benefits into a Value Proposition? If yes, for whom?

Agroecological practices of farmland management reduce environmental pollution, enhance food quality and safety, and stimulate the local economy by creating quality jobs and keeping money spent on food within the local economy.

Environmental benefits:

- reduction of greenhouse gas emissions and carbon dioxide sequestration (contributing to climate change mitigation),
- reduction of pollution – clean, pesticide and fertiliser free water, soil, and air,
- reduction of risks of flooding and erosion - building a healthy soil that holds water,
- biodiversity conservation - habitat restoration, crop rotation and smart landscaping.

Social benefits:

- contribution to better health - nutritious, safe, quality food,
- contribution to justice – more and fairly paid farm jobs (by reason of e.g., price premiums, direct sales), proper work conditions on the farms, respect for animal welfare.

3.3 CASE STUDIES, GOOD PRACTICES

In this section we present an example Sustainable BMC of an organic farm producing milk and cheese.

KEY PARTNERS	KEY ACTIVITIES	VALUE PROPOSITION	CUSTOMER RELATIONSHIP	CUSTOMER SEGMENTS
Organic cow fodder producers Milk bottle producer Producer of cheese packaging paper Marketing consultant Organic certifier	Milk production Cheese making Sales Delivery Brand development	Providing healthy food (organic milk and cheese) Providing environmental benefits	Transparency by farm visits	Health & quality conscious customers Environmentally conscious customers Families with young children Wealthy consumers demanding local delicatessen
	KEY RESOURCES		**CHANNELS**	
	Farm- & grassland, livestock, buildings Family members + 1 employee Car to deliver milk & cheese to consumers Stories about the farm Website, social media Money		Direct sales from farm and on markets Home delivery of fresh milk Members of the CSR community (Community Supported Agriculture)	

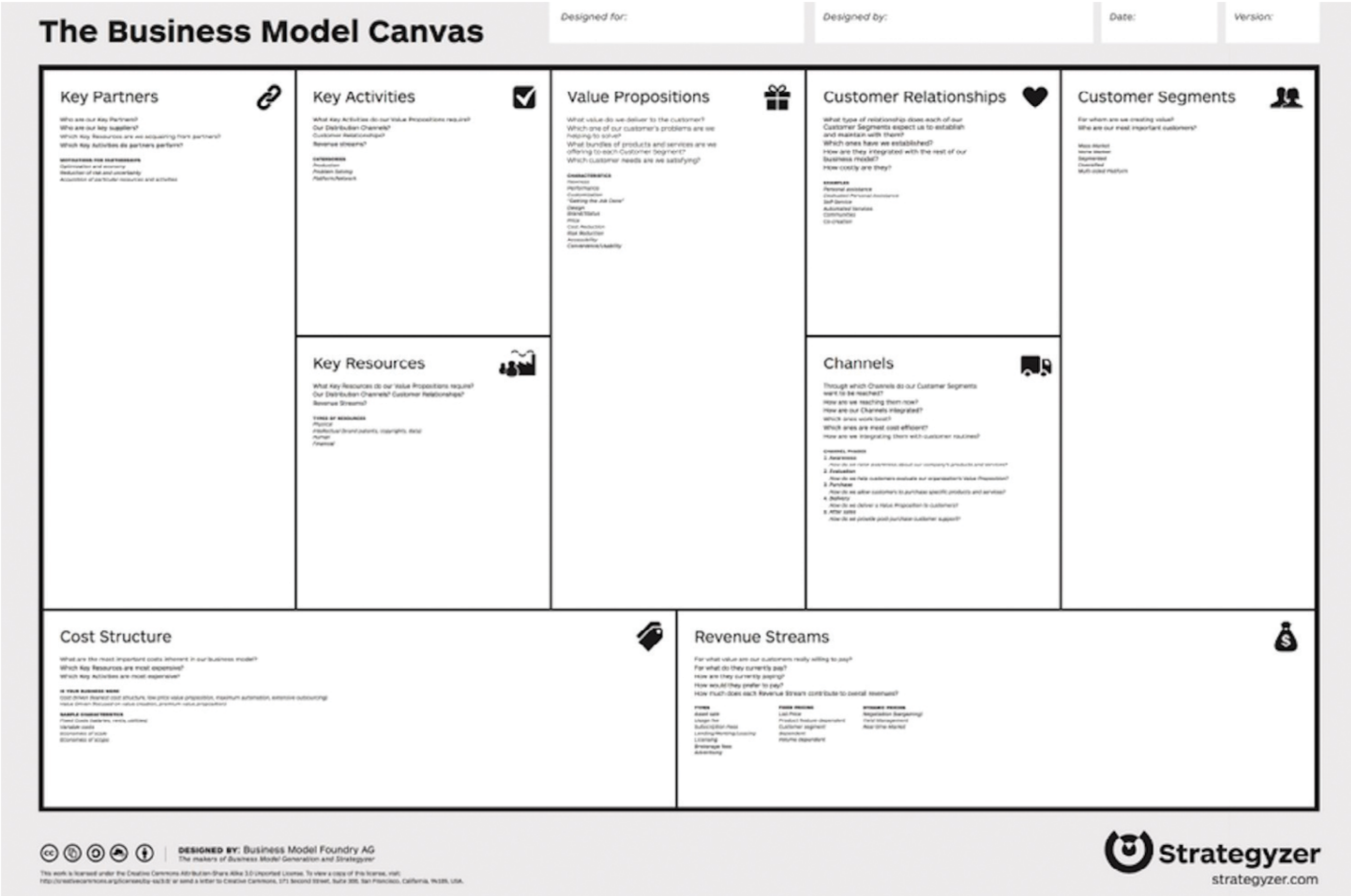
COST STRUCTURE	REVENUE STREAM
Packaging cost / Delivery cost / Employee salary / Marketing costs / Public utility and building costs / Organic certification cost	Sales of fresh milk and cheese Agricultural subsidies Grants

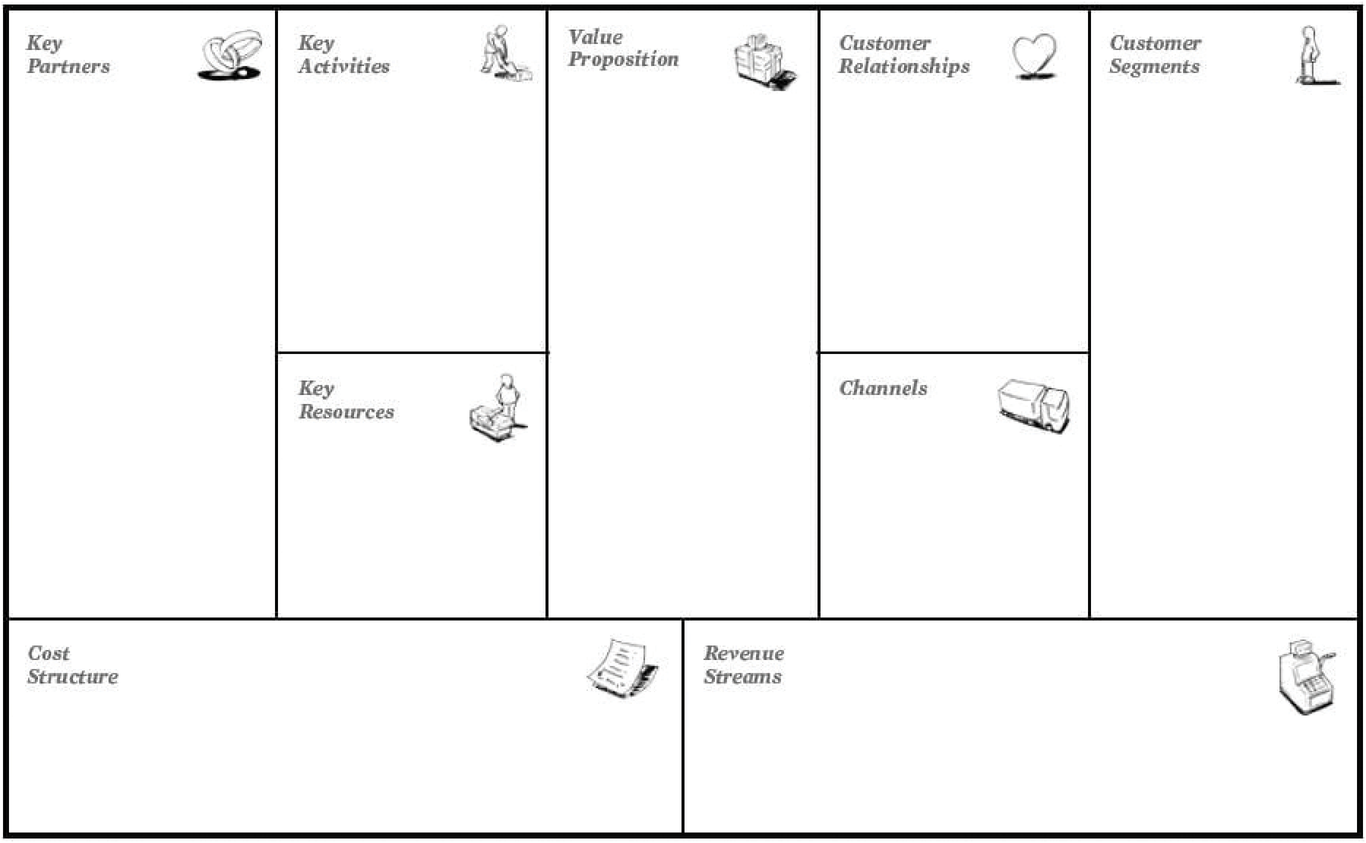
ECO-SOCIAL COSTS	ECO-SOCIAL BENEFITS
Consumers pay a premium for milk and cheese Public money subsidies for organic conversion and production	Healthy soil / clean groundwater / higher on- and off-farm biodiversity / no bioaccumulation of chemicals throughout the plant-animal-human food chain / decreased use of machinery

Table 3.3: Sustainable Business Model Canvas example of a milk and cheese organic farm.
Source: Own editing

3.4 SAMPLES, TEMPLATES

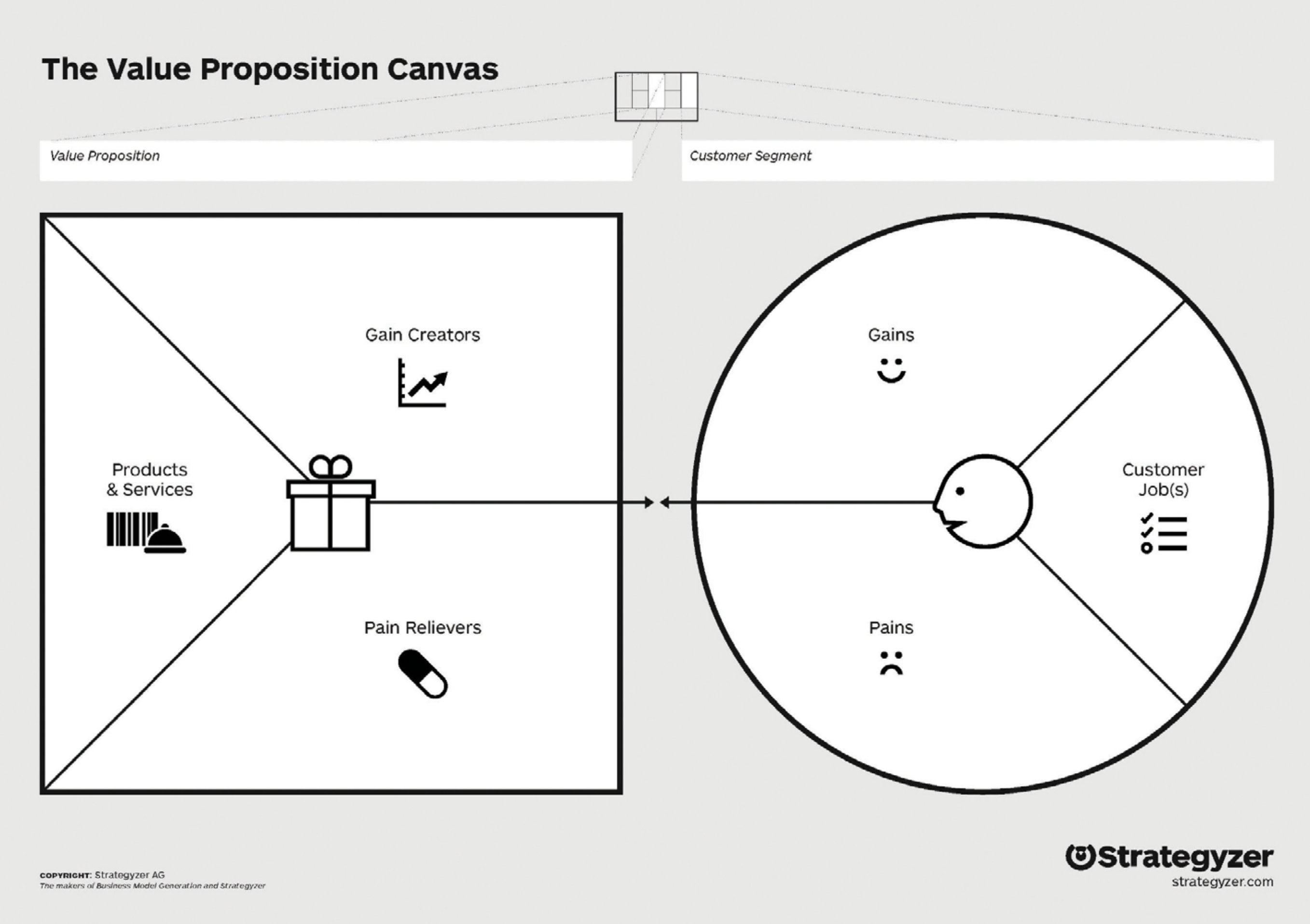
BUSINESS MODEL CANVAS TEMPLATES





Source: https://www.strategyzer.com/canvas

VALUE PROPOSITION CANVAS TEMPLATE



Source: https://neoschronos.com/templates/

Value proposition canvas explained: Strategyzer's Value Proposition Canvas Explained

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https://www.strategyzer.com/business-model-canvas

Canvanizer: create your own canvas
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AGROECOLOGY IN ACTION ON THE FARM

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4.1 INTRODUCTION

Agroecological farming is not limited by scale of operation, and techniques which are impactful on small scale farms and gardens have relevance in larger arable crop operations, animal husbandry and grassland production areas. It is expected that farmers can make good use of an introduction to agroecological concepts in practice at different farm scales in order to assist in making decisions on what techniques can be incorporated in steps in their own operation. The following chapter will summarise practical applications of agroecology (see more on page 176) in grassland and livestock management, arable land management and small scale diversified vegetable production & market gardening. It is difficult in a concise text to create a comprehensive list of agroecological techniques which can be applied in practice, but the aim of this text is to highlight major pillars of agroecology in practice in three major farming classification, hoping that learners can find useful practices and links to additional learning material in each section which can be combined in practice.

4.2 GRASSLAND AND LIVESTOCK MANAGEMENT

4.2.1 OPENING

Grasslands represent a significant agri-ecosystem (see more on page 177) in Europe covering more than a third of the European agricultural area. Grasslands have a basic role in feeding herbivores and ruminants and provide important ecosystem (see more on page 180) services, including erosion control, water management and water purification. Grasslands also support biodiversity (see more on page 177) and cultural services and are an important stock of carbon. Grasslands are very diverse in terms of management, yield and biodiversity value. They range from semi-natural grasslands with low yields and high biodiversity values to fertilised mono-cultural grasslands. (Velthof et al., 2014)

Out of the 500 million tonnes of animal feed given to livestock annually in the EU about 40% of it is grass (expressed in dry matter). A grassland area of around 65 to 70 million hectares is needed to produce feed for the EU livestock sector.

The many functions of grasslands result in them playing a major role in agroecology. Since they are considered to be the most biodiverse habitats on the continent, agroecology should emphasize the cultivation of biodiverse grasslands as a fundamental principle. Our chapter below focuses more on this aspect than on intensive monocultures (see more on page 184).

Figure 4.1: Biodiverse grassland in Transylvania. Credit: Gergely Rodics

Grassland management can successfully incorporate many practical aspects of agroecology, and properly managed areas represent valuable ecosystems. Grasslands can incorporate agroforestry (see more on page 177), be applied in regenerative agriculture by rotational grazing (see more on page 186) have a positive effect on natural nutrient cycling (see more on page 184), improve agrobiodiversity (see more on page 176), and be a strong element of organic or climate resilient farming (see more on page 178).

INTENSIVE GRASSLAND MANAGEMENT	EXTENSIVE GRASSLAND MANAGEMENT
Higher yield	**Lower yield**
Species composition is man made	Species composition is natural
Nutritional value of hay can be controlled by the choice of plant species and varieties	Nutritional value of hay can not be controlled but it is diverse
Hay can be made 3-4 times a year	Hay can be made 1-2 times a year
Agrotechnology provides a growing range of interventions	Intervention is needed only when hay is made and if manure or slurry is applied
Low biodiversity (carrying between 2-6 species)	High biodiversity (species number up to 400-500)
Some ecosystem services	Larger number of ecosystem services
Economically more sustainable	Ecologically more sustainable

Table 4.1: Comparison of intensive and extensive grassland management. Source: own editing

4.2.2 SOIL AND NUTRIENT MANAGEMENT

For establishing a grassland management system (see more page 188), missing soil organic matter (see more on page 187) and minerals must be replaced on the fields to replenish those which are lost through mowing or grazing. In nature-imitating systems this is done with the help of animal manure and slurry. Both are rich in nitrogen (N), phosphorus (P), potassium (K) and in carbon (C). These elements can be useful if they are well managed but also harmful if uncontrolled.

Agroecological systems are at their best when animal husbandry and plant production occurs on the same farm or at least in the same landscape. In such mixed systems these two sectors have mutual benefits supporting each other; thus animal manure is a great locally sourced input for crop production.

Nutrients for the plants are available after a one-year natural maturation of the manure. Manure however also carries some dangers. It can cause serious groundwater or surface water pollution: 1) if it's not properly matured; 2) if it's spread on the snow or 3) in wet weather, or 4) if too large quantities are distributed (regarding maximum N quantities per hectare please observe national and EU regulations).

Another risk caused by manure occurs when corralling livestock. If corrals remain in the same place too long, the overdose of manure can be harmful on the soil, on the plants as well as on natural water bodies. The other disadvantage of overused paddocks is the excessive trampling of plants and compaction of soil by the animals. This can result in the complete disappearance of the plant cover within the boundaries. Moving the paddock in proper time can prevent these problems from happening – this is only a matter of attention by the farmer.

Figure 4.2: Overgrazing and trampling in sheep paddocks. Credit: László Demeter

Slurry as an input material can be sprayed on fields however its chemical composition greatly varies based on farm management, animal diet, housing and meteorology. The sustainable use of slurry as a fertilizer must avoid the fast release of nutrients to reduce negative environmental impacts (see more on page 181). Slurry collection in stables is common practice however a mix of gases, mainly methane and carbon-dioxide (biogas) develops during its maturation. These are greenhouse gases (see more on page 182) strongly contributing to climate change. It is therefore recommended to collect and utilise biogas. It is a possible energy source for a farm or a potential source of income if the energy (heat and power) generated can be sold. The composted dry matter as an output of the biogas unit is a high-quality fertiliser; much more concentrated in nutrients than slurry.

The basis of manure nutrient management is the "nutrient management plan" or NMP. It starts with valuing how the nutrient quantity is annually removed from a meadow, through production, and then combined with tools to calculate the quantity of nutrients and in which form should be applied back on the field. In the section below you can find tools which aid in helping to develop your own NMP.

Additional resources
Livestock and Poultry Environmental Learning Community, USA

- Nutrient Management Simplified - A fact sheet for small farms
- Manure Nutrient Management
- Treatment Technologies for Livestock and Poultry Manure
- Snap-Shot Assessments of Nutrient Use on Dairy Farms and an additional Survey guide
- Software and Web-Based Resources for Nutrient Management

Floodplain Meadows Partnership
- Protocol for taking a hay sample for nutrient analysis
- A comprehensive guide on floodplain meadow management

Northeast Recycling Council: Manure Management Handbook
Biowaste treatment technologies - videos: Organic waste treatment; Biogas treatment

4.2.3 REHABILITATION VERSUS INTENSIFICATION OF GRASSLANDS

Semi-natural temperate grasslands - the species-rich grasslands (see more on page 187) of Europe - are the second most species-rich habitat types on Earth following rain forests. These are grasslands growing in the temperate climate region and are only semi-natural because they are managed by humans even if full of wild species. These biodiversity hotspots are however in serious decline in abundance because infrastructural development and the intensification of agriculture (see more on page 183) have made them almost disappear especially in Western Europe and the USA.

To maintain this extremely high biodiversity, it is recommended to create and reestablish grasslands on fields converted from arable crop production areas. Farmers can choose between establishing intensive or extensive grasslands. However, they should consider that intensive grasslands (see more on page 183) have extremely low species numbers (typically 2-4) in exchange yields are higher.

It is also a common occurrence in Europe that less frequently maintained grasslands begin a natural conversion to forest. Farmers can influence this development through maintenance practices, grasslands can be preserved by regularly clearing dense brush and new growth from the area. Or they can manage afforestation practices, with the intent to cultivate a mature forest.

When introducing or restoring semi natural grasslands, seed mixes should have grass species with a similar growth intensity. It is recommended to include plants for pollinators and some nitrogen fixing plants (see more on page 184) suitable for local conditions such as Clover species, Sainfoin or Bird's-foot trefoil.

The least demanding and also often the really successful way of such conversions only leave arable land uncultivated and natural regeneration happen from the surrounding natural vegetation. If this is not possible, then natural seed mixes can be used for reseeding the area. If possible, use only seed mixes harvested from natural grasslands in the same bio-geographical area. Foreign species should be avoided. Overseeding is only necessary if natural species are suppressed over a number of years. It is recommended to avoid any form of cultivation, fertilisation and chemical weed control during the conversion because these can prevent the natural return of wild species. Reaching the original level of plant biodiversity can take 10-15 years.

Unlike arable conversion, in the case of "improving" semi-natural grasslands with intensive grass species the effect on biodiversity can be detrimental. Intensive species will dominate the grass composition and by escaping the overseeded territory, and they can have a negative effect on the landscape level if they outcompete endogenous species.

Semi-natural grasslands have a series of ecosystem services and have high resilience (see more on page 185) against climate change. This means that out of the many different species there will always be a number of them which perform well under changing (possibly dryer and hotter) circumstances. A general rule for their management is that late mowing is beneficial for plant seed development as well as for bird chicks to reach the age when they can escape from mowing.

Additional Resources

Europarc Federation: From forest to grassland conversion
Farm Wildlife: Reversion of arable land to lowland chalk grassland
Successful farming: Converting cropland to grassland - a farmer's perspective
Magnificent meadows: Restoring species-rich grassland

4.2.4 HAY MEADOW MANAGEMENT

Hay meadows are not only hotspots of biodiversity but they also compare favourably to pastures in plant species numbers. Less intensively managed species rich meadows with no manuring and mown only once a year have also higher biodiversity than those which are more intensively managed.

MOWING

Mowing is completely non-selective, it removes every plant equally at the same time. However, it can have a detrimental effect on all animal species living in grasslands. Mowing in traditional farming systems (see more on page 181) using the hand scythe was a slow and gradual process. Manual mowing would allow a greater chance to protect most of the animals inhabiting the area as opposed to machine mowing. In contrast, mowing machines make this process much faster therefore wildlife has a much lower chance of vacating the grassland.

Cutting height is an important factor for plant regeneration. While hand mowing hardly leaves behind any stubble, machine mowing height can be oriented to leave more crop remaining in the ground. A stubble height of about 6-8 cm is considered to be optimal for plants as well as for insects and amphibians to survive. With the application of flushing bars on the tractor the insects higher up on the plants fall down to ground and thus they have a high chance to survive (see more on grassland biodiversity in section 4.2.8.).

Figure 4.3: Flushing bar mounted on a tractor. Credit: Birdlife Hungary

Flushing bars are bars with a chain curtain hanging down that ride ahead of the blades. They scare wildlife out of the way. They are an approx. 3 m long horizontal square steel tube, removable and the end section is adjustable to suit different mower widths. Galvanised chains at 15 cm intervals are hung vertically to penetrate vegetation. Some research suggests that a denser series of chains (5-8 cm) results in higher survival rates. Slow mowing speed and stopping whenever necessary can also save a lot of animals. A seven year research program in Hungary found that out of 5739 mammals and birds spotted while mowing, 5357 (93,3%) escaped, 312 (5,5%) were saved by the tractor drivers and only 70 of them (1,2%) were injured or killed thanks to these wildlife friendly mowing practices (Viszló, 2011).

Among the different mower types, bar mowers are considered to be the most nature-friendly. Unlike mowers with rotating tools, bar mowers work with moving blades. They work relatively slowly and they let the grass lie down like a carpet. Rotary mowers work faster, leave shorter stubble and drum mowers even make a wild whirl under their cover which kills most of the animals (including insects) which inhabit the grass. (Flade et al. 2003)

There are some general rules for nature friendly mowing practices.

- Raise mower blades – 6-8 cm are ideal.
- Use flushing bars for mowing tall vegetation.
- Avoid flail mowers, rotary mowers and conditioners - use preferably bar mowers or swather mowers without conditioners.
- Mow fields from the inside out - this lets birds, insects and mammals escape (see Figure 4.5).
- Don't mow to the edge - leaving an unmoved strip will create an extra-rich habitat.
- Mow slow - high-speed mowing gives wildlife no chance to escape.
- Unmowed patches - keep some areas unmowed every year between mowed patches in a rotational system.
- If there are several fields to harvest, save the fields closest to wetlands. These fields will likely have a high nesting density.
- Mow in July or even later if possible. It is good for most plants' natural reseeding as well as a good time for the young generation of birds leaving their nests in the grassland.
- Be cautious of wildlife while mowing - careful tractor drivers save thousands of wild animals every year.

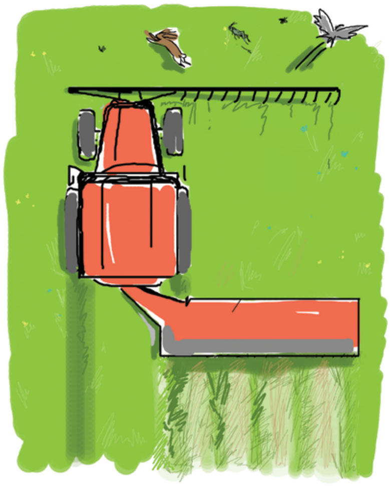
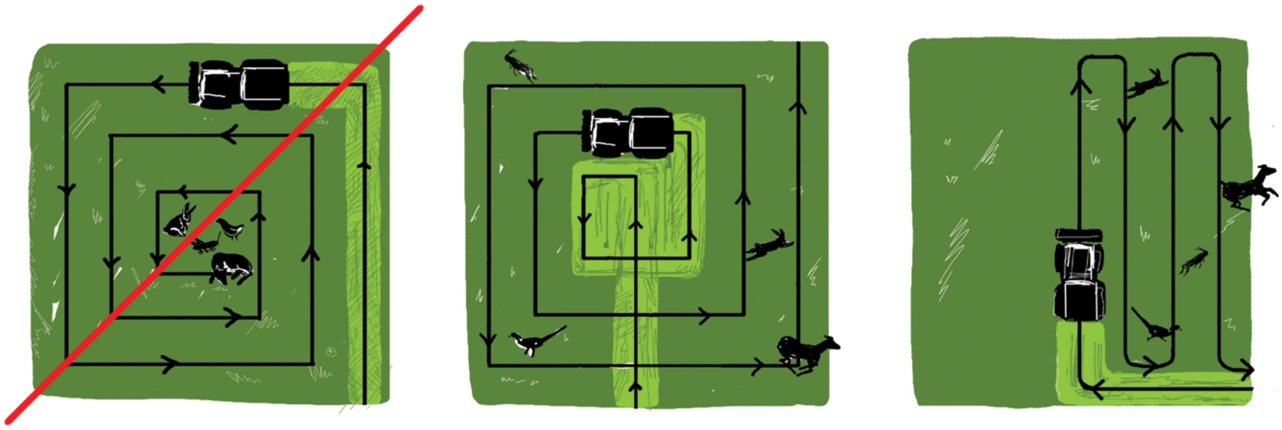


Figure 4.4: Schematic operation of mowing with flushing bar. Credit: Júlia Csibi



1) 2) 3)

Figure 4.5: 1) Mowing the field towards the centre creates a trap for wildlife 2) and 3) Mowing the fields from inside out allows wildlife to escape. Credit: Júlia Csibi

Additional resources

Farming for Nature: Species-rich grasslands management
Magnificent meadows: Advice & Guidance
One Earth: How to Mow Better For Habitat!
Oklahoma State University: Reducing Mortality of Grassland Wildlife During Haying
Pogány-havas Association (video): Mountain hay meadows - hotspots of biodiversity and traditional culture

TURNING AND COLLECTING HAY

Hay rakes can be horse or tractor drawn. There are star-wheel rakes which don't need additional power from the tractor motor so can be used by horses too. Rotary rakes in contrast do need power from the tractor. Star wheel rakes have the advantage of turning and collecting the hay, and can be pulled behind the trailer reducing the number of turns between the field and the hay storage.

DRYING THE HAY

Dried hay is considered to be the best fodder for ruminants. However, drying the hay is not always straightforward. Since many plant's stems dry slower than leaves (i.e. alfalfa), it can be a problem to collect very dry leaves because they tend to fall off the stems during processing and collection. Shredders are a solution to this problem but their use consequently causes another one: they don't only break plant stems but they crush everything including animals. Thus, insects, amphibians and small mammals will be minced too. Our recommendation, therefore, is to avoid using shredders and instead start raking these cultures in the early morning when plant leaves are moist from dew. Alternatively drying the moist hay after collection is also an option which will be discussed later in more detail.

Figure 4.6: Hay dryer rack; round and square bale dryer; silage bale in wrap.
Credit: Univ. Wisconsin-Eau Claire; Agricompact-technologies; Blain's farm & fleet

PRESERVATION OF GRASS

Grass or hay can be preserved in two basic ways: drying or fermenting. Drying hay can be done on the ground; or on racks or by specialised hay dryer machines which blow lukewarm, dry air through the hay. Dried hay best suits ruminants' biological needs and hay-fed animals' milk is desirable for making mature cheeses unlike milk from animals fed on fermented fodder.

Drying hay in the social zone of the farm (in or next to the farm buildings, such as: house, barn, etc) instead of in the hayfields is a more expensive, however less risky form of haymaking. It eliminates the risk of rain and dew rewetting the hay, and the unwanted impact of sunshine can also be minimised to preserve maximum nutrient content. The freshly cut hay spends a short time on the ground while some of the plant's moisture content evaporates and later in the farm it will be dried to about 10% moisture content. Hay dryers can dry loose hay as well as lightly pressed square or round bales.

Compressing the fodder into bales facilitates the transport, handling and space-saving storage of forage. These technologies have spread since the middle of the twentieth century, starting with the small square balers, then the round balers, and finally the large square balers. Due to their high demand for manpower, small cube balers are increasingly being pushed out of practice, and can mostly only be found on small farms.

In connection with round balers, the airtight plastic wrapped production of fermented fodder has become widespread. This method involves compressing the partially dried grass and sealing it airtight with several layers of foil. It is economically unfavourable compared to putting silage (or haylage) in a stack (silo). The agroecological disadvantage of silage bales, in addition to its high energy demand and emissions, is the environmental impact of the huge amount of one way packaging material thrown away every year.

Making haylage or silage are two ways of preserving grass by fermentation. The difference between them is their moisture content (haylage having between 15 and 40% moisture content and silage having more than 40% moisture content) (Niblock, 2021). By eliminating the step of drying, the process leading to fodder is faster, cheaper and there is no reliance on longer sunny periods nor additional machine drying costs. Livestock will willingly consume it and it improves milk production in quantity (but not in quality: please refer to the section about hay milk).

Additional resources
Ministry of Agriculture, Food and Rural Affairs, Canada: Barn Hay Drying
HSR Heutrocknung Sr: Round bale drying system
Veda farming: Hay Dryer
Hustler Equipment: Which is better? Baling Silage or Putting Silage in a Stack

ALTERNATIVE USAGE OF HAY

To maintain grassland biodiversity hay production is key. If producing fodder is not a viable option anymore (like in many European countries) alternative ways to utilise grass can contribute to biodiversity protection. Ideas can be: 1) small-scale like building hay furniture and small structures; 2) mid-scale like mulching (see more on page 184) with hay; 3) industrial level which would make a serious demand for hay. A widespread form of processed grass and hay are pellets which allow more efficient transport and a more condensed storage of hay. Small pelletizers allow home production at a small farm level too.

A few new alternatives to utilise grass on an industrial scale are explored by the EU financed research project "Go grass" such as:

- biochar, a substitute to mineral fertilisers, or supplement for biogas production;
- briquettes for animal bedding and later a fertiliser and/or biogas supplement;
- high-quality packaging and paper;
- organic protein concentrate to be fed to pigs and poultry to enrich their diet, and to dairy cows to increase their milk production.

Figure 4.7: Pellets from grass. Credit: Horse Sport

Additional resources
Go grass: Grass-based circular business models
Farm Fresh For Life: 12 Uses for Old Hay
Rural American Know How: 19 Clever Uses for Hay You May Be Missing Out On
Horse Nation: 4 Unusual Uses for Hay Bales

4.2.5 LIVESTOCK GRAZING

Grazing can be beneficial for our livestock as well as for natural biodiversity if done properly, because grazing animals can freely select what they eat and what they leave behind on the field. The benefits for the animals are the natural way of feeding as well as moving in a healthy, open environment. For biodiversity the benefit is that grasslands remain open instead of being overgrown or converted to arable land. Grazing provides a more favourable opportunity for some plant species to spread than for others; resulting in a shift of the overall species composition. To help biodiversity recover, it is necessary on a yearly basis to cut or saw and to remove the plants not consumed by grazing animals. It's beneficial for nature and it coincides with the interest of the farmer to propagate edible plants and to stop the inedible ones from dominating the pasture.

OPTIMISING NUTRIENT CONTENT AND BIODIVERSITY PROTECTION

It is a general rule that the best fodder for ruminants is grass - being fresh or dried. They can find all necessary nutrients in a diverse grass mix from starch, cellulose to protein. However there is a certain trade-off between fodder quality and wildlife protection. Grass fodder is best if mown when dominant species start blooming. However for plant seed development as well as for young birds reaching their adulthood late mowing is essential. Traditional farming practices (see more on page 189) recognised this and to have a sustainable system they gave up best fodder quality for natural reseeding every few years. An alternative opportunity is to maintain landscape level mosaicity and especially in mountain systems: the higher, less productive and also later maturing grasslands are mown later; while intensively managed meadows are mown earlier and possibly more than once a year. Additionally to this, another approach can be to reseed in spring with hay-rests rich in flower seeds collected from the hay storage. In lowlands, planned rotational mowing can also be a good solution.

RUMINANTS IN AGROECOLOGICAL SYSTEMS

Ruminant animals (such as cattle or sheep) changed a lot during the history of agriculture. Cattle traditionally were used as working animals, while milk production and beef was a secondary benefit. With specialisation and modernisation of agriculture milk and beef production became their primary purpose. Walking distances from pasture to barn, and grazing disappeared in many cases and super intensive farming encouraged different physical traits from modern breeds. Many traditional regional breeds were first "upgraded" by cross breeding with Simmenthal cattle, and nowadays the genetic properties of these breeds has been further altered prioritising efficiency and productivity. The increase in milk production achieved has come at the cost of becoming reliant on a more nutrient dense mix of high input requiring feeds (corn, silage, seed crops, soybeans) which may not be indigenous or regionally accessible.

Figure 4.8: Hungarian grey cattle. Credit: Árpád Lovász

However grazing systems still need resistant and tough breeds. Every region of Europe has its own traditional breed such as Brown swiss, Tyrol grey, Simmenthal, Hungarian grey cattle, Highland cow, Maronesa or Mertolenga breeds in Portugal, etc. which can walk longer distances and are much less sensitive to weather and illnesses. These breeds' typically produce less in quantity however higher in quality. To make agroecological farming also economically sustainable, these products have to be sold more expensively such as organic, biodynamic, under regional brands or as the hay milk and hay meat. A further step is on-farm processing.

Multi-species grazing (see more on page 184) is a good way of economic and sustainable grassland management. With a good mix of ruminant species we can make sure that most if not all plant species are eaten and thus our grassland is managed better than with one species. This approach is still existent in traditional transhumance and other extensive grazing systems in some parts of Europe. By having healthier animals and a larger carrying capacity of a given area, incomes can be 20-25% higher compared to single-species grazing.

Adaptative multi-paddock grazing is a relatively new concept which emphasises the importance of the complexity of biological systems and the presence of grazing animals in the landscape. As the description on the webpage goes: Holistic Management (see more on page 182) provides a framework for decision-making – rooted in the fundamentals of ecosystem processes – with a suite of planning procedures that include planned grazing, land planning, financial planning, and ecological monitoring.

Additional resources

EUR Lex - Access to European Union Law: EU regulation on Hay Milk
European Network for Rural Development: Hay meat and milk
Sacred cow: How multi-species grazing benefits ecosystems, farmers, and consumers
Karen Launchbaugh: Multi Species Grazing
Encyclopaedia pratensis: A knowledge hub around hay: tools, studies and best practices from Europe
Inno4Grass: Grassland use in Europe - A syllabus for young farmers
Savory Institute: Holistic Management

ORGANIZATION OF GRAZING

Grazing is the most natural and healthy form of feeding livestock; and for the farmer, it is the least labour intensive and the cheapest approach. Landscape level free range grazing - when cowherds or sheepfolds were walking longer distances accompanied by humans and herding dogs - is being replaced by paddock grazing. Paddock grazing enables a more intensive however still nature friendly grazing system: rotational grazing.

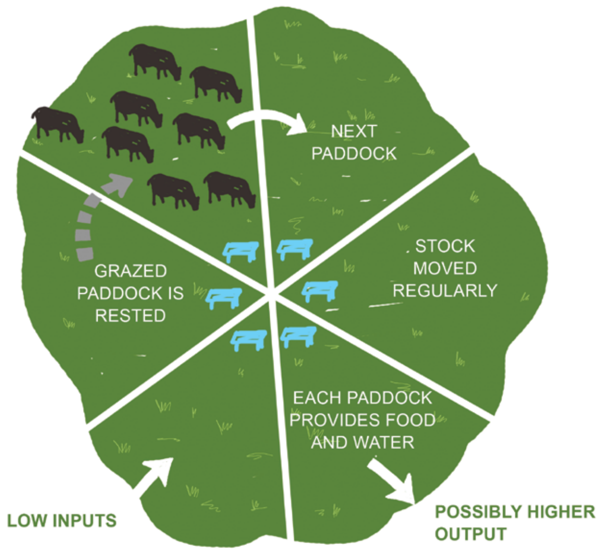


Figure 4.9: Logical framework of rotational grazing. Source: Ian Alexander, adapted by Júlia Csibi

Under rotational grazing, only one portion of pasture is grazed at a time while the remainder of the pasture "rests." To accomplish this, pastures are subdivided into smaller areas (referred to as paddocks) and live-stock are moved from one paddock to another, for a specific period of time, according to a previous plan. In a system where livestock constantly use the entire pasture - Continuous grazing -, although less labour is required, fodder supply will decrease with a high soil compaction risk. It is disadvantageous for both animals and pasture. Rotational grazing means more planning, more attention and more work. Animals, on the other hand, get more fresh fodder, vegetation has time to regenerate, and biodiversity can be maintained/ improved. Another advantage is that the spread of parasites is limited, with individual sections being sterilised naturally. The number of paddocks typically varies between 3 and 14. If the number of paddocks is low, livestock will spend more time in each one of them. It is economically favourable to create more sections and move livestock every 1-2 days. In the most intense version, the animals have access to a new paddock twice a day. The goal is for the grass to be around 15 cm at the beginning of grazing and around 6 cm afterwards. If grass isn't grazed evenly, it is worth mowing the residues.

The presence of woody plants (trees and shrubs) in pastures is beneficial from both an animal welfare and ecological point of view. Even the maintenance of orchards and vineyards can be efficiently solved by grazing. Please refer to our section about wood pastures below.

Additional resources
Fibershed: Integrated Crop & Livestock Systems and Fuel Load Reduction
Hunter Local Land Services: Rotational grazing to improve pastures

4.2.6 A SUPERB MIX FOR AGROECOLOGY: WOOD PASTURES

The term wood pasture, with the technical name of Agro-silvopastoral land-use, means a grassland scattered with trees. They are often considered to be a type of forestry of grassland management and of agroforestry systems. Despite the fact that there is no unified and officially recognized definition of wood pastures, we present here this special habitat type since it involves grassland and livestock management, it has great ecological and cultural importance thus it is probably the most valuable crown jewel of agroecology.

Agro-silvopastoral land-use has a long tradition throughout Europe. Wood-pastures may be defined as tree-land on which farm animals or deer are systematically grazed (Rackham 2004). This type of land-use always involves grazing animals and trees or shrubs, and sometimes grass cutting, acorn collecting, litter raking and field crop cultivation. Depending on the region, wood-pasture occurs as a vanishing relic of historical land-use, or still more or less widespread as multiple-use rangeland. There is a promising new development that former intensively managed land is being left to evolve towards wood-pasture as an economically and ecologically favourable alternative. European wood-pasture habitats distinguish 24 types based on the geobotanical criteria of region, structure, land-use and tree species composition (Bergmeier et al. 2021). Wood pastures are of high ecological value being the home of over 300 plant species and of at least 37 European bird species. And for 18 species a high proportion of their European populations utilises this habitat (Birdlife International, 1997).

Their management of wood pastures is typically multi-species grazing (mainly cattle, sheep and pigs) but especially in Northern Europe hay making in wood pastures also has a long standing tradition. Grazing systems - besides their biodiversity importance - in Southern Europe are still important and economically viable. They can provide food and non-food products which increase the resilience as well as the complexity of the system. Therefore the stewardship of these systems require a complex knowledge of how different elements interact throughout the course of time.

Knowledge about the economic viability of agroforestry systems including wood pastures is scarce but there is an increasing number of related research exploring their performance under the current economic circumstances.

A case study in Spain found that the economic viability (net margin) was maximised at around 27% tree cover of the land for a carrying capacity of 0.4 livestock unit per hectare from which livestock 61% were ruminants and 39% Iberian pigs (Jalón et al. 2017).

A comprehensive research project studied five agroforestry systems to represent traditional and innovative Integrated Food and Non-food Systems (IFNS) in different socio-economic and environmental settings in Northern, Eastern and Southern Europe (Lehmann et al. 2020). The most important findings relevant for farmers, of this research paper are the followings:

- The studied IFNS systems are 36–100% more productive compared to monoculture, depending on the differences in crop types, crop arrangement, management and pedo-climatic zones (Pedo-climatic zones are areas of relatively homogenous soil type and climate conditions).
- Agroforestry gross margin was lower in a Combined Food And Energy system in Denmark (€112/ha/year) compared to the Alley Cropping (see more on page 177) system in the United Kingdom (€5083/ha/year). The crop component yielded high returns compared to negative returns from the tree component in agroforestry.

- There is a need to quantify and commodify the non-marketable goods and services (such as water retention and purification, biodiversity maintenance, air purification, etc.) from agroforestry for comprehensive assessment of agroforestry systems.

- The study calls for a holistic assessment of the IFNS systems which can justify the subsidy support for the farmers adopting IFNS.

Considering the wide variety of wood pasture systems, their economic viability or agronomic approaches cannot be presented in any further detail here but in the resources section below some useful reading material is provided.

See trAEce video - Montado: Regenerative Silvopastoral System in Portugal: https://www.youtube.com/watch?v=Hcatt_ZYEqU

Additional resources
European Parliament: Agroforestry in the European Union
Agforward project: WP1 - Existing agroforestry in Europe
Forage-SAFE model: A tool to assess the management and economics of wood pasture systems
SustainFARM project: Productivity and Economic Evaluation of Agroforestry Systems
Remarkable trees of Romania: About the project

4.2.7 ORGANIC LIVESTOCK AND GRASSLAND MANAGEMENT

Grassland management is probably the easiest task among organic farming (see more on page 184) sectors especially if managing semi-natural grasslands. Not using pesticides is the baseline practice and because normally grasslands support livestock management, animal manure is available. Even intensive grassland species are normally resistant therefore chemical pest control isn't necessary. Many grasslands contain some nitrogen fixing legumes which improve soil fertility.

It is an important rule of organic animal husbandry that all fodder needs to be of certified organic origin – even if they are not produced on the farm but bought from another source. There are limitations on the amount of manure or slurry to be applied to the fields. If the farmer also produces arable crops, the seeds need to come from a certified organic producer or at least they have to be free of artificial coatings.

Livestock can also be certified as organic. Besides the above-mentioned rules on fodder also certain animal welfare rules need to be followed: animals cannot be kept tied in barn areas, they have to be able to walk outside barns and during summer they must be able to graze. The basics of handling diseases is prioritising prevention. In certified organic production if an animal was prescribed doses of medicine for treatment, its products (meat or milk) cannot be sold as organic before twice the normal withdrawal time of the medicine applied is over.

Additional resources
Rodale Institute: Livestock Management
Rodale Institute: Livestock conversion to organic
FAO: Training manual for organic agriculture

4.2.8 GRASSLAND BIODIVERSITY

PLANT BIODIVERSITY

Semi-natural temperate grasslands are the richest in plant species on Earth. This statement is true if we take into account species density as well: rain forests host more species altogether but only if we look at large areas comprising 100 m^2 or more (Wilson et al., 2012). Semi-natural grasslands therefore are a real concentration of life from hundreds of different plant species through insects, amphibians up to mammals. It is positive news that many of the world record sites of plant species diversity observed within an area of specific size, were documented in Europe.

AREA (m^2)	SPECIES NUMBER	COMMUNITY	COUNTRY
0.001	12	Limestone grassland	Sweden
0.004	13	Semi-dry basiphilous grassland	Czech Republic
0.01	25	Wooded meadow	Estonia
0.04	42	Wooded meadow	Estonia
0.1	43	Semi-dry basiphilous grassland	Romania
0.25	44	Semi-dry basiphilous grassland	Czech Republic
1	89	Mountain grassland	Argentina
10	98	Semi-dry basiphilous grassland	Romania
16	105	Semi-dry basiphilous grassland	Czech Republic
25	116	Semi-dry basiphilous grassland	Czech Republic
49	131	Semi-dry basiphilous grassland	Czech Republic
100	233	Tropical lowland rainforest	Costa Rica
1000	313	Tropical lowland rainforest	Colombia
10 000	942	Tropical rainforest	Ecuador

Table 4.2: World records: the richest communities in vascular plant species at different area sizes. Source: Wilson et al., 2012

If we want to contribute to the survival of many forms of life in an efficient way then the proper management of grassland areas is essential. Grasslands provide fast growing animal fodder thus they can support wildlife and domesticated animals at the same time. This is why grassland management should take into account its great potential to create natural habitats while being profitable too. It's also the reason why we don't recommend replacing semi-natural grasslands with intensive ones - as was encouraged during the modernisation process of agriculture in the 20th century. An alarming example: the UK has lost over 98% of its flower-rich hay meadows since the 1930s (Knowles, 2011). To successfully manage species rich grasslands traditional and local knowledge is key because these systems were tested and tailored for many centuries to optimise production to the natural carrying capacity of a landscape. Copying and carefully improving traditional management systems can lead to successful modern agroecological approaches.

ANIMAL BIODIVERSITY

Grasslands are home to an enormous variety of animals. They are key habitats for the existence of European wildlife. In the following paragraphs we present some approaches on how we can improve the survival rate of wildlife in our grasslands especially while mowing.

Mammals

Some of the most important grassland mammals are the roe deer, hare and different rodent species such as the fieldmouse or the ground squirrel. Roe deer give birth in May-June. The young faws often spend time laying in the high grass while does (female deers) are looking for food - sometimes at quite a distance. Such invisible fawns often fall victim during machine mowing just as hares and rodents. A study showed that rotary disc mowers with conditioners caused double the number of small mammal deaths compared to double blade mowers (Oppermann et al. 2000).

Birds

Grasslands provide both food and nesting places for birds. The period between egg laying and fledging (feathers and wing muscles sufficiently developed to fly) takes around 40 days during which mowing is basically inevitably lethal for the chicks. It is important to know which species are present in our grassland but most species leave the nest by the beginning of July. Corncrakes and quails however leave their nests later. Careful driving while mowing can save many birds. Birds which lost their chicks before fledging often start a second brooding which doubles the time of endangerment. When we talk about grasslands as feeding grounds, the best we can do is to provide patches with different mowing times (providing shelter and food) i.e. to maintain mosaicity in the landscape.

Different mowing machinery can make a difference: fewer nests were covered by grass and fewer nests were abandoned at the egg stage when using a swather mower (23% nests covered) compared with bar mowers (60% covered) according to a study carried out from 2006 to 2008 in Dorset, UK. (Defra 2010).

Amphibians and reptiles

Grasslands are rich in both amphibians and reptiles, as they feed and reproduce there. It is a big advantage for them if they find pastures instead of hay meadows, however raised mowing blades and avoiding the application of rotary mowers can save the majority of these animals.

Arthropods

Out of the huge variety of arthropods present in grasslands, the most numerous groups are the orthoptera (i.e., crickets, grasshoppers, locusts) and butterflies. Many of them have very specific dependence on certain plant species for their diet or reproduction. Therefore, declining plant diversity leads to the disappearance of certain arthropods as well. They can be present in every level of the grass therefore using flushing bars can save them by scaring away or encouraging them to fall on the ground.

A randomised replicated trial in 2007 and 2008 in Switzerland (Humbert et al. 2010) found that harvesting meadow plots using a hand-pushed bar mower killed or injured on average 20% of caterpillars (Lepidoptera) added to plots before mowing, compared to 37% when using a tractor-pulled rotary drum mower, and 69% if a conditioner was attached to the rotary mower.

A replicated trial in Switzerland from 1996 to 1999 (Fluri & Frick 2002) found seven times more honey bees (Apis mellifera) were killed or unable to fly when white clover Trifolium repens plots were mown with a rotary mower and mechanical processor (which crushes mowings to accelerate drying) than without a processor (14,000 vs 2,000 honey bees/ha dead or unable to fly respectively). To avoid such dramatic killing it's strongly recommended to avoid the active period of bees thus it's better to mow in the early morning or the evening and much better to use bar mowers.

To minimise killing wildlife in grasslands please refer to the proposed mowing methods introduced in the above section entitled: *Mowing*.

Additional resources
Conservation evidence: Mowing techniques to reduce wildlife mortality

4.3 ARABLE CROP PRODUCTION

4.3.1 OPENING

In most countries in Europe, the majority of agricultural land is arable crop production. Arable crop production is the systematic design and cultivation of typically larger areas of land, often relying on mechanised support, to produce food, fuel, feed, oils and fibres. Over the last 50 years some of the dominant characteristics of arable production include mononculture, increased mechanisation, chemical inputs, and production of cash crops/commodities for long distance international markets. A significant portion of food calories produced and consumed globally are the product of arable crop production. However, as a farming sector, the energy and resource requirements, land disturbance and degradation caused by industrial scale production operations are accepted to be unsustainable. Agroecological techniques adapted on arable farms represent proven methods for sequestering carbon, maintaining healthy living soil, remaining highly productive while also contributing to ecosystem enhancement. As an agroecological farmer, we have to manage our arable fields in a manner which allows plants to have the ability to grow healthy and resilient, to cooperate and utilise the soil food web (see more on page 187) and manage all life processes themselves as much as possible.

Figure 4.10: Field management in an agroecological way: Organic no-till with the roller-crimper method. Credit: GRAND FARM

Additional Resources
TiFN's Regenerative Farming project: How to make regenerative practices work on the farm

4.3.2 SOIL AND NUTRIENT MANAGEMENT

The management of healthy and fertile (nutritional) soil is most important for successful agroecological arable field farming. Plants do need nutrients, which are provided through the soil or coming directly from the air (e.g. carbon, nitrogen). When a crop is harvested, these nutrients are carried away from the field. To make sure there is still enough food available for plants, nutrients have to be either refilled or mobilised from fixed stock directly in the soil. Taking the example of phosphorus, only a small percentage may be in plant-available form in soils. Therefore, if there is a lack of plant available phosphorus, either the nutrient is applied from outside or mobilised from (not plant available) stock in soil. Mobilisation is controlled by plants through connecting to soil microbes and feeding them. To make sure there is enough stock of each specific nutrient in soil, test results from a laboratory are necessary and identifiable where fraction analysis can be done. As long as the stock is sufficient, we only have to mobilise nutrients instead of adding them to the soil.

Within the last decades, nutrients for plants were provided more through input strategies (applying fertiliser in mineral or organic form).

Figure 4.11: Compost application on an organic field. Credit: GRAND FARM

Nutrients stored in the yielded crop were calculated and replaced by inputs which were either created on farm (manure, compost (see more on page 179)) or externally (mineral or organic fertilisers and soil amendments). More and more researchers and practitioners are pointing into the direction of biological instead of nutritional management of soils, which is a more natural and therefore agroecological approach, mimicking natural processes.

In nature, plants rely on the natural nutrient cycle and on their own activities, controlling nutrient uptake by releasing root exudates (substances originating from photosynthesis, see more on page 185). When plant debris (leaves, stems, roots, etc.) from the last crop are decomposed, organically fixed nutrients are slowly transformed into a plant available form and can be utilised.

If there is a lack of nutrients, plants additionally release root exudates and feed microbes in the soil (bacteria, archaea, fungi, protozoa). These microbes also leach nutrients from mineral and organic compounds in the soil and when they die, nutrients are released. They are plant-available and utilised by roots. Plants can also get into even more complex symbiotic relationships with rhizobium bacteria (see more on page 186) and mycorrhizal fungi. The bacteria are allowed to grow within the root and can fix nitrogen from the air, which they make available to the plants.

Figure 4.12: Plant debris from soybean decompose and release nutrients. Credit: GRAND FARM

Mycorrhizal fungi (see more on page 183) on the other hand exchange water, phosphorus and nitrogen with the plants and help with disease defence. Through the resulting mycorrhizal network, plants exchange nutrients and information with other plants even from different species. All of these processes are more active when there is a certain lack of available nutrients in soil. If farmers provide an excess of plant available nutrients through overfertilization, these processes are slowed down until completely stopping. Plants then fully rely on farmer's service. The active cooperation from plants with microorganisms on the other hand increases the resilience of the plant-soil ecosystem and plants can "self-manage" several life processes.

Primary productivity: Food, fodder, fibre, fuel production
Water purification: Infiltration, purification and regulation
Carbon sequestration: Climate change mitigation
Nutrient cycling: Maintaining a healthy store of available nutrients in soils
Biodiversity: Soil food web, genetic pool

Additional resources
TiFN's Regenerative Farming project: Regenerative agriculture - The Soil is the base

4.3.3 CROP ROTATION

One of the most important necessities to manage soil and nutrient management in arable field farming is the incorporation of a certain crop rotation (see more on page 179). The more diverse the crop rotation is, and the more different plant families are included (eg. legumes, grasses, brassicas) the better. In general, 20-25% of legumes are recommended in organic arable field farming. When deciding which crops are grown year after year on the same field, we have a strong impact on a series of important farming characteristics:

- availability of nutrients
- weed suppression
- general soil health aspects (soil functions)
- disease management
- pest management
- tillage reduction
- cover crop implementation
- plant coverage through the year
- risk management (weather, market)
- crop sales

Example of an extended crop rotation including cover-crops (CC):

barley+lucerne - lucerne - winter wheat (CC) – hemp (CC) – soybeans or lentils - rye (CC) - hemp (CC) - spring oat (CC)– barley+lucerne

Because of climate change, more regions in Europe can adapt to two crops per year in arable field farming. The combination of two short season crops like buckwheat following an early leaving winter barley, pea or oil seed rape can be combined. Still, because of the difference in climate, soil and markets across the European landscape, a general recommendation can not be made.

Additional Resources
SARE Crop Rotation planning manual on organic farms

4.3.4 COVER CROPS IMPLEMENTATION

Cover crops (see more on page 179) are seeded with the purpose not to be harvested (contrary to a cash crop) but to benefit the soil, climate, environment and most important the success of the following crops. The implementation of cover-crops is a strategic decision which does bring a lot of benefits to farming practices. The fear from the competition for water with the following cash crop has been proven irrelevant in most regions, in fact, moisture losses in uncovered soil are equal or even higher without the potential for adding any benefits to the field. Implementing cover crops also provides the opportunity to increase the organic matter in soil as well as providing a cover for the soil, protecting and avoiding evaporation while creating a living, or later on, a dead, but rich in organic matter mulch.

Depending on the crop rotation, different types of cover crops are possible. In most cases and following the agroecological approach, mixes from different plant families are recommended (the more the better, significant improvement is expected from 5 to 8 different families like legumes, grasses, brassicas). When frost is expected during winter, farmers can decide if they use frost killed or frost resistant mixes. The earlier the cover crop is established, the more benefits can be expected. The following benefits can be expected from cover-crop implementation:

Figure 4.13: A diverse and early seeded cover crop has many benefits. Credit: GRAND FARM

- Nutrient availability for following cash crop (collection, storage and mobilisation)
- Carbon sequestration through liquid carbon pathway (photosynthesis)
- Improved soil structure through different root structures
- Incorporation of organic matter (plant debris)
- Reduced soil erosion (wind and water)
- Reduced weed pressure
- Food and habitat for pollinators, beneficial insects and wildlife
- Food for livestock (mob grazing)
- Catching water from the air (fog)
- Reduced unproductive evaporation

Additional Resources
Rodale Institute: Cover Crops
CSUCHICO: Cover Cropping

4.3.5 ORGANIC AGRICULTURAL INPUTS

Aiming for a higher amount of organic matter in the soil is aiming for soil structure, water infiltration, available nutrients, habitat and food for the soil food web, carbon sequestration, pore volume and even more benefits. If available, inputs can help to raise the level faster. Compost, manure, plant debris from cash and cover crops help to feed the soil. We have to make sure the quality of the input material is good enough to put them into our soils. Besides analytics for chemical and physical characteristics of input materials, absence or presence of non-decomposable debris (microplastics) is important.

4.3.6 TILLAGE

The management of soil health and nutrients can be done through different activities. Tillage has an enormous impact on soil characteristics and functions and therefore has to be taken seriously.

Any tillage activity has to be evaluated for necessity, intensity, benefits and disadvantages. If tillage has to be done, it is recommended to try to reduce passes, tillage depth and intensity (rpm) as well as weight and tire pressure of the equipment.

Figure 4.14: Impact of tillage on soil. Credit: GRAND FARM

Figure 4.15: Simple tyre pressure adaptation system. Credit: GRAND FARM

Figure 4.16: Using a spade, soil conditions can easily be checked before tillage activity. Credit: GRAND FARM

Tips for more conscious tillage practices include:
Before starting, check soil and weather conditions (dry, wet, frozen) to adjust and complete tillage during optimal conditions.

In organic arable field farming, we have to reduce weed pressure through different management methods (crop rotation, cover crops, mixed seeds, tillage).

According to the previously mentioned crop rotation strategies including cover-crop implementation, a recommended tillage management strategy could be performed as follows:

YEAR	SPRING TILLAGE	CASH-CROP	AUTUMN TILLAGE	COVER CROP OR CROP
1	Reduced	Oat+lucerne	No	Lucerne
2	No	Lucerne	No	Lucerne
3	No	Lucerne	Reduced	Winter-wheat
4	No	Winter-wheat	Reduced or no	Cover-crop
5	Reduced	Hemp	Reduced	Cover-Crop
6	Reduced	Soybeans	Reduced or no	Rye
7	No	Rye	Reduced or no	Cover-crop
8	Reduced	Lentils	Reduced or no	Cover-crop
9	Reduced	Oat+lucerne	No	Lucerne

Table 4.3: An example for crop rotation. Source: trAEce 2022

This example is only theoretical and in practice will not happen as described. With every single situation, before conducting no-till management the weed pressure has to be observed and considered carefully.

Reduced and no tillage

20 years ago, it was considered necessary to use a plough in organic farming to reduce weed pressure, now reduced tillage is more often incorporated into organic arable field farming. Specific equipment is now used instead of deep ploughing which results in lighter tractors and much shallower tillage (e.g. 4 cm instead of 30 cm). Using such methods, even the termination of lucerne and grass clover mixes are possible as well as reducing the pressure of e.g. thistle. Sometimes, when the field does not have significant weed pressure, no till can be conducted right after harvesting. Some farmers even spread cover crops before harvesting and when they combine later, the seed is covered with chopped up straw or they seed the cover crop directly into the remaining crop residues.

Figure 4.17: Example for specific equipment for reduced tillage (4 cm). Credit: GRAND FARM

Additional Resources

Rodale Institute [What is tillage]
Resilience.org [Notill farming]
FAO [Notill improves soil functioning and water economy]

Nurse crops, relay cropping

Another method for avoiding additional tillage is the use of nurse crops to establish perennial lucerne or clover crops. Spring oat or barley is seeded together with lucerne (Medicago sativa) or a grass-clover mix, the cereal is harvested, and the perennial crops stay for the next years. Additional equipment has to be available to apply relay cropping. Winter wheat is seeded in wide rows (e.g. 45 cm), hoed in spring and later soybeans are seeded in the middle of the rows using differential GPS. Later in summer the wheat is combined (the tires are only allowed to drive on the wheat rows) and the soybeans remain until autumn.

Figure 4.18: Oat as a nurse crop for lucerne is harvested. Credit: GRAND FARM

Additional resources
Smartproteinproject.eu protein crop production
Agricology.co.uk living mulches

Organic no-till roller crimper method

Figure 4.19: After slicing the seed into the soil which is covered by the created mulch, soil should no longer be visible for good weed suppression. Credit: GRAND FARM

An innovative method for using no tillage at all for crops which would normally need intensive tillage like corn or soybean was established by Rodale Institutes CEO Jeff Moyer. The so-called roller-Crimper method utilises a cover crop, seeded in early autumn (like rye). In spring, the rye is rolled, the stems are crimped, and soybean seeds are sliced into the created mulch layer (see also figure 4.10).

The process needs a roller-crimper and a seeder which can manage the mulch.

When the whole process is done right in one pass, the next time going over the field is already for harvesting. The roller crimper method needs some experience, the right equipment and weather conditions. When it can be established successfully as an aspect of farm management, it offers significant opportunities in carbon sequestration, increasing biodiversity, reducing costs, stopping erosion and other additional benefits.

When using corn as a cash crop, the cover-crop has to deliver nitrogen, therefore hairy vetch is recommended as a cover-crop instead of rye.

Figure 4.20: Roller-crimper mounted in front of a tractor-seeder combination. Credit: GRAND FARM

Figure 4.21: Plant debris from soybean decompose and release nutrients. Credit: GRAND FARM

4.3.7 CLIMATE RESILIENT AGRICULTURE IN ARABLE LAND MANAGEMENT

Everyone is aware nowadays that we have to mitigate climate change. Still, even if we stop emitting greenhouse gases, the turnaround will take decades to come. Therefore, we have to adapt to the change of the climate. For all regions, this means it is getting hotter, for most regions even dryer. Even if it is expected that the precipitation stays on the same level, because of raised air and soil temperature, there will be the requirement to conserve water. A good method to adapt to climate change is the installation of agroforestry systems.

Figure 4.22: Multi-functional hedges are typical in agroforestry systems. Credit: GRAND FARM

With each metre of height of such a wind barrier, 10 m to 20 m of reduced wind speed is provided to the leeward side of the agroforestry system. Less wind means less evaporation and therefore saving water for the crops. Another method to adapt to climate change is the use of reduced tillage. When only tilling 3 cm to 4 cm deep, the seed can be put into uncultivated soil, where water transport can still take place and much more water is available for germination. Another benefit of reduced tillage is that biomass is not buried into the ground during tillage, but stays on top and covers the soil. Again, evaporation is reduced.

Another effect of climate change is heavier rain events. Soils must absorb and allow huge amounts of pouring rains to infiltrate during thunderstorms or weather events which keep going for days or weeks. Reducing tillage maintains healthy soil structure and allows for water infiltration. The more earthworms are active (mulch on the surface keeps them thriving), the more water can be infiltrated, stored and provided to the plants during a following drought. Tilling along the contour line is a good method to slow down water runoff and make sure water can infiltrate. But infiltrating water is not only good for storing water for the next drought. The less water is leaving the field on the surface, the less soil is taken away with the water. Soil erosion does not happen because it rained, it rather occurs because the farm landscape could not hold the water (and therefore the soil) on the field.

Figure 4.23: Brown water is a clear indicator, rainwater could not infiltrate and caused erosion, soil is lost forever. Credit: GRAND FARM

4.3.8 MECHANISATION AND CULTIVATION PRACTICES

Farmers can spend hundreds of thousands of Euros on equipment. Regarding soil health, often less is more. Even if the trend still leans towards heavier equipment, it is recommended to try to use lightweight equipment, which is often better for reduced tillage. If affordable, semi-mounted equipment is better because smaller tractors and reduced tire pressure can be used.

Figure 4.24: Semi mounted equipment is more expensive but has its advantages. Credit: GRAND FARM

Before buying tillage equipment, one must make sure to fully understand the advantages and disadvantages of the tool in regard to a tractor, crops, soils, and even landscapes which are managed. Tillage is always a compromise, between quality of work, damage of the soil, energy input and costs.The aim for reduced tillage is to have a lower number of passes on the field, reduce the depth of the tillage measure and also the intensity of the measure. Therefore, PTO driven rotary cultivators should be avoided or used with low number of rotation per minute only. Also the speed of the tools going through the soil is important. It is recommended to not go faster than 12 km/h, because the damage on the soil structure is heavier if speed is increased. Regarding the costs, tillage equipment can easily be shared, sometimes including tractors.

Tire pressure

Adapting tire pressure with the standard tire valve installed takes too long and most farmers try to avoid it in the long run. But there are significant advantages, when different tire pressure is used for field work versus street work. Depending on the weight of the tools mounted on the three point hitch, tire pressure can vary from 0,5 bar to 2,5 bar. This makes a huge difference to the impact for compaction of the soil, but also on the consumption of fuel. If a tractor sinks one centimetre deeper into soil, the fuel consumption can be increased by 10%. Reduced tire pressure increases the surface area of the tire and therefore the tractor does not sink as deep into the soil.

Even if the usual tire pressure adapting systems are expensive (starting with € 5.000) there are simple solutions (€ 300) capable of 90 % of the benefits from an expensive tire pressure management system. These systems are easy to install and the tire pressure is only adapted once when mounting the next equipment to the tractor. (see figure 4.15)

4.3.9 SEASON EXTENSION TECHNIQUES IN ARABLE CROP PRODUCTIONS

Depending on location, climate, soils and crops a certain season is available for growing on the fields. This growing season can be extended, sometime in a way to even grow two crops instead of one in a year.

Extending the season is providing suitable conditions for the crop on the field for a longer period of time. This can be implemented, when a hedge is planted and the crops on the nearby field can grow longer because of reduced water evaporation. This can also be achieved through the usage of irrigation systems, which allow crops to grow despite hot and dry conditions. Sometimes variety selection is key, which can allow crops to thrive longer into the frost free season, due to climate change or a fleece-cover on top of an e.g. potato field, which makes it possible to grow early potatoes. When extending the season on an agroecological farm it is worth to estimate if the method is still sustainable, otherwise you end up heating asparagus in open fields, which is also season extension but not exactly the approach which is compatible with agroecological practice.

4.3.10 INCORPORATING LIVESTOCK AND ANIMAL HUSBANDRY

One of the most promising methods to increase soil health is the implementation of livestock on the farm. Not only are they capable of converting side products (e.g. from crop separation) into animal based produce like milk, egg, meat, wool or even workforce, while at the same time providing manure as a soil amendment and fertiliser. One of the preferred options is mob grazing, where herds with a dense population are used to graze a specific area for a certain time. The idea behind mob grazing is to mimic nature. The herd is supposed to graze 1/3 of the area, trample 1/3 and leave 1/3 of the plant biomass. The density of the herd (animals per area) and the time spent between rotations strictly depends on the condition of the grazed area. Implementing such methods is beneficial for soil health, productivity, the landscape, biodiversity, risk splitting and farmer's profit. Still, adding another sector to the farm also means additional need for knowledge, investment and labour.

4.3.11 PLANT PROTECTION TECHNIQUES

The agroecological approach for plant protection is to avoid spraying plant protection agents at all. Instead, precautionary measures are recommended. This includes the incorporation of agroforestry, flower strips, mixed seeds and strip cropping (see more on page 188) to provide a habitat for beneficial insects, birds, bats and wildlife. The aim is to mimic nature in diversity and develop healthy ecosystems, where pests and diseases are not killed but suppressed to a level where the damage is acceptable. This is also the strategy, when applying crop rotation or implementing diverse cover crops into the management practices. But also compost application, seed coating with compost tea/liquid compost and tillage measures can help to control pests and diseases. For some crops, it is even worth to cover the plants with insect fleece or to mix a plant species in, which attracts the pests instead of the cash crop. Creating healthy ecosystems is the aim, even if this will take years to develop and there is still a lot of research and development necessary. Strong and healthy plants do not attract pests and diseases at all and if infected, can protect themselves for a large part. This may not be true for all and every pest and disease pressure, but often makes a significant difference between a healthy and a damaged crop or a damaged and a lost crop.

4.3.12 DATA ANALYSIS AND MONITORING

Sustainability (see more on page 188) is defined through three pillars: environment, society and economy. On agroecological farms, there is often a strong focus on the environmental and the social pillars. , we also have to be economically sustainable, otherwise we will soon be out of business. Monitoring costs and income is critical to make sure we know what the financial situation is. But this is not the only reason for monitoring. Organic certification does need a variety of information and monitoring, as well as the documentation of pesticide and fertiliser application. All of that can be done by hand, or documented and calculated with the help of spreadsheet applications.

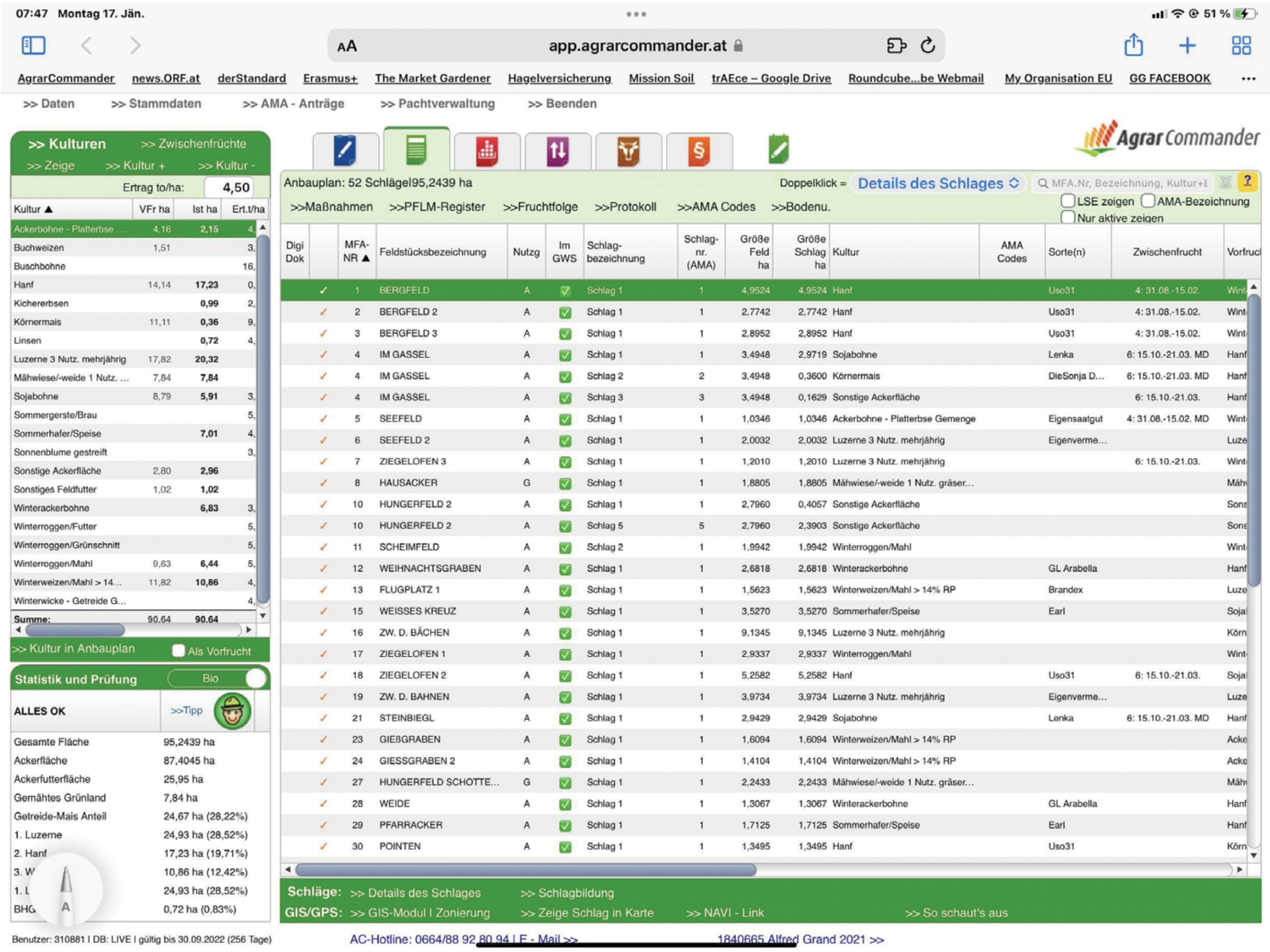


Figure 4.25: A typical farm management software. Credit: GRAND FARM

There is also a range of farm management software available, which can support the work on the farm. These apps should be adapted already for use in a specific country, because not only the rules and legislations are different in each country, but also the implementation of the Common Agricultural Policy.

Additional resources

Rodale Institute, USA: https://rodaleinstitute.org
The Organic Research Centre, UK: https://www.organicresearchcentre.com
Forschungsinstitut für biologischen Landbau, FIBL, CHE: https://www.fibl.org/en/
Organic prints: https://orgprints.org
Agroecology Europe: https://www.agroecology-europe.org
Centre for Sustainable Food Systems, UBC, USA: https://www.litefarm.org/

4.4 SMALL SCALE DIVERSIFIED VEGETABLE PRODUCTION & MARKET GARDENING

4.4.1 OPENING

Small scale diversified fruit and vegetable farms and market gardens represent valuable links in agroecology inspired, localised food networks. Such gardens provide a framework for creating dynamic and financially viable micro-scale growing systems which personify agroecological principles of material and nutrient flow balance, species diversity and biodiversity, equality and social cohesion, waste reduction both on farm and in distribution, with ecosystem enhancement. Diverse market gardens also help show that farm communities (see more on page 179) can thrive at small scale, and that profitable agriculture is possible without being reliant on area based subsidies.

Market gardens are oriented to produce a diversity of fruits, vegetables and animal food products on relatively small parcels of outdoor land, often in combination with polytunnels (usually from 5 to 10 hectares in total). They sell fresh and minimally processed products directly to food communities, typically employing a higher number of workers per hectare than conventional farms. Small scale diversified gardens have a historic legacy in locations across Europe and globally, and can be adapted to local climatic, soil and weather conditions. Producing food for local markets is not novel, but contemporary gardeners face obstacles where local channels of distribution have disappeared, cooking habits have changed and supermarket culture dominates. Market gardeners attempt to find the right recipe for creating economically stable, intensive and diverse crop production plans while farming with less mechanisation and fewer chemical inputs.

Farm managers at all scales can learn from the numerous resiliency principles embedded within the market garden model and their potential for empowering proximate food networks. Helpful roadmaps published for aspiring market gardeners have gained popularity in gardener communities, including numerous publications on all-season biointensive gardening by *Eliot Coleman The New Organic Grower* (2018), *Jean-Martin Fortier's (2014) The Market Gardener*, *Jesse Frost's The Living Soil Handbook (2021) and Josh Volk's (2017) summary collection of functioning Compact Gardens.*

Several principles which guide small-scale diversified fruit and vegetable production and market gardening have great potential in positively impacting larger operations, including arable farms and animal husbandry operations. A number of advantageous principles of such "human-scale" farm models include:

- Lower upfront costs in establishing farms that intensively cultivate small areas with reduced reliance on machines, with an integrated use of appropriate technologies (i.e., hand tools) (see more on page 177)
- Maintaining models independent of area- or yield-based subsidies
- Avoiding common pitfalls of attempting to recoup financial losses by gradually increasing cultivated areas and yields
- Opportunities for higher prices per unit for premium products and greater control over price-setting
- Increased resilience against impacts of crop losses caused by unfavourable seasonal conditions, pests or diseases through crop diversification
- Diversified income from on farm events, training and community days
- Greater ability to develop loyalty through direct connections with customers.

A number of base characteristics of market gardens such as species diversity, day to day contact with soil, a reliance on skilled human labour for maintenance and cultivation, and a robust crop rotation are examples of agroecology in practice on the farm and such techniques can serve as the foundation for agroecological transition (see more on page 189) on farms of all types. In addition to garden practices, the direct marketing techniques which market gardeners establish provide the basis for localised food networks which shorten the distance between food producers and consumer communities. A number of examples of agroecology in practice relevant in small scale diversified vegetable production and market gardening are described within this section.

4.4.2 CLIMATE RESILIENT AGRICULTURE IN DIVERSIFIED VEGETABLE PRODUCTION

With increasing climate change, farmers should expect, if they are not yet already experiencing, the more frequent occurrence of extreme weather events and climate induced disasters, such as flash floods, extended drought periods, heat waves, wildfires, violent storms and overall greater climate variability (Oxfam International, 2021; Choptiany et al., 2015). These climatic events result in crop failure and consequently in food insecurity, threatening farming livelihoods and rural communities.

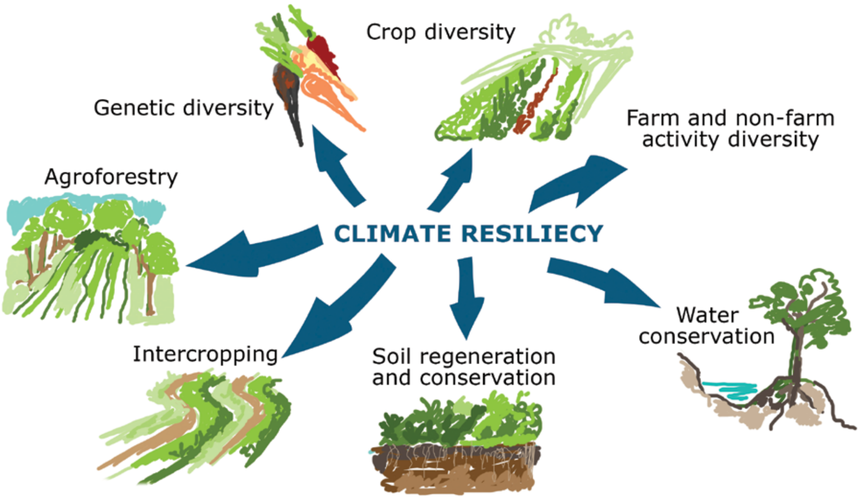


Figure 4.26: The different aspects of climate resiliency. Credit: Miguel Encarnação, adapted by Júlia Csibi

The set of practices that allow agroecosystems to withstand the adversities of climate change and still remain productive is called climate resilient agriculture (Badjie & Barrow, 2017). Every agroecosystem in the world has its own particularities, so it's impossible to describe universal practices that fit all contexts. As a general approach based on a set of common principles climate resilient agriculture can be interpreted as: using different varieties of the same crop (genetic diversity), diversifying crops produced, diversifying farm and non-farm activities, increasing the use of water conservation techniques, implementing soil conservation and regeneration practices, intercropping (see more on page 183), mixing high yielding water sensitive varieties with less productive drought resistant ones, the integration of agroforestry and forestry practices (Choptiany et al., 2015). Specifically, in coping with climate change, market gardens can adopt several practices, including:

EXAMPLE OF PRACTICES	EFFECT
Efficient irrigation system	Increases the resiliency of the system in the face of drought.
Mulching with organic residue	Reduces evaporation; protects the soil against extreme temperatures, sun rays, and rain impact; suppresses weeds and pests.
Raising or mounding beds	Drains the excess water from the beds, during the wet season, preventing root asphyxiation.
Sinking beds	Concentrates the water in the crop during the wet season.
Installing biodiverse hedges	Creates habitat and provides food for beneficial insects, reducing pest pressure; slows wind speed, reducing evaporation.
Cultivation on contour	Reduces erosion; retains water.
Permanent soil cover with crops, green manures and crop residues	Reduces erosion; increases the SOM content; supports biodiversity.

Table 4.4: Example of practices that contribute to climate resilience, and some of their practical effects in the agroecosystem. Source: Agrisud International, 2010

Agroecological diversification also creates new market opportunities, thus reducing the risk of failure in the face of climate change. Farmers can diversify by integrating annual and perennial crops, with livestock and other agroecosystem components. A goal of increasing diversity is to maximise ecological processes (see more on page 180), leading to resource-use efficiency and resilience. This lowers the dependency on external resources and consequently results in greater autonomy and resilience in the face of climate and market shocks (FAO, 2018).

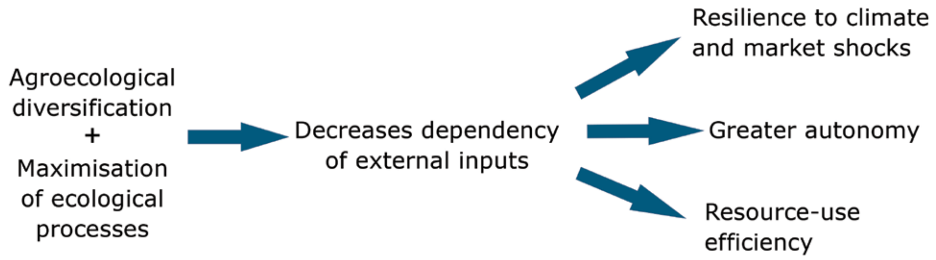


Figure 4.27: Results of agro-ecological diversification combined with maximisation of ecological processes. Credit: Miguel Encarnação, adapted by Júlia Csibi

In order to adapt to climate change, farmers need to implement agroecological innovations adapted to their context. Promoting local discussion groups, where farmers open their farms to neighbours and share the results of different experiments, results in the co-creation and sharing of context-specific knowledge.

See trAEce video - Syntropic Garden: Dryland Agroforestry in Portugal https://www.youtube.com/watch?v=3Ow9pkjQNmU

4.4.3 BUILDING ORGANIC MATTER

A healthy soil lies at the heart of any well-functioning agroecosystem, and a holistic soil management with the aim of building soil organic matter (SOM) (see more on page 187) is a key to the success of organic market gardens. SOM is a general term to describe a multitude of organic compounds present in the soil in different stages of decomposition. In its most stable form, we find humus which stores a great amount of carbon for hundreds of years. In agriculturally productive soils, organic matter content, or the fraction of soil which is composed of live or formerly living matter, may only be around 5%, and depending on geographic location and historical usage, less than 1% (Rodale Institute, 2021). Some benefits of SOM and humus in soils are listed in Table 4.5 below.

BENEFITS OF SOIL ORGANIC MATTER (SOM)
The humus content of soil results in a stable store of nutrients
Improves soil structure, soil's water and nutrient retention capacity, making clayey soils more aerated and sandy soils more moist
Provides readily available nutrients and habitat for beneficial microorganisms in soil
Helps sequester atmospheric carbon
Increases the biodiversity of soils making it harder for pests and diseases to dominate

Table 4.5: The different functions of organic matter in the soil. Source: Rodale Institute, 2021; Agrisud International, 2010

Life within soil, including microorganisms such as bacteria, algae and fungi, and macro organisms such as worms and insects, is the primary responsible for the decomposition of organic matter. Organic molecules composed mainly of carbon are the fuel that makes the engine of the soil work. The energy they provide fuels the soil food web (see more on page 187) and ultimately creates humus (Agrisud International, 2010). In market gardens in particular, building soil organic matter (SOM) (see more on page 187) content is a goal in order to maintain healthy growing conditions and to avoid an imbalance in soil nutrient flows (Rodale Institute, 2021).

A long term soil health improvement strategy will also have positive financial impacts in relation to greater predictability of production and higher quality products. A number of key aspects for building healthy soil, including steps for increasing soil organic matter content in small gardens are listed below, with key additional reference resources featured for additional research. Independent of soil types, a soil enhancing program that includes informed tillage decisions, consideration of soil organic matter, the usage of crop rotations, cover crops, compost and soil amendments will have a positive impact on soil health (Rodale Institute, 2021).

Additional Resources
Best 4 Soil Project: Soil Organic Matter

4.4.4 BALANCING NUTRIENTS IN A MARKET GARDEN

When considering nutrient flows, natural landscapes, like forests, coral reefs, prairies and savannas, are able to produce and maintain healthy and complex communities of big plants and animals without ever receiving synthetic fertilisers or human intervention. This happens because of the complex interactions between all life in the ecosystem. The different ecosystem processes result in the recycling of nutrients which in turn allows the nutrients to be used multiple times by different plants and animals. Natural ecosystems also have the particularity of being closed systems, meaning no big amount of nutrients are permanently exported out. On the other end of the spectrum we have agricultural systems, which are open systems, where ecological processes are simplified or eliminated and replaced by input use, and a large amount of nutrients is tendentially exported out of the system. This is typically the case in market gardening systems as well which can only remain productive while pursuing sustainability if "exported," or utilised nutrients, are replaced.

Plants need macronutrients (nitrogen(N), phosphorus(P) and potassium(K)) in big amounts, but the presence of micronutrients (boron (B), nickel (Ni), iron (Fe), zinc (Zn), molybdenum (Mo), manganese (Mn), copper (Cu) and chlorine (Cl)) is a necessary condition for healthy plant growth (Coleman, 1989).

ELEMENT	ROLE IN THE ECOSYSTEM	WAYS TO ENHANCE THE PRESENCE
Nitrogen(N)	It is a structural part of essential molecules such as: amino acids, proteins, chlorophyll, vegetable hormones, etc.; Essential for the decomposition of biomass in the soil.	Biological fixation by the association between rhizobium bacteria and leguminous plants and posterior incorporation in the soil through green manuring; Application of soil amendments such as fava bean meal, alfalfa meal, compost, manure, etc.
Phosphorus (P)	It is a structural part of essential molecules such as: nucleic acids, nucleotides, lipids, coenzymes and sugars; It is essential for the transfer of energy inside organisms; Regulates the ripening of fruits.	Minimum tillage of soils enhances the presence of mycorrhizal fungi, which in turn mobilises phosphorus and gives it to plants; Application of amendments containing phosphorus in mineral form.
Potassium (K)	It participates in several processes inside organisms, such as: photosynthesis, synthesis of starch and proteins, cellular extension, opening and closing of stomata, transport of photo-assimilated compounds.	Adding potassium in soluble mineral forms; Adding potash, seaweed, compost and manure; Adding rock powder can have a long term effect on potassium availability.
Micronutrients (Fe, Mn, Cu, Zn, Ni, B, Mo, Cl, etc.)	They participate in many essential processes inside organisms.	Adding micronutrients in mineral form; Adding manure, compost, etc.

Table 4.6: Macro and micronutrients - presence and effects. Source: adapted from Römheld & Marschner, 1991; Schachtman et al., 1998; Amtmann & Rubio, 2012; Leghari et al., 2016

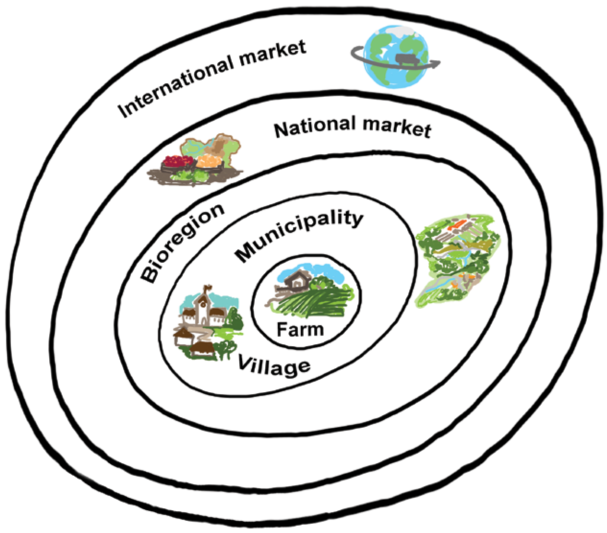
Such techniques aim to create a healthy soil environment which has the proper conditions for ensuring plant nutrition through natural processes, as opposed to conventional methods which seek to "feed" crops with artificial inputs. Nutrient depleted gardens benefit greatly from the periodic application of such micronutrients in mineral forms, but this should only be done by experienced farmers or with the aid of extension/advisory services. Additional strategies for developing healthy soil in practice in market gardens can be found in this section.

The dose makes the poison. The overuse of manure can have the same contamination effects on ground and surface water as synthetic fertilisers and stimulate pests such as aphids. Excessive applications of micronutrients can prove toxic for plants and animals. A rational and balanced application of amendments should be cared for.

Additional Resources
Nebraska Extension: Nutrient management in organic farming
OFRF: Soil biology guide
Minnesota Extension: Understanding nitrogen in soils

4.4.5 ORGANIC AND AGROECOLOGICAL INPUTS

Agricultural inputs can be divided in two categories: consumable inputs (seeds, compost, fertilisers, pesticides and fungicides, water, feed and fodder for animals, fuel, etc) and capital inputs (tractors, ploughs, irrigation systems, tools, etc) (East-West Seed, 2018). Because of the concentration on orienting a production system towards high value outputs in market gardening, the source of inputs and compatibility with social and environmental concerns is often overlooked. With such an orientation market gardeners may maximise value generating activities, but on the other hand, remain dependent on external inputs. Many times for the sake of time efficiency and geography, many market gardens tend to buy their seeds, plants and amendments from specialised companies that very often are a long distance away. Agroecology transition is a process that takes time and knowledge, and the source of farm inputs is a key factor. Replacing synthetic inputs with organic inputs is a key step in agroecological transition. However, transition from input replacement to agroecology can only happen if farmers start switching inputs for ecological processes. For example, switching from pesticide application to beneficial insect habitat creation, and from synthetic fertiliser application to agroforestry and domesticated animal integration are examples of integrating ecological processes which can substitute artificial inputs.



Adopting ecological processes takes time and even the most advanced agroecological farms use inputs to an extent. In ideal conditions with the aim of reducing associated environmental impacts, inputs should preferably be produced in the farm, but if this is not possible, they should be procured in the village, municipality or bio-region (see more on page 177) in which the farm is located. This type of localised production helps support local supply chains and the local economy. When the required inputs are not available in the territory, then farmers should see if on a national level they are present, and if not, on an international level. But

Figure 4.28: Different possible origins of agricultural inputs. The more a farmer goes away from the centre to get the required inputs the less sustainable the farm becomes. Credit: Miguel Encarnação, adapted by Júlia Csibi

be aware that importing from large distances is not sustainable and does not contribute to the local autonomy. Being dependent on external inputs that come from large distances can be a major threat in case a crisis happens.

Seeds can be bought from suppliers, saved on the farm or exchanged in local seed networks. The same goes for crop transplants. Manual tools used by market gardeners can reduce on farm fuel use (The Market Gardener, 2021). Tractors can be replaced by a rototiller, animal traction or manual tools. As mentioned before, the most common way of managing fertility in a market garden is to add organic matter. It can be added in a processed form (compost, manure, bokashi (see more on page 178), vermicompost (see more on page 189) (Munroe, 2007)) or in an unprocessed form (organic residue). Additionally to SOM, there are different types of rock powder (ex: basalt, limestone, gypsum), and other amendments (wood ash, specific micronutrients) that can be used to supply micronutrients, improve soil health and capture CO_2 (Beerling et al., 2018). Creating relationships with surrounding animal farms, processing plants and municipalities can provide a good source of raw materials.

Rock powders and wood ash should always be applied in moderate amounts and after consulting an experienced person or extension services.

4.4.6 LOW IMPACT CULTIVATION AND REDUCING TILLAGE

When gardeners cultivate soil they are often aiming for an efficient means of managing weeds and creating good conditions for germinating seeds or transplanting seedlings. A clean bed after mechanised cultivation does not necessarily equate with optimal "tilth" or a soil's ability to hold moisture, circulate oxygen, and support root growth (Rodale Institute, 2021). Soil tillage and any form of cultivation have an impact on the structure of soil, and life within the soil. In market gardens, farmers aim to maximise the utility of smaller growing areas, while pursuing the most efficient way to maintain soil health and structure, and create conditions for multiple cycles of crops which can be produced throughout a growing season, or where feasible, in all seasons. A useful technique for achieving this includes implementing permanent growing beds.

Establishing permanent beds (see more on page 185) creates an alternative to deep cultivation through ploughing or digging at the end of each season. Systematically designating growing beds allows for the possibility to manage and build fertility, reduce and control weed growth, and avoid soil compaction while also efficiently managing areas manually with simple but effective tools. In this arrangement, the growing areas are referred to as **"**permanent beds**"** as they are established as the growing mediums which are retained from season to season, year after year. Permanent beds are typically sized based on the type of plot they occupy, with fixed widths (typically 80cm to 120cm to promote efficient handwork and harvesting from both sides) and uniform lengths which help standardise crop rotation planning. Beds can be "raised" slightly (about 5cm to 15cm based on preparation) above adjacent walking paths (typically 30cm to 50cm based on maintenance practices) by marking out and slightly digging out walking/working paths at the beginning of each season, and topping up with compost additions throughout the season based on subsequent crop requirements. Walking paths/working paths on the sides of each growing bed can be covered with a mulching layer of ramial woodchips (woodchips created from younger branches and twigs of deciduous trees and woody shrubs, see more on page 185) or other organic materials to help prevent weeds throughout the season while feeding microbiological activity within the soil.

See trAEce video - Zsamboki biokert introduction - permanent bed systems, composting and bed preparation in regenerative organic farming in Hungary: https://www.youtube.com/watch?v=4ol9cIqq4ZM

Figure 4.29: An example of permanent raised cultivation beds with ramial wood chips in paths. Credit: Zsámboki Biokert

4.4.7 ESTABLISHING PERMANENT BEDS

A farm manager can decide what parcels of land can be divided into fixed permanent beds by determining the most efficient use of land area while considering a number of factors:

- starting soil quality (soil properties, compaction and soil structure, drainage properties)
- the desired number of growing areas (beds and block of beds which will hold crops of the same family in a rotation) to support a diverse crop rotation
- the width and length of permanent beds, and amount of space between each bed, with an aim for uniformity to standardise crop sowing, planting, maintenance and harvest
- the location of the beds to other farm infrastructure (vegetable preparation areas, washing areas and tool storage, wells and irrigation system reach, housing and building infrastructure)
- a fertility management system for the beds (composting applications and regularity)

Once it is determined how a cultivation area will be divided into parcels at an appropriate time in the season the entire future permanent bed area can be prepared. There are many options for starting from scratch in preparing growing areas on new plots of land which include varying levels of soil disturbance. Traditional cultivation methods (see more on page 189) with machine or horse have typically been carried out before winter frosts, allowing the soil to break down with freeze and thaw cycles before shallower cultivation can take place in the spring when the soil dries out (Ferencz et. al, 2017). Less intense deep cultivation options include ploughing with traditional horse drawn equipment and modern chisel ploughing machines which reduce the risk of compaction and overcultivationIn recent years the multiple benefits of avoiding soil disturbance as a means of protecting delicate soil ecosystems through no-till approaches have been described in detail in research and practical guides, and no-till approaches for starting market gardens have been summarised in detail in Jesse Frost's *The Living Soil Handbook: The No-Till Grower's Guide to Ecological Market Gardening, 2021.*

During the first occasion of establishing permanent beds, when the soil in an area previously cultivated dries out, beds and pathways can be marked out with measuring string. Beds and paths can be established with specific tractor assisted bed making machinery, but digging out paths and topping up beds with a standard shovel can work just as effectively with less risk of compaction. After the first year of establishment, the necessity for deep cultivation will be avoided, and beds will only require remarking and topping up at the onset of each new season.

Figure 4.30: Traditional ploughing with horse in Hungary. Credit: Logan Strenchock

Figure 4.31: Left below - wheel hoeing out walking paths. Right- digging and topping up permanent beds. Credit: Cargonomia

4.4.8 CULTIVATION AND MAINTENANCE OF BEDS

A major benefit of establishing permanent cultivation beds is the ability to drastically reduce the need for intensive, or deep tilling requirements while still managing areas with low impact tools during preparation, sowing and transplanting, maintenance and harvest periods. Once permanent beds are established a gradual reduction in the amount of recurring weeds should be noticed, and because of a gradual buildup of soil organic matter, moisture retention properties should improve while also remaining in a state which is favourable for sowing and transplanting after shallower cultivation.

A potential problem associated with the permanent bed approach to minimum tillage is the spread of perennial ryzhomal grasses, such as *Cynodon dactylon, Pennisetum clandestinum, Elymus repens*, etc. Ryzhomal grasses should be dealt with as soon as they appear to prevent them from extensively spreading their root systems. (For further information see: Dempsey, 2021).

There are a number of tools for shallow cultivation of permanent beds which can achieve the desired aim of creating a loose, workable layer of soil suitable for sowing directly or planting transplants into (Ferencz et. al, 2017). A number of the steps and useful tools for maintaining permanent beds are listed below.

Broadforking: At the beginning and end of each season, and after each preceding cycle of crops, fixed permanent beds can be aerated with a broadfork. The broadfork is a large metal double handed fork which is typically 60cm-80cm in width with teeth which penetrate 25cm-30cm into the soil. Some broadforks are more adapted to harder clay soils, others to looser sandy soil, and they should be acquired according to soil type. As opposed to turning the soil over directly, the broadfork is used to loosen and lift the soil, while also introducing air into a deeper zone. The tool is specifically useful after preceding crops with less established root systems which have spent a long life cycle in a bed area. After a number of years of following permanent bed cultivation practices, the necessity of broadforking should be reduced, as bed areas develop a healthy soil structure which is maintained throughout the seasons (Frost 2021).

Figure 4.32: Broadforking beds for aeration. Credit: Cargonomia

Before Sowing and Transplanting: Wheelhoeing & Shallow Cultivation

After aeration with broadforking, beds are ready for additional cultivation with hand or small mechanised tools. It is important to only cultivate soils further when they are sufficiently dry to avoid compaction or clumping due to moisture. Testing a soil by hand or with a digging fork is always a reliable way to determine its readiness for cultivation, if the soil does not stick or clump together when grasped in hand or if it does not stick to a fork penetrated into the soil then it is ready for cultivation. Permanent beds can be prepared for sowing or transplanting manually with a wheel hoe, or mechanically through shallow cultivation with a rotary hoe/rotovator. Wheel hoes allow for a quick, manual cultivation of larger areas and can result in the timely removal of any young weed growth while also resulting in a good soil tilth. Rotavators can be used in areas that are difficult to manage with a wheel hoe, or where an additional layer of compost or a significant amount of organic residue from the previous crop remains. It is important to know the barriers of beds when preparing growing areas with the wheel hoe or rotavator to ensure that beds are maintained and that established walking paths are not cultivated. A mechanized rotavator should be used with caution to avoid destroying a healthy soil structure or creating a compacted hardpan between the upper layer of soil.

Figure 4.33: Preparing a bed for sowing with a wheel hoe. Credit: Cargonomia

4.4.9 SOWING, TRANSPLANTING AND MAINTENANCE: RAKING AND HOEING

Once the shallow cultivation of a permanent bed has been completed, the soil can be raked to form a flat surface of loose soil, into which planting and sowing rows can be marked with a row marker. Rows can be marked according to the necessary requirements of the plants which will be grown in the bed. A useful tool for marking out rows is an adjustable row puller, with which spacing can be set according to the requirements of crops, and in correlation with the types of tools which will be used throughout the season for weeding and plant maintenance. Seed sowing and transplant density should be decided accordingly to maximise the utility of space without crowding plants or germinated seeds, while also keeping in mind ease of harvesting the crop when it reaches maturity. Stirrup hoes are useful and accurate hand tools which can be used to manage weeds over large areas, and in agroecological farming weeds are inevitable so timely hoeing is of paramount importance. There are many types of hand hoes available and a farmer can select the type of equipment which they work best with. Staying ahead in the battle against weeds typically depends on three factors: the proper usage of suitable tools, appropriate spacing between crops, and effective soil preparation (Ferencz et. al, 2017).

Figure 4.34: Marking a sowing row, weed control with a stirrup hoe, and hand weeding a bed of spinach. Credit: Logan Strenchock

Additional Resources
No-Till Permanent Beds

Cornell University: No-Till Permanent Beds for Organic Vegetables
Maine Organic: Permanent Raised Beds
The Market Gardener: Benefits of Permanent Raised Garden Beds

4.4.10 COMPOST ADDITION, RETAINING RAISED BEDS & FERTILITY MANAGEMENT

Smaller gardens following certified organic and agroecological practices may find difficulty in "closing the nutrient loop" of the soil food web by lacking the basic resources for creating compost on the site of the garden. Composting is the process by which a usable concentrated soil amendment, rich in organic matter and concentrated nutrients (compost) is created (Ferencz et. al, 2017).Producing compost on site allows for garden managers to have more direct knowledge about the soil amendments they are applying on their own farms, avoid environmental contradictions of sourcing concentrated, pre-made amendments which are products of industrial agriculture (see more on page 182), adjust compost based on local conditions on the farm, while also working towards true closed resource loop production systems.

Stable, mature compost can be applied to soil at any time of year, and has applications in large and small gardens. The application of mature compost on arable fields and in smaller garden plots increases soil organic matter, along with microbial diversity in soil, while also reducing the likelihood of soil borne diseases (Grand 2020). Any amount of manure or vegetable remains stacked in a pile is not necessarily composting, and this text will not be comprehensive enough to introduce the science of composting in detail, but with a good plan, a good base of local resources and a basic knowledge of composting processes, those interested can find success on their own plots. Below are listed a number of key factors which must be considered before initiating a composting regiment on site, along with a number of helpful resources for learning more about composting at different scales (Hayes et. al 2013).

Location: The composting area must be accessible for delivering base material and maintenance, also not a threat to local water sources and in line with local regulations.
Management Methods: Composting at small scale can be achieved without the usage of machines, or at larger scale with assistance from loaders and turning mechanisms. The volume of compost required on site will influence the management plan.
Turning, Aeration and Moisture Control: Compost piles should be turned regularly after their initial placement to ensure a complete breakdown of materials and uniformity of mixture. In addition to regular or mechanical turning, there are a number of new methods for ensuring a proper air flow through a compost pile, including raising compost rows above the ground on base stands and encouraging more airflow through the pile (See figure 4.35: Johnson-Su Compost reactor below). In addition to air flow, moisture retention is a key aspect of biological breakdown, and compost piles should be covered with insulating layers (straw, or permeable synthetic materials) to ensure they do not become too dry, or too water saturated.
Application and Incorporation: A composting regime, or the timing and application plan for composted soil amendments is an essential process in the fertility management strategy in a garden. The amount of farm manure or raw organic material to be composted, and the rate of compost creation should correspond with the amount required to be returned to garden cultivation beds throughout and at the end of each season. Farms which practice animal husbandry will benefit from a good local source of stable manure which can serve as a quality starting resource for composting, and farms without animals on site can explore sources of manure within their locality.

Additional Helpful Resources for On-Site Composting

Best 4 Soil Project: Compost Practical Information
Compost: Advantages and Disadvantages
Compost: Vermicompost
North Carolina University State Extension, USA: Composting on Organic Farms

4.4.11 MANUAL COMPOST PRODUCTION EXAMPLE: MODIFIED JOHNSON-SU BIOREACTOR

A common and traditional method of creating compost consists of the packing of farm manure, vegetable residues, and organic materials in a stacked heap, or windrow, which is stored in place while the biological breakdown of a calculated mix of nitrogen and carbon rich elements occurs. Moisture and oxygen are two key elements which influence the breakdown of organic materials for conversion into a concentrated "compost" resultant mixture. A limitation of common windrow composting is that an imbalance of moisture and airflow within the system does not allow organic material within the pile to degrade sufficiently, resulting in a heterogeneous or immature end product. Research conducted at the Center for Regenerative Agriculture and Resilient Systems at the University of California Chico by Dr. David Johnson and his partner, Hui-Chun Su has uncovered the benefits of fungal rich compost for carbon sequestration and increased soil health (California State University Chico, 2021). The pair's research has indicated the extensive benefits for composting programs which use simple solutions for introducing more air to compost piles. The encouragement of airflow within a compost pile allows for aerobic breakdown of organic materials, while also reducing the amount of water which needs to be introduced into the system for moisture control. An example of a modified Johnson-Su bioreactor which can be applied in windrow scale composting is listed below, along with additional helpful links which go deeper into on-site compost production for farms of different scales. Modified Johnson-Su bioreactors can provide efficient composting solutions on farms of different scales, and can be managed without complex equipment.

Figure 4.35: Modified Johnson-Su Bioreactor. Left: Stacking organic material on wooden pallets with vertical plastic piping remaining in place. Middle: Plastic piping is held in place vertically by a metal post embedded slighting into the ground and with framing between each pipe. Right: After organic material is stacked about to about 1.8-2m in height, pipes and metal framing are removed, leaving air pathways within the windrow. The windrow is then covered with a protective straw insulative layer. Credit: Cargonomia

Figure 4.36: Manually turning and reforming a more than one year old compost windrow. Credit: Cargonomia

Additional Resources
Johnson-Su Bioreactor

California State University Chico: How to Build Your Own Bioreactor
Research on Fungal Dominated Compost and Carbon Sequestration

4.4.12 GREEN MANURES, COVER CROPS AND CROP RESIDUES

Protecting soil from open exposure through cover cropping and cultivation of “living” green manures (see more on page 182) has positive impacts on reducing soil erosion and nutrient leaching, improving structure and increasing soil organic matter and suppressing weeds (Michael, et. al 2020). Green manures and cover crops can be utilised in permanent bed systems and have the same practical benefits as when applied over larger areas. Certain species of cover crops are known for their properties of fixing nutrients (leguminous varieties) or helping make nutrients more available (buckwheat) and can be selected for their growing properties: height, or fast spreading and ground covering, cold resistance or frost sensitivity, according to their desired effects (Michael, et. al 2020, Ferencz et. al, 2017). Crops of this nature are grown for a certain period so then the biomass can be incorporated into growing beds directly, adding valuable organic material to soils before being followed by productive crops in a rotation. Intercropping deep rooted herbaceous plants (such as: mayze, alfalfa, sorghum, etc.) or trees (be it fruit or other helpful trees) with vegetable beds in the garden, can also help capture leaching nutrients from lower soil layers, and enhance soil quality by decompacting it (Ding et al, 2021; Kuht and Reintam, 2001). Deep rooted plants play a key role in the agroecosystem by cycling nutrients, bringing them back to the surface in the form of biomass, where they are decomposed and fuel the soil food web. In smaller gardens, or those practising fixed bed growing areas, green manures and cover crops can be utilised early in season, before temperature sensitive crops can be planted out, during the season, after a spring crop is harvested but before an autumn crop is sown, and late in the season, as “living mulch” which can limit weed growth while overwintering. Some useful varieties of green manures and cover crops which can be used in smaller gardens and fixed beds include:

COMMON NAME	SCIENTIFIC NAME	USAGE
Phacelia	*Phacelia spp.*	Good for short term soil cover, will germinate in cool soil conditions, particularly good in advance of carrots and the flowers are very attractive to bees.
Buckwheat	*Fagopyrum esculentum*	A fast growing, non-invasive green manure good for mid-season catch cropping, and suitable in seed mixes.
Clovers: red, white	*Trifolium incarnatum, Trifolium repens*	Very good nitrogen fixer. More appropriate for longer term leys.
Hairy vetch	*Vicia sativa*	Very good ground cover and good for nitrogen fixation. Often used in combination with a cereal crop - e.g. rye or oats.
Peas and field beans	*Pisum sativum, Phaseolus vulgaris*	Very useful catch crops which can be used singly or in polycultures for biomass and N-fixation. Also useful for germinating in lower temperatures.
Mustard	*Brassica spp.*	A useful, quick green manure with allelopathic effects against some soil borne diseases and pests. When utilising mustard, its place within a balanced crop rotation must be considered. Mustard greens are typically classified as part of the cabbage family or "cruciferous" plants.
Cereals: wheat, barley, oats, winter rye	*Triticum aestivum, Hordeum vulgare, Avena sativa, Secale Secale*	Deep-rooting and often good for outcompeting annual and biennial weeds. Can be used in combination or singly, and incorporated at different stages of growth.
Lucerne/alfalfa	*Medicago sativa*	Dry climate tolerant, deep rooting leguminous cover crop. Good for fodder as well as N-fixation. Benefits accrue in second and third years, although incorporation of older plants can be challenging. Good in polycultures.

Table 4.7: Examples for cover crops. Source: Ferencz et. al, 2017; Clark, 2007

Additional Resources
Best 4 Soil Project Green Manures and Cover Crops-Practical Information
Green Manures and Cover Crops-Advantages and Disadvantages
Rodale Institute Transition to Organic Course: Soils

Figure 4.37: Green manures in different seasons. Left: Green manure mix used as an active soil cover before first summer crop sowing. Right: On the right side of the photo, winter oats "killed" and broken down after winter frosts serving as a ground cover. Credit: Logan Strenchock

4.4.13 END OF SEASON PREPARATION

Towards the end of a growing season and before deep winter frosts, compost can be applied to raised beds after autumn crops are harvested. Residues, roots and thinner stems which remain in soil can be left in place to also contribute to soil organic matter. As part of a season closing process, beds can be broadforked before receiving a layer of compost to encourage healthy structure in the following spring thaw after a winter of freeze/thaw cycles. To reduce the chances of winter and early spring weed germination, silage tarps can be applied to permanent beds which are targeted for the earliest start in the next season's crop rotation. The tarp coverage blocks light from encouraging weed germination while not completely prohibiting biological activity in the underlying soil layer.

Figure 4.38: Permanent beds in their winter stages: Left – beds topped off with a layer of compost after broadforking. Right- beds covered with a silage tarp which are targeted for early spring usage. Credit: Logan Strenchock

4.4.14 HOLISTIC PLANT HEALTH AND PROTECTION

The past years of industrial agriculture have simplified ecosystems to the extent that they cannot function in a healthy way, and pest and disease problems became a serious concern. But pest problems are mere symptoms of biological imbalances. For example by using pesticides, especially broad spectrum, farmers directly kill beneficial insects or damage their ecosystem, creating a vicious cycle which only makes pest invasions more common and damaging, thus obliging farmers to buy more pesticides which then kills more beneficial insects, and the cycle continues, resulting in an increase of external input use. An agroecological approach to plant protection must be based on ecological interactions that come from ecosystem biodiversity. Only by increasing diversity can a farmer stimulate the necessary positive interactions that assure pest and disease regulation.

Figure 4.39: Example of an insect hotel. This type of structure creates habitat in which beneficial insects thrive. It is made with old wood, clay, pine cones and other materials. This infrastructure should be put less than 100 metres from crop fields. Credit: Miguel Encarnação

In agricultural systems that are constantly disturbed and thus have low biodiversity, beneficial organisms struggle to survive. Instead they make adjacent natural habitats their home and later return to the agricultural field when their target pest attacks the crop. These beneficial organisms are the immune system of the farm, but they only appear and establish themselves if the appropriate conditions are present. The time necessary for them to arrive at the attacked patch depends on the distance to their natural shelter. Pest control agents can be insects, mammals, reptiles, amphibians, viruses, bacteria, fungi, nematodes, etc. As with every living organism, they need diverse microhabitats, diverse food sources and diverse microclimatic conditions to survive and maintain themselves in the agroecosystem. These can be expressed in water availability, food for adult natural enemies, alternative prey/host and places to shelter from adverse conditions (Landis et al, 2000).

The most basic principle for establishing beneficial organism populations in a farm is to create zones of permanent non-disturbance, where no tillage is done and perennial plants thrive, to provide shelter for the permanent presence of beneficial organisms. The more diversified food sources and habitat, the greater and more complex population of beneficial organisms appear. By planting an arrangement of native herbaceous plants, trees and shrubs, in such a way as to have flowers throughout the year, the farmer is ensuring the food for the beneficial predatory and parasitic insects in the agroecosystem. Flowers from the Umbelliferae, Lamiaceae, Boraginaceae, and Leguminosae families are very good at attracting such insects (Hopwood et al., 2016). Providing food sources (organic materials) and habitat (non disturbance) for soil biodiversity is also very important for the control of soilborne diseases. Additionally, integrating livestock in the system can also provide the necessary interactions for pest regulation.

Another way of controlling pests, diseases and weeds is to implement a crop rotation (Mohler & Johnson, 2009). Monocropping (see more on page 184) creates tillage, watering and crop patterns prone to the spread and permanent installation of large populations of pests, diseases and weeds, that eventually adapt to such patterns. Crop rotation, on the other hand, creates a diversity of disturbances, resources and resource availability periods, that breaks insect, disease and weed life cycles. Crop rotation also has the potential to build nutrient and organic matter content of cultivated fields, and lower the risks of total crop failure. Crop rotations in market gardens will be covered in detail in the following section.

Figure 4.40: Example of an intercropping system. From the left: fava beans, basil, cabbage and tomatoes. Credit: Miguel Encarnação

Strip cropping and intercropping are good strategies for pest prevention, because mixing two or more cultivated species helps "disguise" them from pests, and some crops can attract beneficial insects. More spacing between plants increases airflow and in turn prevents fungal attacks but at the same time more space can also mean more light and thus problems with weeds. In market gardens, the planting of closely spaced vegetables originates a rapid soil cover by the crop, which leaves less light available for weeds. The quicker the crop shades the soil the less weeds develop.

Mulching vegetable beds can also prevent pests and weeds. The straw creates a light barrier that prevents annual weeds from germinating and at the same time creates a more favourable habitat for spiders which in turn hunt pests. Fresh plant residues used as mulching have allelopathic properties (see more on page 177) that prevent weed germination and development (Clark, 2007). However, mulching comes with some disadvantages: it consumes time and in some cases it's difficult to apply, it prevents the soil from heating up in the winter and early spring, and creates a favourable environment for slugs and snails that can be particularly bad in the early stages of plant development (Fortier, 2014).

Figure 4.41: Example of the application of lucerne (Medicago sativa) mulching on pepper (Capsicum annum) beds in Austria. Credit: Miguel Encarnação

Weed management in market gardens can be either passive or active. To passively control weeds market gardeners can use thick plastic tarps. As discussed before in this text, this technique is especially effective against perennial grasses. To actively manage weeds there is a big array of techniques. It can be done with efficient manual tools (The Market Gardener, 2021), or with a flame weeder used before crop emergence. However, the guiding principle behind manual weeding is to do it when weeds are in the early stages of development. If weeds are left to grow, the amount of work it takes to pull them out also grows. Prevention of weeds should guide the strategy for weed management: techniques like not letting weeds go to seed, using compost with no weed seeds, crop rotations, and constant bed use.

Soil nutrient and biological imbalances make plants more susceptible to pests and diseases. High levels of organic matter in the soil tend to suppress plant pathogens. If vegetables are given optimum growing conditions (light, temperature, water, nutrients, beneficial biology, etc), plants grow stronger and can better resist pests and diseases. Compost teas/liquid compost (Amos, 2017) can be applied as a foliar preventive disease control, as it coats the leaves with a big variety of beneficial microorganisms that prevent the harmful ones from dominating. The use of resistant varieties is a good way of preventing diseases, and farmers can either buy them from suppliers or start saving the seeds of healthy crop plants in their fields. Pests can also be physically controlled by putting row covers over the vegetables, and thus creating a physical barrier to the passage of insects and birds. Curative measures should be considered a last resort. Plant derived insecticides (Neem oil, etc) are less harmful for the environment because they degrade quickly, but they can eliminate big portions of both beneficial and pest populations. More specialised pesticides like Bacillus thuringiensis can also be used.

All and all, looking at the agroecosystem as a whole and designing it through habitat management to favour biodiversity and ecological interactions should be the basis for a healthy farm, but it shouldn't be considered as a standalone method. Other techniques explained in this section can help complement plant protection and help farmers make the transition while remaining productive.

Additional resources
Oklahoma Extension: Beneficial insect identification
Maryland Extension: Row covers
FAO: Multiple plant protection techniques
UK Agriculture and Horticulture Development Board (AHDB): Crop pest and natural enemy encyclopedia: identification, monitoring and control
eOrganic: Insect monitoring and identification
Entomologist lounge: Insect hotel guide

4.4.15 CROP ROTATIONS IN MARKET GARDENS

Crop rotation is a fundamental principle in agroecology and organic gardening, and the high diversity in practice in market gardens allows for resilience throughout seasons in addition to nutrient and organic matter building, pest and disease resistance in crops, and maintaining control over weeds. Rotating crops, or the principle of avoiding growing the same crop year after year in the same area can be practised in gardening operations of all scales, and larger scale farmers can learn from the creative diversity found in market garden crop rotations. In the most basic sense, crops can be separated into major categories including: leafy crops, root crops, flowering crops, fruiting crops and leguminous crops, and planning can ensure they are grown in different areas year to year. When first planning a crop rotation simplicity is the key, and for those looking to learn about the more complex relationships between plant families, there is a wealth of information available on rotations that support healthy soil available online, with some helpful resources listed below. This text will not go into detail on the many possibilities for creating rotations beyond a few base examples of decision making processes and tips for crop rotation planning

4.4.16 PLANNING A CROP ROTATION

When planning a crop rotation, or when looking to incorporate more diversity into an existing growing plan one should consider a few base questions before implementing changes in the garden. A few useful questions include:

What do I know how to grow well already and what am I confident in learning how to grow?
Where can I access the inputs for crops and at what price? (Seeds, seedlings, etc)
What will grow best on my land?
What crops does my market dictate?
What timing is the most sensible for crops I am considering in my region?
What fits well with my farm's scale, infrastructure & team?

You can see an example of a diverse crop rotation in a fixed permanent bed system on figure 4.42.

After considering these fundamental questions it is possible to come up with a list of crops which are feasible to grow, and at this point a farm manager can begin to plan a rotation. The next decisions involve creating crop groups, quantity selection and area usage, annual timing and sequencing (Ferencz et. al, 2017).

Grouping Crops - based on preferred method and knowledge, crops can be placed into rotation groups either within the 5 general categories, which correspond with development directions, or which part of the plant will be harvested and sold listed above (leaf, root, flower, fruit, legumes) or based on more complex plant botanical families, which take into account the physical and chemical characteristics, and growing requirements which plant species share.
Quantity Selection and Area Usage - based on your garden plan and market requirements, you will need to make a decision on the amount of area of the farm which will be dedicated to each crop. It is advised to pursue simplicity in the first years of planning a crop rotation and to diversify a plan after gaining a few years of experience. When deciding on quantities, one must take into consideration the amount of seeds or seedlings required at different points in the year to satisfy a cultivation plan. Once quantities are estimated it is necessary to see how groups of plants will fit into designated growing areas. This is another case where uniform growing areas, or fixed permanent beds can be helpful in simplifying crop rotation planning.
Annual Timing - Once crops are grouped, and desired quantities are selected, one must plan the timing of germination and sowing which will take place to make sure that crops are sown on time taking into account seasonal weather and regional climate. In temperate

climates it is likely possible to have early crops, mid season crops and autumn crops, or three separate sections within one annual rotation, so planning out a full season of activity ahead of time is wise to maintain order throughout the year.

Sequencing - After a rotation is planned for one growing season, subsequent years can be planned ahead, prioritising creating favourable conditions from year to year based on plant fertilisation requirements, the impact on soil structure of each crop, disease and pest concerns for different plant groups, and the potential positive relationship between preceding and following crops.

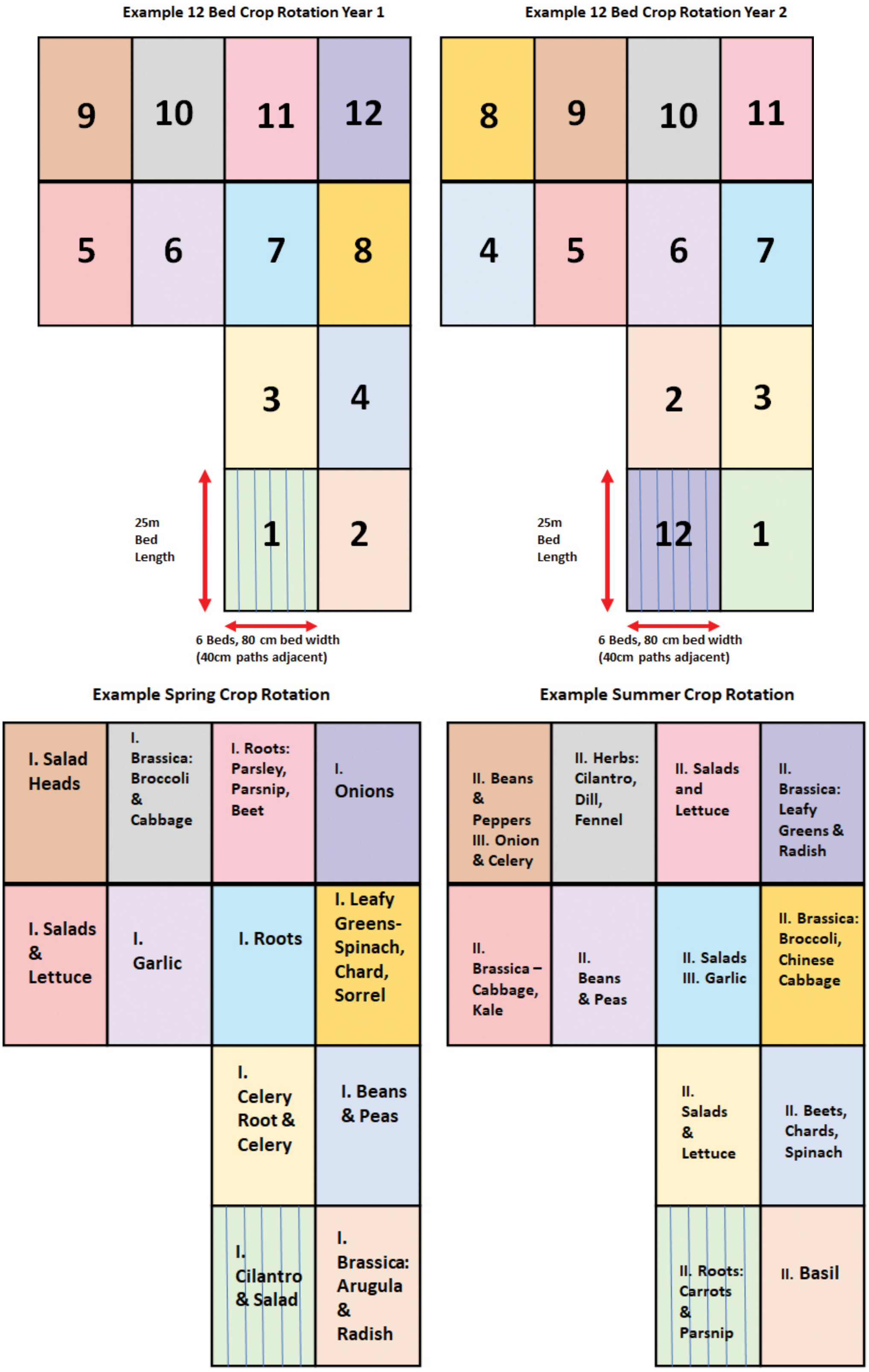


Figure 4.42: Example of a 12 bed annual crop rotation with spring and summer crops. Credit: Logan Strenchock

Additional Crop Rotation Planning Tips
Best 4 Soil Project: Crop Rotation - Practical Information
Rodale Institute: Transition to Organic Course - Crops
Euroeducates Project: Handbook of Modules for Study Course Agroecology
Carolina Farm Stewards: Cover Crops and Crop Rotation
NC State Extension: Beekeeping and Small Farms
Pollinator Paradise Garden

4.4.17 INCORPORATING LIVESTOCK AND ANIMAL HUSBANDRY

Market gardens offer opportunities for incorporating animals into production systems at small scale. There are broadly two types of farm animals: ruminants (animals that feed predominantly on grass, such as cows, sheep, goats, donkeys and horses) and omnivores (animals that feed not only on grass but also on other animals and starchy materials, such as pigs and chicken).

The ecological and social benefits of incorporating animals into a small farm are numerous. Animals create conditions for on-site nutrient cycling by turning food and crop waste into valuable animal products and manure. Incorporation of animals on the farm can also assist in making functional use of marginal land through controlled grazing, which not only transfers the fertility from these marginal lands to our productive garden but also reduces the severity and intensity of wildfires. They offer the possibility for assistance with pest and weed management, and numerous other social benefits of working in close contact with animals. Having animals also increases farm resilience and autonomy, because by filling the ecological process of nutrient cycling, they reduce the need for synthetic fertilisers, and the opportunity to supplement income from vegetables sales with animal products.

The decision to incorporate animals into a small farming system must be considered carefully, weighing the time and financial costs and benefits of tending animals on site, while keeping in mind the responsibility to provide healthy and appropriate conditions in compliance with agroecological practices. The adoption of an agroecological approach to small scale animal husbandry encourages the acknowledgement that animals are respected as serving more than solely a productive purpose on the farm, but play a central role as sentient beings which contribute to the health of a small farm ecosystem.

Additional Resources
Rodale Institute: Transition to Organic Course - Livestock
North Caroline University State Extension: Backyard Flocks and Eggs, Small Scale Livestock

4.4.18 SEASON EXTENSION TECHNIQUES IN MARKET GARDENS

Market gardens may not be able to produce a quantity of storable crops to ensure having a full stock of products during the darkest and coldest months of the year. A production option in response to this challenge includes mastering production techniques for high value and specialty crops throughout all seasons, and having such crops early and late in the growing season when they are scarce in local markets. The practices of season extension have relevance in gardens of all sizes and can both contribute to the financial viability of gardens while also being complementary to agroecological pursuits. Growing crops in all seasons empowers the possibility of a “local” diet for customers throughout the year while also offering all season employment for workers on a farm. Advantages of year round production include income stabilisation throughout seasons, retention of customers throughout the season, price premiums at times of year when fresh produce is scarce, and potentially higher quality and yields of crops which benefit from controlled conditions. Some disadvantages of all season growing can include costs of crop protection infrastructure, increased management and labour requirements for maintenance and upkeep, and an increased usage of plastic based products on the farm (Bachmann, 2005). A number of focus topics which relate to maximising the output of high value crops throughout different seasons are listed below.

Protected Cropping

There are a number of methods for protecting crops from heat and cold through the use of permanent and semipermanent glass (glasshouses, greenhouses), plastic (polytunnels, hoop houses, mobile caterpillar tunnels), and fleeces (internal and external covers) which help to create altered thermal and moisture conditions for crops. The usage of such techniques allows growers to create warmer, cooler conditions for crops which assists in starting the growing season earlier, extending it further into autumn and winter, and protecting sensitive crops from intense heat during the summer months. Apart from thermal protection, protected cropping also allows growers to control moisture conditions (keeping crops dryer) which can help reduce fungal diseases (Hayes et. al, 2013). A few examples of structures and equipment for protecting crops includes:

Greenhouses/Glasshouses - permanent structures made of glass or carbon fibre which crops can be cultivated in. Positives:greater thermal protection and ventilation control. Negatives: costs for construction can be high, depending on local legislation may require planning permission for construction.
Polytunnels/High Tunnels - Polytunnels are hooped metal frames covered with a layer of polyethylene plastic and come in a wide range of shapes, heights and sizes. Tunnels of this type can be ventilated through the opening of doors and sides of the tunnels. Positives: beneficial thermal protection and moisture control properties and lower cost in comparison to more permanent greenhouses. Polytunnels can be fixed permanently in one location or if composed of lighter materials, be constructed and dismantled easily (*see caterpillar tunnels/ Spanish tunnels*). Both greenhouses and polytunnels can be heated passively through solar heat, or supplemented with additional heat sources. *Negatives*: the decision to supplement solar heating is one that comes with weighing the financial and environmental costs of the additional heat source.
***Internal covers, external fleeces and row covers* -** Lightweight fabric or plastic fleece based covers can be used as complementary thermal protection tools inside of greenhouses and polytunnels during the coldest months of the year, and be useful in outdoor growing areas to provide frost protection in the transitional portions of the growing season. Internal fleeces, supported by frames placed over growing beds in greenhouses and polytunnels, are typically removed from crops during the sunniest portion of the day to allow the maximum amount of light to warm up the soil before being placed back over crops before temperatures drop in the afternoon or early evening. Removing fleeces during the daytime also ensures proper ventilation of crops and helps avoid fungal diseases. External covers create "low tunnels" which are supported by metal, wire, or PVC hoops or frames and placed over cropping beds in rows. Covers can be adapted to the size of outdoor growing beds and cut to a desired width and length. Positives: effective thermal protection with relatively low cost Negatives: increasing the amount of short usage plastic based materials on the farm, covers must be kept in place with weights or dug into the ground in windy locations.
***Shade and Summer Protection* -** Polytunnels and mobile tunnels can be covered with commercial shade fabrics to allow crops which grow better in cooler temperatures to be grown into the early summer period, and sown or transplanted earlier near the end of summer.

Figure 4.43: Frames and thermal fleeces in place over chard and mesclun salad during winter in a polytunnel. Credit: Logan Strenchock

Natural Heat Sources for Germination

For growers who produce their own seedlings, traditional hotbeds can be an important tool for creating a healthy germination medium near the end of winter. Germinating plants early through the help of the natural heat product of composting organic material can help growers ensure that healthy seedlings can be transplanted into outdoor areas and in protective structures as early in the season as possible. (For more information on manure heated hotbed construction please see *The Organic Growing Start Up Manual* p. 69, *Hayes et al. 2013*)

Figure 4.44: Constructing a frame for a manure heated germination bed, hotbed filled with manure. Credit: Zsámboki Biokert

Figure 4.45: Adding a table frame above a hotbed frame, germination trays on top of the hotbed. Credit: Zsámboki Biokert

Variety Selection and Succession Planting

The selection of crops and crop varieties is a key in season extension pursuits. In addition to considering the ideal conditions which crops grow in, the time duration from sowing, to seedling, to maturity of crops must be considered. Some crops will germinate better in cooler conditions than others, and the germination rate of plants will be impacted by thermal conditions. When planning crop rotations for all season growing, staggering sowing dates of crops, and choosing different varieties of the same crop with varying maturation rates is important to ensure that a sufficient number of seedlings are ready in time, or that an ideal amount of crop reaches maturity at an optimum timing when sown or planted. Such practices are an example of succession (see more on page 188) planting.

Crops can be classified by their resistance to damage from cooler weather, being grouped into the basic categories of tender (will suffer damage at temperatures around freezing), *semi-hardy* to *hardy* (will survive at lower temperatures or recover from minimal frost damage) and *very hardy* (will endure colder temperatures and even frost conditions for short durations).

Hardier crops sown in the autumn within a greenhouse or polytunnel will have the time to mature and can be maintained throughout the winter in temperate climates with the additional usage of internal covers. A number of crops which can be applicable in season extension programs with the help of the above listed infrastructure for thermal protection include:

***Very hardy*:** Leeks, Parsnips, Spinach
***Hardy*:** Cabbage, Broccoli, Brussel Sprouts, Rutabaga, Mustard, Kale
***Semi hardy*:** Lettuce, Cauliflower, Carrots, Beets, Chard, Peas
***Salad crops and leafy greens popular in all-season production with thermal protection*:** Spinach, mesclun salad mix, cilantro, dill, lettuce heads, winter purslane/miner's lettuce, sorrel, leaf beet, leafy brassicas- oriental mix, mizuna/mibuna, mustard leaves, russian red kale, arugula, lamb's lettuce
(Summary Compilation from: Roos and Jones, 2012)

Figure 4.46: Oriental Salad Mix grown in a polytunnel in winter in Hungary.
Credit: Logan Strenchock

Additional Resources
Seed Savers Exchange: Cool Season Crops
TreeYo Permaculture: Season Extension - A key to temperate living and food security
NC State Extension: Season Extension: Introduction and Basic Principles
University of Kentucky: Greenhouses, High Tunnels, and Low Tunnels - General Resources
University of Kentucky: Season Extension Tools and Techniques
Johnny's Seeds: Succession Planting Principles & Practices
Bootstrap Farmer: Guide to Hoop Houses and High Tunnels
ATTRA Sustainable Agriculture: Scheduling Vegetable Plantings For Continuous Harvest
Organic Seedling Propagation: Proven organic seedling propagation in Zsamboki Biokert (HU)

4.4.19 DATA ANALYSIS AND MONITORING

Recordkeeping is a difficult but essential task in market gardens. By gathering information on planting and harvesting dates, yields, seeding density, plant spacing, pest and disease appearance, number of beds/area planted of each crop, fertilisation applied, and every detail that one considers important noting (Fortier, 2014; Coleman, 1989; Roos, 2021), farmers are able to generate site specific data that allows for the continuous improvement of internal processes (Bachmann, 2002). A number of helpful farm management books which include suggestions for on-farm data collection in market gardens have been published in recent years including Ben Hartman's *The Lean Farm, 2015* and *The Lean Farm Guide to Growing Vegetables, 2017.*

Monitoring processes happening in the garden is a key aspect of the preventive approach to farming. Systematic monitoring allows for early detection of problems and effectiveness of preventive techniques. Sweep nets, yellow or blue sticky traps and pheromone traps are useful in detecting exactly which insect may be attacking crops, and assessing population densities. Farmers can also rely on nearby extension/advisory service agencies for pest and disease warnings. Consultants, books or the internet can be used to identify pests and diseases.

Additional resources
University of Wyoming: Insect Identification Guide
Ben Hartman: The Lean Farm
Ben Hartman: The Lean Farm Guide to Growing Vegetables
Tend Smart Farm: Farm Management Software for Small-Scale Diversified Farms
Insect identification: Insect identification

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ADDED VALUE CREATION AND MARKETING

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5.1 INTRODUCTION

This chapter will help readers to gain an overview of the concept of a marketing plan.

A marketing plan is a concept that outlines the farm's marketing strategy for the coming year, quarter or month. Typically, a marketing plan includes:

- An overview of the farm's marketing and advertising goals.
- A description of the farm's current marketing position.
- A description of the farm's target market and customer needs.
- A timeline of when tasks within the strategy will be completed.
- Key performance indicators (KPIs) to be tracked to measure the success.

(source: venngage.com)

It should be noted that to work out a detailed marketing plan in every component requires considerable financial and/or human resources and typically agroecological farms do not need to scale up to this level. However, it is considered to be very useful if farm owners take the time to consider and even to draw up some of the main elements of a marketing plan. The marketing strategy described in this document can - as a template - help farmers to gain an overview of what the elements of successful marketing are. By spending some time going through its structure, farmers can rethink and develop their existing marketing actions in a more intuitive way.

To help readers understand the rather technical language of the marketing plan three examples of existing agroecological farms will be presented. The examples will be mentioned as part of the different marketing plan elements so that readers can experience a concrete application of the theoretical information. The examples will refer to three sectors already known from the chapter 4 "Agroecology in action" and will be distinguished by using the same colour throughout the whole chapter as follows:

1) **ARABLE LAND MANAGEMENT,**
2) **MARKET GARDENING,**
3) **GRASSLAND AND LIVESTOCK MANAGEMENT.**

Before kicking off with the marketing plan, please find a brief introduction of each real-life case study farm:

1 ARABLE LAND MANAGEMENT (AUSTRIA)

The GRAND FARM is Austria's first research and demonstration farm of its kind, located in Absdorf, Lower Austria. At its core, this farm is all about the natural health of soils, plants, animals, and people. On approx. 90 hectares, it works with various concepts that are intended to help counteract climate change, the decline in biodiversity, and the loss of soil fertility. All these measures are combined in three areas: soil health, agroforestry, and market gardening.

In addition to regular agricultural production, GRAND FARM cooperates with research institutions in Austria and abroad to jointly find solutions to current agricultural problems. It has set itself the task of acting as a hub between science, practice and society in order to promote the all-important exchange between these. The demonstration of tried and tested methods plays a central role in this work.

Figure 5.1: Grand Farm. Credit: GRAND FARM

2 MARKET GARDENING (HUNGARY)

Zsámbok Biokert (Zsámbok market garden) located in Zsámbok in Hungary. The enthusiastic garden team is working towards a farming system which is self-sustaining and has its own cycle of nutrients. They work their land (3.5 hectares) using horses and tools that are gentle to the soil. The fertility of the soils is based on crop rotations, composting and the use of green crops which build fertility in the soil.

The farm and all the products that it sells are certified organic so the farming system and the products comply with recognized organic standards. However, they aim to go far beyond the required minimum for being organically certified. Zsámboki Biokert's Organic Vegetable Box System has evolved out of the earlier Nyitott Kert (Open Garden) CSA system (the first CSA in Hungary). Many of the features are maintained (a close connection with consumers), but the box system allows more flexibility and requires less fixed commitment from consumers.

Figure 5.2: Zsámbok market garden. Credit: Logan Strenchock

Their sales and distribution system (Zsámboki Biokert Organic Vegetable Box System) is based around distributing their products from a few centrally located collection points, which consumers can conveniently reach without having to travel long distances from their homes. The Biokert also serves as a site of numerous practical organic gardening courses, customer and student group visits, research studies and international projects. They have hosted many guests, students and growers from around the world. It is challenging to manage the daily responsibilities of the farm while making time for guests, but transparency and outreach are a priority for the farm.

3 GRASSLAND AND LIVESTOCK MANAGEMENT (TRANSYLVANIA, ROMANIA)

This small family farm consists of 13 ha of grassland, 2 ha of arable land, 9 milking cows plus 7 calves. The farm is situated in a mountain basin, also cultivating biodiverse high mountain grasslands. Every family member has some role in running the farm, the only full time farmer is the owner (54 years old). He also makes the food product of the farm: handmade mature cheeses. He has a degree in theology, has worked in rural development for about 25 years and is now a full time farmer (calling himself a "new peasant"). His approach to marketing reflects his rather unusual career decisions and personality, and also adequately represents the values of agroecology.

Figure 5.3: Tejbánya. Credit: Anna Bányász

5.2 MISSION

5.2.1 MISSION STATEMENT

The overall mission of the farm.

A visionary outlook on the future: the ideal state of the farm. What sort of farm and farming activity would be the best but also most realistic dream? This includes the plans of what the farm owner wants to produce (i.e. milk, cow fodder, potatoes), and for what purpose (i.e. livelihood for my family, healthy food for my customers, providing a good example for my fellow farmers in the region, etc.).

AE perspective: The future vision of an entrepreneurial activity that is environmentally sustainable, socially inclusive, and economically viable.

Questions to ask yourself:

- *What is your personal ideal of your own farm in 10 years time?*
- *Will there be some distinguishing features that will make your farm stand out? Please consider farm size (ha, no. of animals) , special crops/products, special farming methods, responsibility to your community or some disadvantaged groups, mentally or physically less able people, unemployed, etc.*
- *Would you take action to become more environmentally friendly?*

(Don't try to impress anyone! Only mention those ideas that you would seriously consider to implement in the future. This plan is about you and your farm, the way you would like to live and the goals you would like to achieve.)

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1 ARABLE LAND MANAGEMENT

In ten years, GRAND FARM should be a fully established regenerative farm preferably with a closed circuit of inputs and outputs. The research and demonstration activities will be strongly extended and a broad offer of educational services will be provided. Plant production will be complemented by animal husbandry and the arable land production will be used in a far more diverse way. The vast majority of all farm produce will be sold directly to consumers.

2 MARKET GARDENING

Zsámbok market garden's long term goals are developed by the garden team and revised each year. Long term goals grow out of the mission of the farm, with a recognition of the capacity of the market garden, determined by the market garden capacity. The farm's mission statement is: to grow and offer bio-intensive food in a deeply sustainable way. We are committed to sharing the farm as a resource to a broad range of people who can benefit from being part of the farm community. We see our work as part of the larger context of regenerative farming, to bring health back to our soils, our water, our atmosphere, our relationships with each other and with Nature.

Short term goals are driven not only by the market garden team member's personal desires but also by real business issues: pursue a programme of efficiency (inspired by Lean farm design (see more on page 183)), which helps eliminate wastes both in terms of time and resources and ensures efficiency in terms of farm scale and size. This approach ensures produce quality and that the operational costs are not higher than the financial benefits that the farm receives back from it.

Efficient work is the most important issue that is always the major challenge for small farms. Human labour is expensive, causing personal and infrastructural challenges. Based on the 10-year experience of the farm, we want to consolidate the financial stability of the farm operation through developing a strong farm infrastructure and a stable team, in order to work together on the production processes, marketing processes and communication processes.

Concerning our long term mission, we would like to prioritise social farm programmes in the garden in the future. Furthermore, the Zsámbok market garden would like to provide a proven working experimental model which is replicable and appropriate in the conditions of Hungary. This garden is establishing itself as a biointensive market garden where participants can learn as apprentices how they can earn a livelihood and learn the trade before they move on to establish their own garden.

In our ten year vision the farm is sustainable, the hybrid box system is competitive even in a market where more emerging competitors from bigger companies are present.

3 GRASSLAND AND LIVESTOCK MANAGEMENT

Personal mission: Farming doesn't have to follow the logic of the market, it has to follow the overall rules of life. Thus it has to be executed as a lifestyle in harmony with nature. To be a peasant nowadays is an intellectual challenge and a serious commitment. Moreover, it should represent a certain level of prestige.

5.2.2 FARM OBJECTIVES

Based on the above visionary Mission statement, clear objectives for the farm should be set. In goal setting it is always useful to make use of clear and measurable objectives. An effective tool that provides the clarity, focus and motivation to achieve goals, is SMART, an acronym for Specific, Measurable, Achievable, Reasonable and Time-Bound. It can improve the ability to reach goals by encouraging the farm owner to define the objectives and set a completion date. SMART criteria (see more on page 186) are easy to use by anyone, anywhere, without the need for specialist tools or training. (More about SMART: on this site) Setting short term (1-2 year) and long-term (3-10 year) goals for the chosen product and market; Deciding whether to get new customers and/or to keep the old ones.

Questions to ask yourself:

- *What are your exact plans for your farm:*
  - *- Ha of what type of cultures by when?/area*
  - *- No. of what type of animals by when?*
  - *- Quantities of what type of products by when?*
  - *- Do you plan any new products?*
- *Will there be some special products or other features (i.e. organic products or pelleted hay) which will distinguish your farm from others? By when will you reach this stage?*
- *What will be the market of these products - break it down by main product groups. Will you need to find new markets/buyers? If yes, who are they, how will you approach them, how many of them?*

---

1 **ARABLE LAND MANAGEMENT**

During the next 1-2 years the market garden will be developed to its full production capacity in order to market about 250 to 300 vegetable boxes. Ideally, in this period of time we will also be able to start establishing egg mobiles with up to 500 laying hens in the agroforestry system and sell free-range eggs in addition to the vegetables directly to our customers. Probably we will also start keeping some sheep beside the hens in the same area for protection against birds of prey. Besides that, we will start experimenting with some new crops in the arable land like lentils, chickpeas, oats etc. for direct sales to our customers. Also, our own production of hemp seed oil should be started within the next 2 years. In terms of educational services, we will continue our efforts in raising financing for an employee especially responsible for workshops, excursions and mentoring of trainees. Also, the information services aimed at politicians and decision-makers will be enhanced and professionalised.

2 **MARKET GARDENING**

Our farm objectives are for next year:

- To increase our net profit for the year enough to provide a sound financial buffer for starting up the successive season, as well as to provide a reserve for infrastructural investments.
- To focus on improving garden processes and essential operational equipment and infrastructure.
- To develop our plant health programme to the point where the focus is on a healthy soil system, with some amending nutrients amendments for plant health, rather than pest and disease interventions (creative rather than reactive).
- To optimise the work of the garden team to develop a good atmosphere and stability for those who work on the farm.

We plan developments of the farm in the short and long term: We always think about the long term development of the land, adding additional elements, such as perennial flowers, trees, fruit trees, firewood trees, water elements (1,000 trees have been planted in the last 2 years as a part of the community fuel wood project that also emphasised the farm's potential social impact inside and outside of the community involving those who are interested in sustainable agricultural activity and ecology).Our future farm development plan is to establish a pond to store water and supplement irrigation. We want to have more sheep in rotational grazing that requires infrastructure (e.g., electric fence) and more knowledge on how to manage more animals and how to handle them in daily routine.

We are not so far from the maximum use of our current infrastructure (washing area, storing area, van that we use for delivery, etc.). To increase the recent number of offered boxes (100-110 boxes; 140-150 boxes in peak weeks which are the end of spring and beginning of summer and September when children go to school and families arrived back from holiday) would mean an increase in the cultivation area or a clear and stable development of grower partnerships that would imply investment in marketing and communication.

3 GRASSLAND AND LIVESTOCK MANAGEMENT

Farm objectives: I don't intend to increase farm size. What we already have is enough to support a family. Our approach is organic in every sense, we don't use chemicals and are in the process to reach a certain level of energy independence, too.

Community objectives: To follow the system of biodynamic agriculture would be a high-level solution for our wider community in case our farmers will be able to make this spiritual and intellectual upgrade. This could also integrate the employment of disadvantaged groups and create a community and - in practice - a cooperative around it.

Products: The overall product of our farm is the representation and demonstration of a holistic peasant lifestyle in the 21st century. We produce mature cheeses, we contribute to the development of regional gastronomy, we provide learning opportunities in the style of Folk High Schools and provide insight into the regional folk culture. Those who want to buy our products have to visit our farm at least once and to learn about the philosophy behind it.

Our products' distinguishing characteristic is to be fully natural. It is „just" a means to attract people to learn about modern peasanthood. To be successful with this mission, the cheese has to be of supreme quality.

Mechanisation: I plan to buy a new grass drier and a manure spreader this year.

5.3 SITUATION ANALYSIS

5.3.1 INTERNAL ANALYSIS

In the internal analysis, it is important to gather the farm's strengths as much as its weaknesses. The answers to the following questions can help with internal analysis: What is the farm good at? (e.g., division of work among employees based on their competencies). In what field does the farm have the most experience? (e.g., vegetable production, gardening). What values do the owner(s) believe in? (e.g., quality matters, not only quantity). Does the farm take tradition into account in its practices? (e.g., use of local varieties, cultivation of traditional plants like hemp). Do the values of agroecology appear in the everyday operation of the farm? (e.g., hiring local labor, applying direct sales, following reasonable nutrient replenishment.)

Questions to ask yourself:

- *How do you assess your farming activity? What are your strengths?*
  - What are your skills, in what area are you experienced?
  - What area are you specialised in?
  - Is there anything unique in your farming activity?
- *What do you see as an area that needs to be developed?*
- *What values do you believe in?*
  - Do you respect tradition in your farming practice?
  - Do you think that the values of agroecology prevail in your farming practice? (this means that you consider all elements of agroecology - environmental, socio-cultural, economic, political - when making decisions about your farming process)

1 ARABLE LAND MANAGEMENT

One of our biggest strengths is probably the ability to inspire people to think about the way our food is produced. The number of (mostly young) people contacting us regarding the possibility to learn more about agriculture, composting, and market gardening is a huge honour and motivation for us. We see great potential in providing the infrastructure for researchers to test various methods and evaluate the best and suitable ones. At the same time, we see our strength in demonstrating those methods and make them visible for different members of society. The connection of those various members of society and the networking on higher political and scientific levels plays a central role in our efforts to make regenerative agriculture the future standard of food production.

The management of all our resources is a task we aim to improve in the future. Additionally, the ideal allocation of our work force and the internal workflow will be refined within the next few years.

2 MARKET GARDENING

One of the strongest values of the farm is its social impact (organising programmes or tours in the farm, teaching apprentices, as well as the farm's accumulated social capital (see more on page 186)). It is a big commitment, but we believe that this is the way to change the agricultural system.

Another strength is the product quality we offer. It is rare for a small farm to offer such a choice of diverse products. But there is no time to 'rest', as bigger companies (Tesco, or the newly emerged Kifli) have also started home delivery, offering ready-made food baskets. Our market garden does not offer the same broad selection of products, so these competitors may present a threat. Thus, the Zsámbok market garden continuously needs to improve the quality of the weekly organic food box. We believe that we offer something different than the large online webshops. We believe that we have a strong partner-producer network based on personal interaction, and hold a good reputation built on integrity over many years.
In the last two years we have followed planning management practices focusing on time and cost efficiency.

We preserve traditions during farming practice but are open to contemporary developments as well. For example, we use a horse for soil tillage, but we want to stay in the forefront with seasonal production, so we use local varieties in a biointensive market garden, which is a mixture of tradition and contemporary. We use the Tend app for production planning, and have developed our own task management tool using spreadsheets. We are always open to low-tech innovative solutions.

We think that in general many things fit into the umbrella of agroecology (AE). Concerning the practice, we try to use our own resources (we try to have the shortest loop of nutrients and to avoid significant imported nutrient supplements), always keeping in mind the nutrient demand of the soil. We make our own compost that requires a lot of time and has a huge impact on the production (with its quality, with its weed seed content etc). Concerning AE political issues, we try to maintain an equitable and conscious environment, but our time is limited to participate in political activism.

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

I don't consider our activity as economic. This lifestyle supports a higher quality of life. Of course it has economic elements but this is subordinated to the higher goals of serving the harmony between nature, humans and God. My personal strengths are „to serve my animals, my fellow humans and nature as a whole". We value, enrich and pass on traditions in case they represent value for today's needs. Agroecology has a role in our philosophy as long as it proves to be more than a catchphrase, since authenticity (the complete overlap between thoughts and action) is essential to me.

5.3.2 CUSTOMER ANALYSIS

The more a farmer knows about his/her customers the better he/she can serve their needs. In marketing it is always about serving the needs of customers by offering value to them, which should then result in profit on the farmer's site. To ensure that the offered product really fits the needs of the farm's customers, or if the farmer wants to increase the number of his/her consumers, it is advisable to define the customers' characteristics as precisely as possible. If a farmer does so, it helps him/her to more precisely set out his/her market activities according to his/her most important customers, which makes the sales more effective with less costs. For the characterisation, the following can be used amongst others:

- Demographic information such as gender, age, ethnicity, income, education etc.
- Geographic information such as location, distance, culture, climate etc.
- Psychographic information such as interests, hobbies, life style, decision making style, etc.

Questions to ask yourself:

- *Who are your existing customers? Can you characterise them? (Categories can be: gender / age / education / financial background, etc.)*
- *Are you aware of their needs?*
- *Do you want to attract new customers? If yes, who are your potential future customers?*

1 ARABLE LAND MANAGEMENT

Nearly all of our vegetables are sold directly to consumers via boxes. The arable land produce is still mostly sold to the agricultural cooperative but should partly also be sold to our vegetable box customers in the future. Nonetheless, our existing customers are those who buy our vegetable boxes. Here, the majority of them are women between 30 and 60, many of them with families. They are interested in healthy and tasty food which is regionally produced. They want high quality, diversity, variety and many of them also like new ideas for cooking. Generally, they have a rather high income. In the coming years we plan to reach more customers with similar characteristics and probably some chefs in the top gastronomy.

2 MARKET GARDENING

We have data about those who buy boxes on a weekly basis. We meet many of our consumers directly in the Budapest organic market. They include young families with small children; Middle to upper income citizens who may or may not have children but want to avoid chemicals and pesticides for health reasons; A small but significant group of foreigners who live in Budapest (they want to eat organic food for social, environmental, and quality reasons); Young professionals with internet culture for whom the box system (ordered via internet) is convenient.

Our system relies on dedicated customers who buy regularly. Moreover, some of our farm team members are members of other initiatives targeting environmentally conscious audiences that provide the opportunity to advertise the farm among youngsters. If we would like to boost our customer base, we would definitely focus on the local pick-up points, where pick-up point coordinators would advertise the farm products better in the proximity.

3 GRASSLAND AND LIVESTOCK MANAGEMENT

The majority of our customers are those who have an interest in the peasant lifestyle. They taste our lifestyle in the first place and our cheese second. A minority is made up of wealthy people who buy our cheese because they like regional, handmade, healthy products, and also like to be fashionable this way.

Our future customers should include those who would like to start a new life as a peasant - and thus to learn about it on our farm.

5.3.3 COMPETITOR ANALYSIS

In order to assess the farm situation, it is important to monitor the market competition. It is necessary to know who is present in the market with similar products or services. It is not enough to pay attention to what products other producers ('competitors') offer in the market, but it is important to know what kind of advertisement they use, what their pricing strategy is, and their form of sale/distribution.

Questions to ask yourself:
- *Do you know those who are present in the market with a similar product or service and are serving the same consumer needs?*
- *How are they threatening your business?*
- *What are you doing to ensure/improve your position?*
- *How are you different from your competitors?*

1

ARABLE LAND MANAGEMENT

In terms of research and demonstration activities there are no comparable farms in Austria so far and even in the next year this type of specialisation of farms is most likely to remain a niche. Small-scale vegetable production (Market Gardening), however, is gaining more and more attention in Austria and especially in Lower Austria, the region where the GRAND FARM is located, there are quite a few other gardens with similar produce. Nonetheless, for now, those enterprises are not really seen as competitors but nevertheless a strong positioning of our own garden is important to raise customer awareness about our offer. Our strong focus on research and demonstration is probably our biggest differentiation, also in the Market Garden.

2

MARKET GARDENING

There are a number of farms who offer approximately similar services and products, but we do not consider these as problematic competition, as in Hungary there still is enough space for CSA and hybrid box schemes. Nevertheless, we are aware of the services they offer. In reality, the bigger companies can become the real competitors, because of a larger budget for advertising and being backed up by professional logistics. All in all, our strategy to outcompete them is the delivery of something more meaningful, something different, something more personal and with clear integrity. Again, the quality of the products and the story behind them are the tools to survive, since cost and quality are still the determining factors in food purchasing.

3

GRASSLAND AND LIVESTOCK MANAGEMENT

Those present in the market with similar products and services are very few. Their number increases but at a slow pace. They do not threaten my business, in fact, the wrong question is being asked here. Competition is a capitalist terminology, it doesn't have a place in holistic agriculture. To keep my "position on the market" I do my work with humility. I don't want to position myself among the so-called competitors, I support the concept of collaboration.

5.3.4 COLLABORATION ANALYSIS

Competition in the market is not always a disadvantage. In some cases, co-operation or the use of the activities of other market participants may be beneficial. (e.g., supplementing the product range with products from another nearby farmer; renting a tillage machine together; buying machines together; using infrastructure, storage, or processing units together; forming brand alliances that support effective marketing).

Questions to ask yourself:

- *Do you know any other farmers, organisations, networks that are helpful in your work?*
- *In which areas of your business or in what resources do you see the need for collaboration?*
- *What are the mutual benefits of collaborating in these areas?*
- *Who can you turn to with your professional questions?*
- *Do you know any organisation, farmer cooperation, or network of consultants that can help, especially with agroecological issues?*

AE perspective: You might be interested in AE-related organizations, networks etc. at least in a national context to whom you can turn with professional questions.

You find Hungarian, Romanian, Czech, Portugal and Austrian organizations in the following national reports:
https://traece.eu/documents/

1 **ARABLE LAND MANAGEMENT**

Knowledge transfer and collective learning processes take place in various settings and help to grow the community of regenerative arable farming even faster and better. Also in the broader sense of regenerative agriculture, there is a very interesting cooperation and information offer in the German-speaking countries. Amongst many others, the organic farmers association BIO AUSTRIA, the research institute for organic farming (FiBL), organic research Austria, and several smaller farmers associations play an important role in the movement.

2 **MARKET GARDENING**

We cooperate with other small- and larger-scale farms, which have products complementing our products. Examples are: winter products and processed products (jams, pickles) that widen our product offering. We also buy other products from other farms: Storable crops such as garlic, carrot, onion, potato; Specialty crops such as kale, broccoli, eggs.

We would love to cooperate with other farms on knowledge sharing, especially in production techniques, anything related to professional support (e.g., plant protection), or support in the field of renewable energy. We can currently address our professional questions to the Research Institute of Organic Agriculture (ÖMKi). To collect professional information, we follow trends related to market gardening (books, youtube videos, online courses such as Jean-Martin Fortier or the Lean farm hand-book that was an inspiration for Zsámbok Biokert). For specific information (e.g., how to manage the official registration to be a social farm), we definitely rely on our personal contact network.

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

There are people sympathising with my activity but actual helpers, collaborators are missing. It would be great if 2-3 similar-minded farmers could work together in order to share the physical work and thus free up time and capacity for the mental work. In terms of professional questions I occasionally consult my former teachers: a network of Swiss farmers and cheesemakers, plus I read specialist magazines online. Formal farm advisory is not available, although I could turn to the Hungarian Organic Farming Research Institute (since I am an ethnic Hungarian, living in the Hungarian populated area of Transylvania).

5.3.5 ANALYSIS OF THE EXTERNAL ENVIRONMENT

In addition to the farmer's own decisions, the business is also affected by external factors that a farmer may not be able to influence directly. However, it is recommended to be aware of these factors as they affect the farm's marketing activities.

There are different market research methods, one of which is the PESTEL method. PESTEL stands for Political, Economic, Social, Technological, Environmental and Legal analysis. It is recommended to perform it from time to time in order to be aware of the external circumstances affecting the farming activity. Its greatest strength is that it helps to identify the external factors influencing the market, from the analysis of which a complete picture can be drawn for strategy making.

The *policy* aspects of the PESTEL analysis (see more on page 185) are determined by the extent to which legislators influence a given sector, such as agriculture and agroecology. These include, among others, laws, taxes, and policies.

Economic factors include any financial practices that may have an effect on the price of services or products you provide. These include, for example, consumer purchasing power or inflation.

All aspects related to the customer, such as age, gender, education, marital status, as well as different cultural trends and attitudes are considered social aspects.

Technological considerations include technological innovations that may have an impact on your business. Agroecology-related research and development are also included (e.g., the emergence of new, innovative solutions in production or processing).

Environmental considerations include social responsibility and environmental protection, whether in production or sales.

Legal aspects include all legal factors related to the operation of the farm and to employment.

Questions to ask yourself:

- *Do you use any market research method (e.g., PESTEL) in order to get a complete picture of the external factors affecting the market?*
- *Do you monitor policies, legislation, and regulations that support or complicate the practice of agroecology?*
- *Where do you get information about policy, economic, social, technology, environmental and legal issues? (fact-based information, not only feelings or opinions)*
- *Is the knowledge of new innovative solutions supporting agroecology helpful for you?*

1 **ARABLE LAND MANAGEMENT**

We have not conducted market research by any method so far. But Alfred Grand, the farmer and manager of GRAND FARM is involved in several political committees and is therefore very informed about political influences and changes. Additionally, we get information via online platforms, specialist media, newsletters and individual networking.

There are so many experienced farmers in the field of regenerative agriculture who demonstrate great methods and innovative approaches. YouTube and social media have become a central place of information exchange in this sense.

2 **MARKET GARDENING**

We do not employ external market research services. Most policy changes have limited impact on us at our scale. We follow changes regarding the organic certification process and business and taxation-related policies and regulations, that change more often than for example the principles related to agroecology. Regarding policy, economic, social, and legal issues we mainly rely on farmer-to-farmer information exchange in the market and reading what comes out in the Hungarian media. If it is a technology issue, we rely on personal research through literature and internet communications.

The knowledge of new innovative solutions is not coming from a specific body, but from farmers experiencing and publicising what they do. These demonstrations are mostly free and sometimes are part of paid courses. Learning from videos and online readings is useful. Usually this information comes directly from farmers, and when these videos get popular enough, their messages become incorporated in the AE communication. This is a sign that the AE movement is catching up and real practical examples are important.

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

I don’t use any market research methodology. Similarly, I only monitor policies and legislation in a very superficial way. I don’t think they are authentic (with very few exceptions) so I don’t trust them. However, some parts of the innovations can be useful such as precision agriculture or biointensive farming. I learn about them mainly from the internet.

5.4 MARKETING STRATEGY

5.4.1 STRATEGIC OBJECTIVES

As discussed in chapter 5.2.2 “Farm objectives”, it is generally helpful to make use of clear and measurable objectives. Of course, the SMART criteria can also be applied to marketing issues such as the strategic marketing objectives. That way it can be ensured that the farmer is capable of tracking the progress and is actually able to reach his/her intended goals.

Questions to ask yourself:
- *What are your objectives in marketing?*
- *What is the timeframe of setting your marketing objectives?*
- *Can you imagine concrete advantages of using the SMART criteria for goal setting in marketing?*

1 ARABLE LAND MANAGEMENT

Right now the short-term objective in marketing is to raise the number of vegetable boxes from 150 to 200 by the end of April. We have not used the SMART criteria so far but can imagine serious improvements if we really used such criteria effectively and consequently.

2 MARKET GARDENING

We have a period (December-January) when we reflect on which crops have performed well, and which crop should be left out of the crop rotation, what are the main areas of infrastructure (e.g., washing area, polytunnel) that need to be invested in, etc. We believe that changing the marketing system rapidly is too risky. We set goals each year, but we find it challenging to continuously monitor the goals set. We have intermittent goal review meetings.

3 GRASSLAND AND LIVESTOCK MANAGEMENT

My main marketing goal is to support the revival of peasant lifestyle. To achieve this I encourage people and organisations to participate in this process. I don't know and don't use SMART criteria. But it could help structure thoughts around these goals.

5.4.2 DEFINITION OF TARGET AUDIENCE

After analysing the farm's current customers in chapter 5.3.2 it is time to decide on the most profitable group(s) of customers that the farmer will focus on with his/her marketing activities. Those groups will be his/her target group. All product development, all brand building activities, and all communication should be adjusted to this target group. That will help to make the marketing as effective and economic as possible and to avoid any waste of money, time, and energy.

AE perspective: Defining the target audience that is interested in AE products. (A good example can be the consumers of the social farm products.)

Questions to ask yourself:
- *Do you know your most profitable customers?*
- *How would you characterise them? What are their needs?*
- *Do you already focus your marketing activities on them?*
- *What could you do to serve their needs even better?*

1 **ARABLE LAND MANAGEMENT**

Since most of our arable land produce is sold via the agricultural cooperative, we cannot really choose our customers at the moment. Our hemp seeds are a bit of an exception because we sell them to a company specialised in hemp seed processing, which also pays us a decent price. We only sell a small amount of our hemp (roasted and natural) directly to our vegetable box customers.

2 **MARKET GARDENING**

To serve customers' needs better we would strengthen our production system and our partner network, to make offered boxes more attractive even in the most challenging months. Currently we try to optimise our production - but naturally we cannot satisfy all demand. What we focus on is ensuring the best selection and quality all year.

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

I concentrate on my most important customers instead of the most profitable ones. These are people who are playing with the idea of becoming a farmer. However, they are careful, they are waiting for the right time. Being a peasant is not always comfortable and comfort is a great attraction nowadays. I serve their needs by being communicative and visible in my opinions and actions. My guiding principle is "Do the right thing and talk about it!"

5.4.3 POSITIONING

To ensure that the farm and the farm's products are recognised by the farm's current and potential customers in a distinctive way, it is recommended to develop a strong image in their mind. The process of doing so is called Positioning (see more on page 185). Based on strengths, special skills, values, and traditions of the farm the most relevant elements are selected and put together to form a strong brand position in the mind of the target audience. The brand position should be unique and of true relevance to them. By formulating the farm's position farmers may want to answer the following question:

Why should consumers choose my products rather than my competitors?

The goal of positioning is to build a strong brand for the farm which will help customers to clearly differentiate this farm from the competitors and make this farm the preferred provider of a given product.

Regarding the AE perspective, the high value that emphasises AE principles while applying production techniques should be highlighted.

Questions to ask yourself:

- *What do you think of the importance of brands in marketing?*
- *Do you intentionally develop your own brand for your farm?*
- *What strengths, special skills, values, or traditions of your farm do you think are most relevant for your customers?*

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1 **ARABLE LAND MANAGEMENT**

Branding is a key aspect in successful marketing of nearly everything, and also in organic food production. Too many farmers do not have a strong branding that would clearly differentiate them from others and that's probably one of the main reasons for weak sales. Building a strong brand is therefore a crucial step to build customer loyalty and long-term success. We have developed professional branding together with a graphic designer and are continuously using social media, excursions, and PR for brand communication. One of our strengths is the ability to inspire and motivate people to start thinking about food production and regenerative agriculture. Our networking abilities and communication activities are a special skill that help us get in touch with our customers and stay in their mind. In day-to-day business we focus on high-quality organic produce that tastes so nice that people will remember us for that.

2 **MARKET GARDENING**

In our sector having a logo and an identifiable brand is very important. They work better for less committed consumers. Brand and logo make customers more responsive to the content we provide. We have a very identifiable logo in the market and on our van. A logo on the packaging looks good but it comes with a financial and an environmental cost. Nevertheless, we have the logo on some of our processed food (like pesto) as well as making sure that it appears in our marketing material. Our main strength is face-to face communication with people, as well as our weekly newsletter, which is a very effective tool for communicating with our consumers. Additionally, our farm is open for visitors, trainees, etc.

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

Brands are an important tool for communication but only if they are honest: they represent what the product really is. I also develop the brand of my own farm but in a really careful way. My strengths and special skills are to represent a modern variety of a nature-friendly lifestyle. I produce quality food from healthy sources. I have an animal-friendly attitude. There is a hint of culture in everything I do. And there is an uplifting taste in my cheeses.

5.4.4 BRANDING

Branding is the visualisation of the positioning strategy. Following the basic positioning decisions, the next step is to develop a brand name, a brand logo and a unique packaging design that is easily identifiable as belonging to the company. All three elements must be harmoniously matched to create a consistent perception. Just as the positioning strategy identifies the farm and its products using ideas and words, the visualisation process in branding helps to distinguish the farmer from the competitors and clarifies what he/she offers that makes him/her the better choice.

Questions to ask yourself:
- *What do you think about the importance of branding?*
- *What is your farm's brand name? Is it already well known in your market?*
- *Do you have a logo? Do you think it is truly distinctive?*
- *Do you apply any 'catch-phrase' to your product?*

1 **ARABLE LAND MANAGEMENT**

GRAND FARM (for the whole research and demonstration farm), GRAND GARTEN for the Market Garden, both of them are already quite well known in the branch. For both brands we have a Logo, but no classic catch-phrase. The Logo itself might not be absolutely distinctive but the whole value proposition itself should build quite a strong position in the mind of customers.

2 **MARKET GARDENING**

We invented our logo that represents our values and the way we work. We use this logo mainly on the internet. Our logo is easily recognisable and has served us well (e.g., a person with a horse emphasises manual labour).

Communicating the brand happens both orally through the activities of the garden's core team members, as well as through our active website and webshop and our internet presence. Our newsletter and delivery van increase the reach of our brand.

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

My farm's brand name is Tejbánya: "Milk-mine" in English. My daughter designed a logo which is mainly known by those who actually buy our products. My catch phrase is: "Peasants are not the last ones from the past but the first ones from the future." (Johann Millendorfer) I do believe our brand distinguishes us in a characteristic manner in the "market".

5.4.5 BUDGET

Now it is all about deciding how much money will be spent on which marketing activities in a given time period.

Questions to ask yourself:
- *What marketing activities do you spend money on?*
- *Do you plan your marketing budget in some way?*
- *Does marketing spending represent a significant proportion of your whole budget? (if they can answer this)*
- *Are you going to spend more on marketing in the future?*

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1 **ARABLE LAND MANAGEMENT**

We spend money on two employees that work about 15-20 hours per week for marketing activities, additionally we invest in: flyers, websites, and sometimes small advertisements in regional print media. We don't really plan our marketing budget and don't intend to spend much more in the future.

2 **MARKET GARDENING**

We allocate a limited budget specifically for marketing, although our weekly box offerings, newsletter, and our long-term presence at the large organic market in Budapest are themselves continuous marketing activities. There are team members responsible for certain marketing activities, and we share the work (a weekly newsletter with news and a farm post, as well as social media posts).

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

I only spend money on small printed labels to wrap up the cheeses when sold. I occasionally also have some leaflets printed, mainly to spread ideas, not to market the cheese. We don't plan these actions much ahead and they aren't costly. In the future I might set up a website but I don't plan to spend more than that on marketing actions.

5.5 MARKETING MIX

A marketing mix (4P) is the set of marketing tools that a company uses to implement plans for its target markets.

5.5.1 PRODUCT DEVELOPMENT

Based on all previous research and strategic decisions, it is now time to think about product innovation, processing, and product portfolio. The product embodies the company's offer. Elements of product policy are: variety, quality, design, features, brand name, packaging, and services.

AE perspective: Agroecological "origin" as product value.

Questions to ask yourself:
- *What is your product and/or service?*
- *How do you actually add value to your products? Do you do any processing?*
- *What needs does it meet and how?*
- *How is your offer different from the competitors' offer?*
- *How could your product/service be substituted by other products or services?*

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1 **ARABLE LAND MANAGEMENT**

As mentioned above, we do not sell our arable produce directly except for some hemp seeds (roasted and natural). The roasted hemp seeds are packed in a nice glass with a professional label. So far, we have not used any other typical branding on our vegetable boxes. In the Market Garden our products are two sizes of vegetable boxes with a broad selection of seasonal vegetables throughout the year.

For developing new product ideas we bring in our personal preferences in terms of healthy food, watch out for trends, and see what is doable at the time considering facilities and labour. We don't do a lot of processing yet, except for roasted hemp seeds and fermented cabbage. But we intend to do more processing in the future in order to reduce food waste to a minimum. Value is added by washing and packing our vegetables in ready-made boxes as well as through the weekly email to our customers with recipes, news, and photos.

2 MARKET GARDENING

Concerning product assortment, our basic products are the vegetable boxes people can order. We offer both fixed-box selections as well as tailor-made boxes, depending on the order. Many consumers choose a combination of both of these, ordering a standard box (either large or small) as well as additional supplementary orders from the wide range available weekly on our webshop. We deliver most boxes to collection points for consumers to pick up, and offer home delivery by cargo bikes within the centre of Budapest. We process our own pesto ("Budapesto"), and a few other processed sauces, as well as offering a selection of jams, preserves, and condiments from other local organic producers. Right now the farm is the brand, as people buy their processed products within the box.

3 GRASSLAND AND LIVESTOCK MANAGEMENT

My products don't have a huge variety, I only sell mature cheeses based on slightly modified Swiss recipes. There is not much 'product development' behind: I listen to the customers' feedback and make slight modifications if necessary. I do read quite a lot, which also supports product development occasionally.

5.5.2 PRICING

Based on all previous decisions a pricing strategy is worked out as well.

The price is the amount of money the buyer pays for the product. Elements of pricing policy are: list price, discounts, allowance, payment period, and credit terms.

Questions to ask yourself:

- *Based on what information do you set your product prices? Do you orientate according to the prices of your competitors?*
- *What are the price preferences of your buyers? Are they rather price-sensitive or not? How does that affect your pricing strategy?*
- *Is there anything special in your product or service that helps to increase the willingness of the buyers to pay more?*

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1 ARABLE LAND MANAGEMENT

In arable farming, we don't have much influence on pricing yet but in the Market Garden we orientate according to more experienced colleagues. In the next 1-2 years we will try to set up a cost accounting system in order to calculate our vegetables accordingly. We will do the same for the products from the arable land that we intend to sell directly in the future. So far, we have not changed our initial prices a lot. At the moment, we try to optimise production efficiency and cut costs rather than raising prices. In summer, during the production peaks, we sell additional vegetables to our box customers for a lower price.

2 **MARKET GARDENING**

In order to set our prices we follow the prices on the weekly market combined with working hard to know our own costs. In recent years we have consciously increased our prices, so that within the Hungarian organic market we are at the mid-range price for equivalent products, having for years endeavoured to keep our prices within the lowest price quartile. The result is that we have become more profitable and stabilised our financial situation instead of constantly struggling to survive. We would like to be able to supply our vegetables to people on a low budget, but realistically we can't achieve this alone. We have to reflect the real costs of production and maintaining our enterprise. Going out of business is not a sustainable approach. Our greatest competitor is the attitude that food needs to be cheap, without properly internalising the externalities of environmental and human health, as well as social costs. We genuinely believe that our prices reflect our real costs.

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

When selling the cheese I set the price based on prices of other cheeses on the market. To 'sell' a lifestyle does not cost anything. Price sensitivity is not a serious issue for me: people have to eat even during the pandemic. Decreasing the price is not my intention, if someone cannot pay for it, they have a piece for free. The willingness to pay is tangible for a special product like this. As Clifton Paul Fadiman said: 'Cheese is the way of the milk to immortality.' And those who recognise this quality in our cheeses are ready to pay for immortality.

5.5.3 PROMOTION

Promotion is the set of activities that a company carries out to raise awareness of the benefits of its products and to promote them in its target market.

Suitable communication methods are selected and planned such as in-person communication, online, social media, print, newsletter, etc.

Elements of a communication policy are: advertising, personal selling, sales promotion, and public relations.

Questions to ask yourself:
- *How can you reach your buyers?*
- *When can you reach your buyers the easiest?*
- *How do you communicate with your customers? How do you think your communication strategy will change/develop in the future?*
- *What is your secret of keeping your consumers?*

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1 **ARABLE LAND MANAGEMENT**

As communication channels we use Facebook, Instagram, our website, and our newsletter, as well as PR in regional and specialist magazines. Our vegetable customers really appreciate the weekly newsletter about the vegetable box and our current garden work but some of them also actively follow us on social media. In the future it might be more important to also offer individually compiled boxes, more basic food products from the arable land, as well as more events and workshops in the garden.

2 **MARKET GARDENING**

We use different channels to communicate with our consumers: website, webshop, newsletter, posts, Facebook page. Having a webshop is the greatest advantage. A lot of people read the Blog posts, but it is hard to make a direct correlation between the number of new consumers and 'likes' under the posts. It was interesting to see during Covid pandemic that cafés and small gourmet restaurants started to be interested in being the distribution points. Our weekly food box scheme is still different from those provided by big companies: in terms of quality as well as how we support small-scale healthy food production. Offering good products coupled with convenient access at competitive prices is the best way of promoting such products. Word of mouth and maintaining a high reputation are our best promotional tools.

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

My communication channels are Facebook, Instagram, LinkedIn, Messenger, magazines, e-letters, YouTube, television and radio. And I often give talks here on the farm and on all sorts of events. Different age groups have different preferences (youth more via the internet, elderly more via the older forms of telecommunication). To keep customers I have to be authentic in my actions and my products. The future trend for quality cheese is fine-dining. For the lifestyle: it's the unsustainable form of our ongoing lifestyle that will create the new trend.

5.5.4 PLACE AND DISTRIBUTION

The 'place' includes corporate activities that make the product easily accessible to customers in the target market.

For this the most effective and efficient distribution channels must be chosen.

Elements of channel policy are: channels, coverage, assortments, locations, inventory, transportation, and logistics.

AE perspective: Direct sales, short chains, CSA

Questions to ask yourself:
- *Where and how can you distribute your products the best?*
- *Which ways of distribution do you think are most favourable for your customers?*
- *What is the size of the area that you can cover with your products?*
- *Do your competitors use similar distribution channels as you do? How can you differentiate your offer from them?*
- *Has Covid-19 generated any fundamental changes in your sales, logistics and distribution practices?*

1 **ARABLE LAND MANAGEMENT**

Our roasted hemp seeds so far are distributed together with the vegetable boxes, but this year we will start selling them to premium chefs and local stores as well. The vegetable boxes are collected from customers directly from the farm or from one of our five pickup stations in the region. A few commercial smaller customers also buy our vegetables for their shop or farmers market stand. We also sell vegetables to a few local chefs. In transport we have had no real issues so far. But we intend to improve our cooling facility at the farm. Also no fundamental changes due to Covid-19.

2 **MARKET GARDENING**

Short chains work well in our case as a fresh produce market cannot be set up everywhere. To set up a distribution point is much easier if it is in compliance with health standards. We participate in distribution chains with zero (market) or one person (distribution point). And we also offer home delivery by bike. Logistics and transportation is expensive and always a challenge. During COVID-19 people travelled less and cooked more. We experienced that the demands were more stable and did not drop during the summer (as people did not travel).

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

The physical presentation of our product happens basically in our kitchen at home - accompanied by a nice chat about my farming philosophy. I also participate occasionally in cheese tastings, and there is one shop specialised in regional products selling my cheese. I also sell through my two messenger groups organised around two distinct regions of two small towns each located about 60 km away from my farm. Due to the small amounts we don't have any logistical difficulties - if customers don't take the cheese from the farm, we deliver it on a case-by-case agreed basis.

5.6 IMPLEMENTATION AND CONTROL

5.6.1 PUT THE PLAN INTO ACTION

All marketing activities are carried out that are described above: farm mission, situation analysis, and marketing strategy.

Questions to ask yourself:
- *How would you start implementing the above plan? Please mention some of your main actions only.*
- *Do you have a team? What responsibilities do the members have?*

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1 **ARABLE LAND MANAGEMENT**

The plan has been implemented already throughout the last two years but there is still a lot to improve. In our team there are two persons responsible for marketing where one is responsible for external communication (society and potential customers) and the other one is responsible for internal communication (existing customers).

2 **MARKET GARDENING**

Dedicated strategic analysis of the boxes is essential as we always need to consider the market competition. We have a sub-team but it is not always prioritised enough to meet and do the work on time.

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

Our activities related to training and education happen on the farm in our dedicated facility called the culture-barn. Our team consists of my family members: my wife (teacher and psychotherapist), my daughter (photographer), and my son (agricultural engineer). They only work part time on the farm, I'm the only full time team member. I am also collaborating with two organisations dedicated to the development of the wider area: research and education projects are executed.

5.6.2 MONITOR RESULTS

Try to think about how the marketing plan was actually managed. Which actions worked well, which ones did not? As the marketing plan is planned and executed, it is advisable to build in monitoring tools from the beginning. For example, talk to the customers. A simple email can be sent out, posts can be placed on the social media profiles or on the farm website. The better the results of the marketing activities can be measured, the better they can be optimised.

Questions to ask yourself:
- *How would you track and measure your effectiveness: which of your marketing actions are successful and which ones are less successful or completely ineffective?*
- *Would you spend time to actually monitor your marketing success?*

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1 **ARABLE LAND MANAGEMENT**

In social media there are some easy options to monitor the general success of posts. Indirectly we can measure our success in the changing numbers of vegetable boxes we deliver each week. But it is difficult to trace those numbers back to the decisive cause.

2 **MARKET GARDENING**

We need to find time to make a matrix to measure the effectiveness.

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

We make sure that expenditures don't exceed incomes. That's all...

5.6.3 OPTIMISE AND ADAPT

Based on the experience of the first period of implementation, farm strategy and/or activities can be optimised. This will eliminate unnecessary spendings and increase the effectiveness of the actual marketing actions. Thus, year by year, the farm's marketing will be more efficient.

Questions to ask yourself:
- *Did you change your marketing approach in the past based on your previous experiences?*
- *What conclusions can you draw from that experience for future marketing actions?*

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1 **ARABLE LAND MANAGEMENT**

We changed the rather strict subscription model in our vegetable box scheme to a variable system where customers get in and out whenever they want. But we will see all the consequences of that decision within the next months. With our arable field produce we aim to sell much more directly in the future and use the cross-selling effect in combination with the boxes.

2 **MARKET GARDENING**

Over time we have evolved our marketing strategy. We used to have fixed boxes but we realised that people like to have a choice. We were afraid of having extra work if we changed the system and provide more choice for consumers, but once we introduced a free choice system through our webshop we found it works really well. We experienced that the system became much more stable when we offered choices.

3 **GRASSLAND AND LIVESTOCK MANAGEMENT**

Yes, my sales activity evolved during the years including using modern information channels or improving the image of our packaging.

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SOCIAL BENEFITS OF AGROECOLOGY

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6.1 INTRODUCTION

Agroecology is an evolving science, practice and social movement, which includes not only the environmental and economic considerations of managing a farm and developing sustainable food systems (see more on page 181), but also recognizes the importance of the social context. Understanding the social context includes seeing how farming works for farming families and communities, and also the institutional and policy making framework in which farming, and food systems operate. Agroecology involves not only the work on the land but the interaction between actors within complex agricultural and food systems. To make such systems work effectively, all the elements should be in balance. People are at the heart of the agroecological movement, not only as individuals but as a community (see more on page 179). In this chapter, we want to introduce you to the social benefits that come with the application of agroecological principles and the role they play as part of it.

This module on the Social Benefits of Agroecology will approach the issues through five sub-topics:

1. Agroecology and sustainable rural livelihoods
2. Multifunctional approaches to farming
3. The social environment
4. Building community-farmer support networks
5. Social farming program

6.2 AGROECOLOGY AND SUSTAINABLE RURAL LIVELIHOODS

When we think about making a living from farming most people think in terms of how much income we can get from our farming practices - we can call this a commodity-based approach (see more on page 179). While farms do provide income and employment, "making a living" includes a lot of other sources of livelihood than simply the money which is made from selling crops, products or livestock which come from farming.
A livelihoods approach is a way of looking at how we make a living which examines what assets we have or can get access to. Some of these assets might directly bring in money, others are the resources which support in a broader context the way we can make a living from farming. For the livelihoods approach to work long-term it needs to be sustainable, so we can talk about a sustainable livelihoods approach (SLA) (see more on page 188)- that is, our livelihood today also allows for the livelihood of others and future generations.

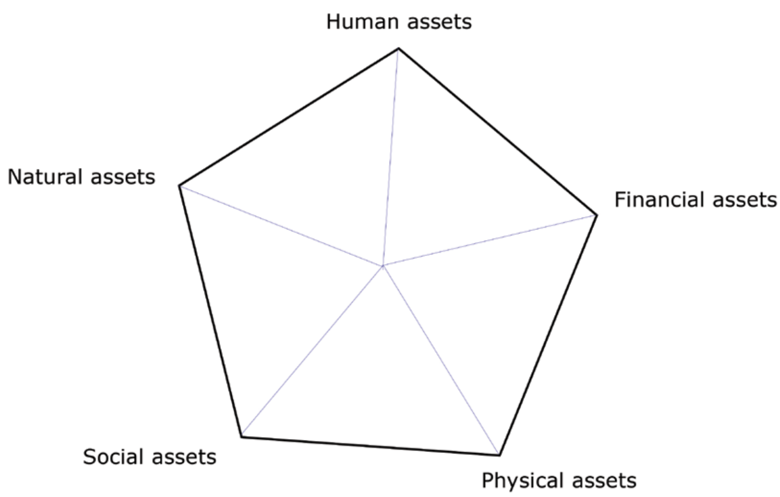

Figure 6.1: Livelihood Assets Pentagon. Source: DFID 1999; adapted by Júlia Csibi

The Livelihood Assets Pentagon (above) illustrates the five elements of a sustainable livelihoods approach.

- Human assets
- Natural assets
- Financial assets
- Physical assets
- Social assets

If we want to develop our farms and our farming practices in a way which supports our broad livelihood (including our well-being and the well-being of others around us) for the long-term, it is worth examining the assets (opportunities) we have available to us, either within our own farm and household, or which we can access through our networks. In order to develop a broad and complex view of how we can improve our livelihood (and of those close to us), it is useful to look more into the 5 types of assets:

Human assets: the skills, knowledge available to allow work to take place and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives. In other words, being able to get stuff done on the farm requires skills and knowledge but also good health and good relationships. The way we (and our teams) think about things and the way we feel day-to-day has a big part to play in how we can get the most out of our human and other assets (DFID 1999).

Natural assets: refers to the agroecosystem that surrounds the farm, from which materials and services flow. In the case of farming, obvious natural assets include our soil, the quality of water and air, as well as biodiversity and climate stability, etc. For these assets to be sustainable is not just a question of who has access to the natural resources, but how can they be conserved for future generations. Agroecology is a lot about how to ensure the long-term security and availability of natural assets (DFID 1999).

Financial assets: include all the financial resources that can be used to achieve livelihood objectives. There are several types of financial assets:

- **Available stocks** - including cash, bank deposits or liquid assets, such as stored crops, livestock, among others. These assets can be easily and quickly made available to use, without relying on outside agencies.

- **Regular inflows of money** - including regular pay, subsidies, pensions, other transfers from the state. We may have less control over these kinds of assets.

- **The value of the property on the farm** as well as the access to credit this can provide, for example, renting out farm buildings or facilities to other businesses or for individual events (e.g. weddings, training days, conferences) could provide a source of income.

Not everybody has equal access to financial capital, and people without financial assets can be held back from reaching their potential. Local authorities, government agencies and NGOs may be able to help disadvantaged individuals or groups get access to financial assets (DFID 1999).

Physical assets: comprises the basic infrastructure and producer goods needed to support livelihoods.

- Infrastructure consists of changes to the physical environment that help people to meet their basic needs and to be more productive.
- Producer goods are the tools and equipment that people use to function more productively.

The following are usually essential for sustainable livelihoods:

- affordable transport;
- secure shelter and buildings;
- adequate water supply and sanitation;
- clean, affordable energy; and
- access to information (communications).

Social assets: here is really about how much we are able to draw on relationships with other people and groups to bring opportunities to support our livelihood. This may sound a bit exploitative, but if we think in terms of networks and connectedness, we can see that there are relationships of real reciprocity and trust.

By being connected through friendships, business relationships, family connections, membership of groups and institutions our "reach" for accessing resources through other people extends. This works through mutual giving as well as taking. By being open to new connections and the sharing of information, knowledge, skills and experience we can share what we can do, as well as benefit from the knowledge and experience of others (see the section "Building community-farmer support networks" below).

Developing social capital (see more on page 186) has a lot to do with developing mutual trust and reciprocity. When we establish a trusting relationship we can save time and a lot of emotional energy, and often reduce the amount of paperwork! Developing trust is a lot about opening up and communicating what is most important to us. When we can create forums where trust builds we are half-way to building more social capital. Social networks help to allow for innovation - for example if we meet other farmers who have similar challenges, brainstorming a problem can lead to creative solutions.

If we are in a group or network in order to build social capital it helps to keep an open mind, to listen as well as to speak directly but respectfully, to establish some ground rules which ensure that everyone gets equal attention and equal access to assets. Democratic procedures can help to ensure fairness and transparency.

The farm team: If we look at the farm as a workplace, the greatest asset on the farm are the people in the farm team. Traditional, hierarchical relationships often just reinforce power relations (e.g. boss setting the agenda for employees, see more on page 185). However, if we want to get the most from the team we need to create an atmosphere of trust and a feeling that what we say will be listened to and valued. Everyone in a group or team has something to contribute. How people express themselves can be very different, but giving everyone a safe space to be heard can do a lot to encourage the quieter members of the group to speak up - it is often surprising what people are able to offer when they feel comfortable and secure.

Figure 6.2: Zsámbok market garden, Credit: Logan Strenchock

Setting sustainable livelihood goals
Being aware of the assets we have or have access to becomes powerful when we know how we want to work with these assets. Establishing sustainable livelihoods requires planning and thinking strategically about where we want to be in life and who we want to be surrounded by. Setting objectives and goals is a critical step in establishing sustainable livelihoods, in order that we know we are living in a way we really believe in, and surrounded by a supportive and supported community. Setting a goal becomes meaningful when we can reflect upon whether we have achieved that goal - for this we need some kind of metrics (measurement) to see if we are moving towards achieving that goal or not. We may want to set the goal within a timeframe to track how things are developing (Hayes et al., 2013).

Summary of the sustainable livelihoods approach
A sustainable livelihood approach is all about taking a broad, unprejudiced look at the opportunities and assets we have available to us, taking us well beyond just commodity (see more on page 179) transactions. Seeing opportunities is helped if we understand livelihood in terms of access to human, natural, financial, physical and social assets which build monetary and non-monetary capital.

Increasing our capital is a lot about developing networks and connectedness to individuals and groups, in formal and informal relationships. Trust, reciprocity, openness, respect, listening as well as speaking are all characteristics and skills which can be developed, help strengthen sustainable livelihoods.

6.3 MULTIFUNCTIONAL APPROACH TO FARMING

Achieving our livelihood goals can be helped when we start to look at our farms not as simply production units for food or fibre, but as dynamic, living systems, which have needs themselves but which can also help to supply all kinds of services beyond primary agricultural products.

A multifunctional approach to farming goes beyond looking at simply diversifying our farming enterprises - it leads us to look at our farms as centres in our community where things can happen. A multifunctional approach creates new opportunities on our farms, so that our livelihood assets are built, but also there are tangible environmental and social benefits to our farming activities. So a farm can host a range of activities, and whilst continuing to grow crops and raise livestock, we can incorporate these productive activities into creating a centre in our community where people come together to increase the value of our basic farming activities and gain social and environmental benefits.

There are almost an infinite number of possibilities for developing multiple functions on our farms, from opening a farm café, to running courses on the farm, to hosting groups of bird-watchers or visiting groups of school children. The possibilities are endless but developing viable new enterprises again depends on a strategic evaluation of the assets available (refer to the Livelihood Assets Pentagon above), taking into account how your farm assets can fit into your local context to generate services which will benefit people connected with your farm and which add to, and secure the natural resources around you.

Table 6.1 provides a selection of types of multifunctional activities (MFA) which can take place within a farm location.

MFA ACTIVITY	DESCRIPTION
Nature and Landscape Management	Services and activities which are undertaken to improve biodiversity and develop awareness
Green care	Activities taking place on the farm which are aimed at groups or individuals with special educational needs or for therapeutic purposes. Often also referred to as social farming and care farming
Educational outreach	Programmes on farms which are aimed at education - anything from short technical courses, to school visits to farm apprenticeships and research.
On and off-farm shop and other commercialisation activities	Which promotes products grown on the farm as well as other locally produced goods
Childcare	On-farm childcare services have become increasingly popular, providing children with hands-on learning experiences with plants and animals, in a rural environment.
Recreation and retreats	Recreational programmes could be anything from summer camps or adventure playgrounds, bike trails to nature trails. If the farm is suitably peaceful and scenic, it might provide a good location for spiritual or well-being retreats
Conference centre	Farm buildings may be converted to be able to host conferences, seminars or workshops for any number of groups
Agro-tourism	Holiday accommodation may be created on the farm or one off events to provide tourists with a real farm experience
Festivals and events	Farms could provide good venues for outdoor concerts, for music or arts festivals, for regular farmers markets or craft markets.

Table 6.1: Multifunctional Farming activities. Source: Hayes, M. et al., 2013


Figure 6.3-4: Volunteer day and summer camp in SZIA Agroecological Garden, Credit: Diverzitás Alapítvány

Multifunctional farming activities usually provide additional environmental and/or social benefit to the portfolio of activities on the farm as well as generate income. Establishing, developing and running additional on-farm activities needs careful organising and thorough planning to ensure a MFA venture is going to be a success. Table 2 identifies many of the critical steps needed to ensure a new activity becomes a productive and enduring enterprise.

Critical steps to establishing multifunctional farming activities	
Prepare a mission statement	Before embarking on any new activities, it is important to have a clear knowledge of your main reasons for being a grower/farmer. Formulating a mission statement for your farm or enterprise can be an important step to make sure that you don't get off track, and stay close to your core values.
Know yourself	A good exercise before choosing how you might diversify is to draw up a list of your strengths and weaknesses, likes and dislikes. Try to make the list as complete as possible, listing all of your talents, interests, phobias, loves. Once you have this list drawn up you can use it to focus on the possible diversification activities.
Know those around you	Don't limit your capacities to your own capacities. Nobody is good at everything, and even if you have multiple talents, you may not be able to employ them all at once. Try to map out the potential of those people you could include in your new venture. There are all kinds of ways to remunerate people – in kind as well as in cash. Sharing ideas and skills can be rewarding in itself.
List your hard assets	Draw up a list of all of the financial assets you have on your farm, and begin to think about how these might be used in multiple ways, or better used, or used at all.
Set your limits	Both personally and for your farm, mark out the boundaries (internal and external) to what is "public space" and what are the "no go areas". It is important that you - don't become compromised by any new enterprises (think of time, family, children, favourite spaces/practices).
Brainstorm	Alone and together with friends, family and colleagues make an extensive list of what could be done. Don't limit yourself initially to whether the idea is realistic or unrealistic. You are not committing yourself yet – try to draw up as broad a list, thinking as laterally as you can of all the activities which potentially could take place on your holding.
Analyse your assets	Start working through your brainstorming list of possibles against the reality of the assets you have, the list of your own attributes and preferences. Try to work through the lists as systematically as you can, to arrive at a much reduced, rationalised list of real diversification options.
Give yourself time	Don't leap onto a new idea too quickly. Work it over many times in your mind and with the people around you before investing too much energy in it.
Prepare a business plan	If you start to fix on a particular venture or set of ventures, work out a full business plan for it (Explained in Module 3). You will need to provide investment budgets as well as project costs and income streams, together with marketing plans, and assess the risks you are taking.

Table 6.2: Planning a Multifunctional Farming activity venture. Source: Hayes, M. et al., 2013

Figure 6.5: Community event in Magosvölgy Organic Garden, Credit: Magosvölgy Organic Garden

Figure 6.6: Workshop in SZIA Agroecological Garden, Credit: Diverzitás Alapítvány

Where can a multifunctional approach take you?
When you start to look at your farm as a place where stuff can happen above and beyond classic primary production of food and fibre you start to launch off into almost endless possibilities. Whilst this is exciting, it can also be overwhelming. The best multifunctional farms are those which manage to maintain a "golden thread" right through their activities, so there is an inner logic which links the various activities and enterprises into a cohesive whole. This kind of complex social and environmental centre takes time to evolve. It is best to start with modest steps and with enterprises which are core to your values and close to your strengths and core knowledge and skills base.

Figure 6.7: Cooking together, Credit: Zsámbok market garden

6.4 THE SOCIAL ENVIRONMENT

The farm is a social centre where personal, family, social and community needs are met and balanced. However, the farmer is not exempt from physical, mental and emotional circumstances that could disturb this balance. Agroecology encourages the participation and inclusion of the farmer within their community. A community that shares the same values and has similar goals. When a farmer encounters any of the above-mentioned problems, he/she can reach out for the support of their community. While agroecology can be practised by one farmer, a transformative agroecology is deeply collaborative.

Agroecology promotes the development of just, inclusive and equality communities advocating the participation of women, youth, indigenous people, groups that are historically neglected or excluded. Participation is one of the principles of agroecology. This participation empowers people to be involved in decision-making processes that impact their lives such as unequal access to resources at the household or farm level or to markets, credit, knowledge, governance, networks and other resources at the community or territorial level. Consequently, governments can and should use government procurement, credit, education, research, extension and other policy instruments to favour agroecological transformation.

When we talk about agroecology we talk about the whole food system. It is important to understand that even though in Europe, the concept of agroecology has been developed more at a farm level, it has evolved to include the whole food system, in that way, there are more actors who can collaborate with each other. Agroecological food systems are local and sustainable, where the stakeholders share common values and awareness. With that said, farmers and consumers are key actors of the system. It would be difficult for an agroecological farmer to thrive without conscious consumers who will support the farmer through regular purchase . Farmers have the opportunity to expand their networks from just farmer groups and develop relationships with consumers and consumer's associations as well. Being aware of the local organisations, seed savers, consumers' associations, etc. is key for finding the support system that farmers need.

Farmer's mental health: A much under-reported issue is the particular pressures farmers and their families and colleagues can be under due to the special nature of farming. Farms can be isolated places, farming is famously vulnerable to the vagaries of the weather, the market, financial loans and other outside influences. The uncertainty, risk and social isolation can put farmers and their families under a lot of strain resulting in mental illness. Farming communities are often quite conservative, and traditionally people may believe that they have to solve all their own problems and not seek outside help, and conform to stereotypes (like men don't talk about their emotions). Often there are stigmas or even taboos around mental illness, which make seeking help challenging. In some countries there are organisations set up to support farmers with mental health or financial crises. In the best cases farmers' chambers of commerce take an active role in promoting mental health for their members. The most important message is: seek outside help and seek it early! The sooner problems are shared and talked about with professionals who can help, the easier it is to find solutions. It is easy to feel trapped and a sense of no options - only through opening up are we able to see the bigger picture. Family help centres, psychological, psychiatric services or debt-counselling services can be found on the internet. Don't be afraid to reach out when you start to feel stressed!

6.5 BUILDING COMMUNITY-FARMER SUPPORT NETWORKS

Farmer-farmer - local networks - and farmer-non-farmer (who belong to different sectors but at the end of the day, everyone is a consumer) networks - external networks - are important because they build community by creating friendships and business partnerships that support the work of the farmers (technical, financial, legal, political support, etc.). They provide education opportunities targeting audiences with shared values, interests, and concerns. They give farmers and consumers a venue for peer-to-peer discussion and mutual understanding, which translates into consumer awareness, innovative production and marketing strategies with the potential of increasing economic possibilities and community development, in general improving the quality of life for all the actors.

Local markets and spaces for commercialization provide benefits to both the farmer and the consumer. Farmers who participate in these systems can benefit from having long term consumers who understand the practice used and the quality of the products, therefore are more likely to be aware of the real costs of the products. The same consumers have the benefit of knowing the source of their products, the quality and conditions in which the products were grown, allowing them to make educated and conscious decisions about their food. In both cases, they contribute to the improvement of the local economy and the preservation of the environment.

Local markets are wonderful opportunities to develop farmer-farmer and farmer-consumer networks. The most known examples are Community supported agriculture (CSA), farmer's markets, farmer's shops, farm stands, food basket/box schemes, etc. Their success depends on the local context and the strategies to develop the networking. Nowadays, the use of technological tools such as social media, can make the connection and awareness more accessible, especially among young people.

Farmer-to-farmer study groups (similar in many ways to Farmer Field Schools FFS) are a way for farmers to exchange knowledge, skills and understanding on both technical and non-technical issues. In some countries extension services have been active in encouraging farmer-to-farmer study groups as a way to disseminate knowledge about new innovations and technology, sometimes linking the farmers directly with the researchers. Starting up a new farmer-to-farmer study group doesn't have to be a complicated process. A group of friends or neighbours could form the core of a new group. Meeting regularly, but maybe just for a quieter period of the year can make it easier to get people to come along. Local municipalities in rural areas would normally be open to supporting farmer-to-farmer initiatives, and could perhaps provide a venue for meetings, free of charge. Farmers can exchange experiences, and can also invite outside speakers or guests. Table 6.3 suggests steps to setting up and running a farmer-to-farmer study group.

STEPS	DESCRIPTION	COMMENTS
1. Decide on the focus of the group	What are the issues and questions most relevant to the participants/farmers	The issues may be technical or non-technical, also including social questions
2. Identify the participants and forming the group	This may involve putting up notices around a village or on social media to advertise the group and recruit interested participants	It may take time for word to get out, so starting with a small group is fine
3. Find a suitable venue	Depending on when and at what time the group is going to meet	Suitable venues could be community spaces, on-farm, church halls, etc.
4. Form a core group	It is often helpful to share the work of organising the group between a small, active, core group.	A core group will share ideas as well as keep each other motivated
5. Hold a launch meeting	The aim is to both assess the local interest and start collecting ideas for a programme (curriculum) for the group	The meeting needs a facilitator who is able to both lead and listen, to gather the ideas of the whole group
6. Decide on a programme/curriculum	Having a programme will allow for planning, and will map out the interest of the group	The programme is not set in stone - it can be changed as the group develops
7. Agree on "ground rules"	Participants share ideas and agree on what are the basic social rules for the group (e.g. inclusive, democratic, freely sharing information)	setting ground rules is important in order to maintain a respectful atmosphere. One ground rule might be "We will make sure everyone has a fair chance to share their opinion in an atmosphere of openness and tolerance"

Table 6.3: Setting up a farmer-to-farmer study group. Source: Matthewson, M., Fery, M., 2013

6.6 SOCIAL FARMING PROGRAMS

Social farming is an emerging topic for different stakeholders across Europe: farmers, farmers' organisations, service-users of social farms and their organisations, providers of social and health care services, other stakeholders in social and health care and local, regional and national authorities. Social farming includes:

- Agricultural enterprises and market gardens which integrate people with physical, mental, or emotional disabilities;
- Farms which offer openings for the socially disadvantaged, for young offenders or those with learning difficulties, people with drug dependencies, the long-term unemployed and active senior citizens;
- School and kindergarten farms and many more. Prevention of illness, inclusion and a better quality of life are features of social farming.

Figure 6.8: Garden work in SZIA Agroecological Garden, Credit: Diverzitás Alapítvány

Figure 6.9: Farm visit in Magosvölgy Organic Garden, Credit: Magosvölgy Organic Garden

Social farming is both a new and a traditional concept. It originates from the traditional rural self-help networks that were well established in rural areas before the modernisation of agriculture and the rise of the public welfare system. Nowadays the concept has been substantially reformed in an innovative and an evolving way. The special added value of social farming is the possibility for disadvantaged people of being integrated in a living context, where their personal capabilities may be valued and enhanced.

Social farming fits with the changing needs in society. It is interesting for the social and health care sectors, as it is linked to the strong demand for inclusive development coming from the fields of social and health care services (processes of socialisation). Nowadays inclusion of service-users into society, providing meaningful activities/work that leads to empowerment, greater independence and better social status and an approach that takes the potential of service-users as a starting point – rather than their limitations, are all central elements in the desired renewal of the health and social care/rehabilitation sector.

6.6.1 IMPACT OF SOCIAL FARMS ON FARMERS

Economic pressure is not the only thing that puts pressure on small farms. The average age of farmers across Europe is rising - meaning a lack of new entrants. Farming is not an attractive profession for many young people. The working day is long, physical work is required, farming is capital intensive and risky, especially due to the exposure to the unexpected fluctuations of the weather, the income is difficult to calculate.

At the same time, there are few livelihoods in the countryside, and it goes without saying that farming has played or should play a decisive role in creating the living conditions for those living in the countryside. The provision of social farm services as a new opportunity can help to make the core business sustainable. It is also beneficial to offer social services on the farm in terms of farm income diversification and financial liquidity, as this constant income can contribute to reducing the uncertainties arising from the farmer's way of life (e.g. seasonality of income).

Social farms can bring both economic and social benefits to the farmer. Some people are transforming their farms mainly for financial reasons, but there are also those who are driven by their attitudes and commitment beyond just the monetary motivation. Major potential benefits of social farming for farmers are:

- Farmers can be proud of their caring work.
- According to research, farming activity is associated with environmental and health problems: farmers live a life full of stress, with few recreational opportunities, but increasingly in social isolation. However, social farms can transform agricultural spaces into thriving and supportive communities.
- With social farming, farmers can therefore become more connected to society. The farm becomes more open to the outside world by regularly visiting groups and individuals to visit or work. Farmers become less isolated and see a contribution to improving the lives of others.
- The name social farm combines the environmental experiences of "green care" and the impact of "therapy" on users. And the "therapeutic community" approach is important not only for the health of users but also for the health, well-being and quality of life of farmers, as this concept presupposes the involvement of all stakeholders.
- Caring, leisure and education services can offer the economy new sources of revenue.
- Farmers are becoming part of wider networks. This can have direct or indirect benefits, it can help to get to know the economy better in the area (marketing), it can access new sources of knowledge and new tender opportunities.

Farmers receive the following social benefits when they open their doors to their fellow human beings with altered abilities:

- They can observe how farm helpers (patients) develop, open up as a result of working on their farms, make changes in the lives of their fellow human beings, and help people on the periphery.
- They make new relationships, acquire new skills.
- Their work pace slows down with the involvement of farm helpers, so they are less stressed and gives them a new perspective.
- Working in a team is often a new experience for farmers working alone.
- They can broaden their network of contacts in their wider community, and the family of farmers also get new experiences.

In addition to new opportunities, we also face new tasks and challenges:

- The infrastructural conditions for the reception of groups (buildings, equipment, movement on the farm, etc.) must be created, which is capital-intensive.
- The farmer must obtain the permits and qualifications that may be required for new activities.

- Social farms can be operated by “social farmers”. Social farming must be prepared not only with infrastructure and new knowledge, but also in spirit, in order to be aware and address social needs/the needs of the people who will be served.. Not all farmers are amenable for regular social gatherings, but there are many opportunities to connect.

6.6.2 GOOD EXAMPLES AT THE INTERNATIONAL AND HUNGARIAN LEVEL

UNITED KINGDOM

The care farming movement is building from below, as the state has not yet embraced the initiative. Care farms are represented by the Care Farming UK team in Northern Ireland, and “Social Farms and Gardens” in Great Britain.

NORWAY

The Norwegian government, more specifically the Ministry of Agriculture, has recognized the economic potential of green care services, and they play a key role in advancing processes. They have developed a national strategy, catalyse collaborations between stakeholders, and participate in international research. Norway’s example highlights the role of political will and commitment.

NETHERLANDS

In the Netherlands, both the health / social sector and the agricultural sector have understood the benefits of social farming, and decision-makers are not excluded.

The Dutch research community has been fully supportive of the initiative: the Netherlands is conducting the most forward-looking research in the field.

HUNGARY

Baráthegyi Majorság - the versatile social farm: The Symbiosis Foundation operates the Bátorhegy Majorság and has created a complex service model. Its main activities are social assistance and employment, sustainability, and attitude change. Its main target group is people with autism and people with learning challenges, but it also provides a variety of services to a wide variety of people.

Hernádszentandrás - called “BioSzendrandrás” social farm on the initiative of the municipality: The basic idea of the Bioszentandrás Program started at 2007 is to create a stable, productive social farming environment for disadvantages local community while producing for the market. During the planning period of the process, it became clear that Hernádszentandrás has excellent soil properties, so agriculture is the most suitable outbreak option.

Farm pedagogy: The aim of the Farm Pedagogy Program of the E-Mission Association of Nyíregyháza is for all children in Hungary to get to know the traditional farming methods that can still be found in our villages through a conscious, life-giving pedagogical program to gain personal experiences in food production, get closer to the rural people, the rural livelihood and respect them.

Diverzitás Alapítvány: is a non-profit organisation founded in 2007. Their mission is to build an inclusive society that is ecologically responsible and sustainable. Most of their projects are located in Gödöllő and the surrounding area, Central Hungary, although they have education programmes in other parts of the country as well. Their main activities are labour market reintegration, adult education, international projects and the social and agroecological farm the SZIA Garden.

Recommended social farm videos:

Revitalist project UK
Revitalist project - Economic viability training, Italy
Revitalist project Hungary
See tr4ce video - Social farming as part of agroecology:
https://www.youtube.com/watch?v=c9H4qrNoWjU

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AGROECOLOGICAL KEYWORDS/CONCEPTS

ACRONYMS

FAO: Food and Agriculture Organization of the United Nations

CAP: Common Agricultural Package (European Commission)

WTO: World Trade Organization

IAASTD: International Assessment of Agricultural Knowledge, Science and Technology for Development

IPES-FOOD: International Panel of Experts on Sustainable Food Systems

CIDSE: International Cooperation for Development Solidarity

HLPE-FSN: High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security (CFS) of the United Nations

IFOAM - Organics International: International Federation of Organic Agriculture Movements

GLOSSARY OF TERMS

Abiotic and biotic (see on page 14)**:** abiotic is referred to the non-living components present in an ecosystem, like the physical conditions (temperature, humidity, salinity, sunlight, pH, etc.) while biotic refers to all living elements.

Accompanying flora (see on page 15)**: see companion plants**

Agricultural System: see Farming System

Agrobiodiversity (see on page 14-chapter1 and page 87-chapter4)**:** is the variability among living organisms from all sources in the frame of agroecosystems. Among the cultural plants and domestic animals, agrobiodiversity includes also wild/natural organisms, living and connected with agroecosystems.

Agroecology (see on page page 40-chapter2 and page 86-chapter4)**:** is an applied science and practice that works with and develops complex and robust ecological relationships in farming and across the whole food system, to nurture sustainable soil health, optimise nutrient cycling, conserve energy and dynamically manage biodiversity as well as spearheading a social movement to reshape relations in society towards equity, food sovereignty and self-governing communities.

Within the trAEce project consortium, the understanding of Agroecology is the following: Agroecology (AE) is developed from knowledge that is premised on a combination of heuristic practices and transdisciplinary science that is supported by participatory action-research; this knowledge is further informed by the ancient traditions of people living in natural ecosystems that contribute towards the sustainability of the food system. AE practices nurture soil ecosystems, nutrient recycling, the conservation of energy and the dynamic management of biodiversity; it is also a flag of a social movement that include peasants, traditional communities, neo-rurals, activists and researchers from academia to reshape the relations within the food system, promoting proximity and solidarity between consumers and producers; in AE systems, both consumers and producers challenge and transform power structures in society, leading to self-governing communities that endeavour to loosen corporate control over food systems to achieve people's food sovereignty.

Agroecosystems or agri-ecosystems (see on page 86-chapter4)**:** is a cultivated ecosystem, used for agricultural production/activities, generally corresponding to the spatial unit of a farm and whose ecosystem functions are valued by humans in the form of agricultural goods and services.

Agroforestry (see on page 13-chapter1 and page 87-chapter4)**:** is a land management system that combines trees with food crops, in the same land e.g. arable crops intercropped with forest or fruit trees.

Allelopathic properties (see on page 125)**:** is a biological phenomenon in which plants produce biological compounds that influence other plants. Through these compounds they can influence germination, growth, survival and reproduction of other plants. They can be either positive (incremental) or negative (detrimental), and thus, for example, through the leaf litter layer prevent competitor plants from germinating.

Alley cropping (see on page 96)**:** is defined as the planting of rows of trees and/or shrubs to create alleys within which agricultural or horticultural crops are produced.

Anthropogenic (see on page 14)**:** of, relating to, or resulting from the influence of human beings on nature (e.g. anthropogenic pollutants).

Appropriate technology (see on page 39-chapter2 and page 111-chapter4)**:** is small-scale technology. It is simple enough that people can manage it directly and on a local level. Appropriate technology makes use of skills and technology that are available in a local community to supply basic human needs, such as gas and electricity, water, food, and waste disposal. See more here: https://www.ncat.org/about/ and http://lsa.colorado.edu/essence/texts/appropriate.htm

Biocentre and biocorridors (see on page 15)**:** are pieces of land kept wild within a bigger farmed land. A biocentre keeps a permanent habitat of wild species and communities connected by biocorridors with other biocentres. These are strategies to enhance biodiversity near to human activities, like farming or urbanisation, which significantly decreases the diversity of animal and plant species present in a territory.

Biodiversity (see on page 13-chapter1, page 54-chapter2, and page 86-chapter4)**:** is the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems.

Bio-region (see on page 115)**:** is an agreement for the sustainable management of a determined territory, based on organic farming. It involves the whole local community, from farmers to producers, consumers, schools, tourism operators, institutions, among others.

Biotechnology (see on page 31)**:** can be defined as the controlled and deliberate manipulation of biological systems (whether living cells or cell components) for the manufacture or processing of products that are useful to industry. These products include genetically modified organisms, bacteria, plants, or animals where a gene from another species is introduced. The most well-known examples are Bt corn or soy, which have received genetic material from a bacteria that produces toxic substances for insects—in this way the corn produces its own insecticide; and Round-up ready Soy, which is supposed to resist to a glyphosate-based, and therefore very toxic, herbicide. More recent inventions include gene edited organisms, where it is attempted to activate or deactivate specific genes.

Biomass (see on page 41) **:** is the organic matter of plant or animal origin used to produce energy.

Bokashi (see on page 116)**:** is an old type of composting process from Japan, that is based on fermentation instead of decomposition of organic matter. Different raw materials and different processing times may be used. The main difference between regular compost and bokashi is that in the latter, the raw materials are mixed with specific beneficial microorganisms that ferment the matter instead of decomposing it, thus creating an amendment that can greatly increase soil health (Quiroz & Céspedes, 2019).

Branding (see on page 71)**:** is the visualisation of the positioning strategy. Following the basic positioning decisions, the next step is to develop a brand name, a brand logo and a unique packaging design that is easily identifiable as belonging to the company. All three elements must be harmoniously matched to create a consistent perception. Just like the positioning strategy does with ideas and words, the visualisation process in branding helps to distinguish the farmer from its competitors and clarifies what he/she offers that makes him/her a better choice.

Business model (see on page 61)**:** is a conceptual structure or an organised idea, describing how the organisation creates, delivers and captures value for both customers and itself.

Business Model Canvas (see on page 61)**:** is a strategic management tool that helps an organisation to design and assess its business model. It is a simple, one-page template that contains nine building blocks representing the essential elements of the business.

Business plan (see on page 61)**:** is a written document that defines the objectives (operational and financial) of the business and explains how those will be realised. It is advisable to periodically re-examine the business plan in order to know that it is accurate and realistic. It is a part of the business model. For successfully starting and running an AE farm a well-developed business plan is needed, where the elements of AE are emphasised.

Business strategy (see on page 61)**:** is a set of plans, actions and goals that outlines the clear roadmap for an organisation to achieve them. Business strategy is a part of a business plan and usually covers a 3-5 year period.

Carbon Sequestration (see on page 26): is a process of long-term storage of carbon in soils, plants, ocean and geologic formations. It can occur from anthropogenic activities as well as naturally, and by changing the actual farming, forestry, grazing and land use industrial practices can greatly contribute to fix carbon.

Circular economy (see on page 24-chapter1 and page 39-chapter2)**:** is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended. In practice, it implies reducing waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible. These can be productively used again and again, thereby creating further value. See more here: https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits

Climate resilient agriculture (see on page 87): is perceived as the set of practices that allow agroecosystems to withstand the adversities of climate change and still remain productive.

Closed loop systems (see on page 40)**:** it means that the needs and outputs of a system are in line with each other meaning that there is no need for external inputs. In natural systems, often the only external input is sunshine, nothing more. In permaculture the aim is to design systems which are independent, and can maintain themselves.

Commodity (see on page 166)**:** is a basic good used in commerce that is interchangeable with other goods of the same type. Commodities are most often used as inputs in the production of other goods or services. The quality of a given commodity may differ slightly, but it is essentially uniform across producers.

Commodity-based farming (see on page 163)**:** is a farming practice which focuses on production output, with the products being valued purely on their financial/monetary value.

Community (see on page 110-chapter4 and page 163-chapter6)**:** is a group of people living in one particular area or people who are considered as a unit because of their common interests and/or desire to achieve something together.

Community Supported Agriculture (CSA model) (see on page 32)**:** is a system that connects the producer and consumers within the food system more closely by allowing the consumer to subscribe to the harvest of a certain farm or group of farms and to share the risks of farming. In return for subscribing to a harvest, subscribers receive either a weekly or bi-weekly box of produce or other farm goods. This includes in-season fruits and vegetables and can expand to dried goods, eggs, milk, meat, etc. Typically, farmers try to cultivate a relationship with subscribers by sending weekly letters of what is happening on the farm, inviting them for harvest, or holding an open-farm event.

Companion planting (see on page 15)**:** is the close planting of different plants that enhance each other's growth or protect each other from pests.

Composting (see on page 101)**:** is the process by which a stable soil amendment, rich in organic matter and concentrated nutrients (compost) is created. By definition, any decomposed material is not considered compost until its composition has reached a ratio of 10 parts carbon to 1 part nitrogen, with a C:N ratio lower than 10:1 still being considered decaying organic matter. Compost can contain a wide variety of organic materials, and be distinctly different in composition. Four classifications of compost include: inoculating, fertilising, nutritional and mulching composts (Ferencz et. al, 2017, Frost, 2021).

Contour Line (see on page 53)**:** is a line on a map that represents an imaginary line on the surface of the Earth, representing the elevation above the sea level. They are very useful to install structures of rainwater capture.

Cover crops (see on page 103)**:** are plants sown with multiple purposes (protect the soil from erosion, be cut for crop mulching, be consumed by domesticated animals, serve as food for the beneficial insects, etc) other than immediately fertilising the next crop**.**

Crop Rotation (see on page 102)**:** is the agricultural principle of avoiding growing the same crop year after year in the same area on a farm. Rotation is a fundamental principle in agroecology and organic gardening, and contributes to building organic matter and maintaining fertility in soils, improving pest and disease resistance in crops, and maintaining control over weeds in growing areas. Crop rotation can be practised in gardening operations of all scales.

Direct and indirect emissions (see on page 18)**:** are defined by the GHG Protocol as follows: Direct GHG emissions are emissions from sources that are owned or controlled by the reporting entity. Indirect GHG emissions are emissions that are a consequence of the activities of the reporting entity but occur at sources owned or controlled by another entity.

Ecology (see on page 39)**:** is the study of the relationships between living organisms, including humans, and their physical environment. It is the overall scientific discipline behind all the other terms detailed below related to ecology. See more here: https://en.wikipedia.org/wiki/Ecology

Ecological Footprint (see on page 12-chapter1 and on page page 40-chapter2)**:** is the only metric that compares the resource demand of individuals, governments, and businesses against Earth's capacity for biological regeneration. (Humans use as many ecological resources as if we lived on 1.7 Earths.) The Ecological Footprint is a method promoted by the Global Footprint Network to measure human demand on natural capital, i.e. the quantity of nature it takes to support people or an economy. It tracks this demand through an ecological accounting system. The accounts contrast the biologically productive area people use for their consumption to the biologically productive area available within a region or the world (biocapacity, the productive area that can regenerate what people demand from nature). In short, it is a measure of human impact on the environment. See more here: https://www.footprintnetwork.org/our-work/ecological-footprint/

Ecological or ecosystem functions (see on page 40)**:** is a term representing the roles, or "services", that species play in the community or ecosystem in which they occur. It can be also interpreted on the ecosystem level, thus the "services" supplied by the whole ecosystem, or a habitat in practice. These functions are somewhat synonyms with ecological processes but rather focus on the outcome of the given natural phenomena and its role in the ecosystem.

Ecological processes (see on page 112)**:** are natural phenomena carried out by the interaction between biological agents. Examples of important ecological processes are: the energy flow of trophic levels, the cycle of minerals (carbon, nitrogen, potassium, etc) and water; community dynamics (pest and disease predation/competition, biological fixation of nitrogen, production of humus and soil; production of food, fodder, timber, etc).

Ecosystem or ecological system (see on page 39-chapter2 and page 86-chapter4)**:** consists of all the organisms and the physical environment with which they interact. These biotic and abiotic components are linked together through nutrient cycles and energy flows. An ecosystem is a geographic area where plants, animals, and other organisms, as well as weather and landscape, work together to form a bubble of life. Ecosystems contain biotic or living parts, as well as abiotic factors, or nonliving parts. Biotic factors include plants, animals, and other organisms. Abiotic factors include rocks, temperature, and humidity. See more here: https://www.nationalgeographic.org/encyclopedia/ecosystem/print/

Ecosystem connectivity (see on page 53)**:** means the connections between natural habitats across the landscape. Agricultural land and farming have a significant impact on it, thus in agroecology, supporting connectivity is desirable. See more here: https://www.cms.int/en/topics/ecological-connectivity and https://ecologicalconnectivity.com/connectivite

Edge effects (in ecology) (see on page 47)**:** are changes in population or community structures that occur at the boundary of two or more habitats. See more here: https://greatecology.com/2018/04/05/living-on-the-edge/

Efficiency (see on page 24-chapter1 and page 44-chapter2)**:** means to reach a goal with the least use of resources.

Endemic species (see on page 13)**:** are species that are native to a single defined geographic location, such as an island, state, nation, country or other defined zone.

Enteric fermentation (see on page 17)**:** is a fermentation that takes place in the digestive systems of animals. In particular, ruminant animals (e.g. cattle, sheep, or goats) have a large rumen (so-called fore-stomach), within which microbial fermentation breaks down food into soluble products that can be utilised by the animal. In the rumen, methane is produced by bacteria as a by-product of the fermentation process. This methane is exhaled or belched by the animal and accounts for the majority of emissions from ruminants. Methane also is produced in the large intestines of ruminants and is expelled.

Environmental impact (see on page 14-chapter1, page 78-chapter3 and page 88-chapter4)**:** is any change to the environment, whether adverse or beneficial, resulting from activities, products, or services. It is the effect that people's actions have on the environment.

Eutrophication (see on page 16)**:** is a process in which nutrients, like organic matter and phosphorus compounds accumulate in a body of water. When it occurs naturally, it is a very slow process. While due to human activity such as the use of farming fertilisers and untreated waste waters, reaching water bodies by raining water run-off or infiltration, it becomes a rapid process, resulting in an excessive concentration of nutrients which stimulates overabundant algal and aquatic plant growth, contributing to the degradation of the water body, by oxygen deficiency and bacterial overgrowth.

Farming system or agricultural system (see on page 39, on page 44-chapter2 and page 90-chapter4)**:** is a complex organisation of different elements in the farm such as soil, plants, animals, people, equipments and other inputs as well as power, labour, capital, culture, that mutually influence each other to varying degrees by environmental, political, economic, institutional and social forces that operate at many levels. All these elements are interdependent and mutually influence each other. The farming system includes other small systems like the system of energy, of water, etc, and it is included in bigger systems, such as the economic system, for example. Under a food systems approach, the productivity and profitability of a farm depends not only on the farming practices or inputs used by the farmer, and on the type of soil, topography, amount of water available or local biodiversity on the farm, but also on the characteristics of the landscape where the farm is integrated, on the agricultural, rural development and health national policies, on the transport infrastructure available, the connection to the food processing sector, the farmers' access to agro-food markets or the consumers food habits and the marketing practices. By understanding the food system where the farm is integrated in, the farmer is more likely to not only produce more but also sell its product better.

Food sovereignty (see on page 13): is the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems. See more here: https://viacampesina.org/en/

Food system (see on page 20-chapter1, page 42-chapter2 and page 163-chapter6): embraces the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption, and disposal (loss or waste) of food products that originate from agriculture (incl. livestock), forestry, fisheries, and food industries, and the broader economic, societal, and natural environments in which they are embedded (FAO, 2018).

Food waste (see on page 17)**:** is food that is not eaten. Food waste occurs along the entire spectrum of production, from the farm to distribution to retailers to the consumer. Reasons include losses from mould, pests, inadequate climate control, losses from cooking, and intentional food waste.

Global North/Global South (see on page 12)**:** is a term that points to the unequal and inequitable power and economic conditions of the overall wealthier countries in the Northern Hemisphere and the generally (with some exceptions) less wealthy and in many cases poor countries of the Southern Hemisphere.

Genetically Modified Organisms (see on page 31)**:** are organisms whose genome has been engineered in the laboratory in order to favour the expression of desired physiological traits or the generation of desired biological products.

Green Manure (see on page 122)**:** consists of the planting of improving plants, like leguminous combined with cereals, for later soil incorporation, in order to fertilise the next crop.

Green Revolution (see on page 12)**:** took off after the Second World War and promised a large increase in crop production in developing countries through the use of artificial fertilisers, synthetic pesticides, and high-yield crop varieties.

Greenhouse gas emissions of Greenhouse gases (GHGs) (see on page 88)**:** are compound gases that trap heat or longwave radiation in the atmosphere. Their presence in the atmosphere makes the Earth's surface warmer.

Greenhouse gases emissions mitigation (see on page 26)**:** is decreasing the amount of greenhouse gases, reduction of their production.

Guild (see on page 47)**:** It is a consciously designed, complex plant assembly, integrating plants beneficial to each other by using the principles of companion planting but with diverse plants not only two. The basic idea behind the design is that the different plant species use separate ecological niches from the available resources therefore there is no competition between the plants, while the beneficial connections can be maximised. More info here: https://www.tenthacrefarm.com/how-to-build-a-fruit-tree-guild/

Hydrologic regime or water cycle (see on page 16)**:** refers to the state of water movement in a certain area. It depends on the climate and considers the occurrences by which water first takes form as atmospheric water vapour, then into a liquid or solid form, falls as rain, moves along or into the ground surface, and goes back to the atmosphere as vapour through the evaporation and transpiration.

Holistic (see on page 39)**:** assumes that the parts of something are closely interconnected and can only be explained by reference to the whole.

Holistic grazing or management (see on page 45-chapter2 and page 95-chapter3)**:** Holistic Planned Grazing is a planning process for dealing simply with the great complexity livestock managers face daily in integrating livestock production with crop, wildlife and forest production while working to ensure continued land regeneration, animal health and welfare, and profitability. Holistic Management supports the understanding of the "whole" of what is managed (not controlled) and making decisions that bring forth abundant outcomes, regenerating life for all involved. See more here: https://savory.global

Indigenous farmer/ing (see on page 20)**: See Traditional or indigenous farming**

Industrial farming/conventional (see on page 25-chapter1, page 41-chapter2 and on page 120-chapter4)**:** is the large-scale, intensive production of crops and animals (often called conventional production), often involving chemical fertilisers on crops or the routine, harmful use of antibiotics and pest control in animals that are generally kept in tight, controlled spaces. It may also involve hybrid cash crops or crops that are genetically modified, heavy use of pesticides, and other practices that deplete the land, disrespect animals, and increase various forms of pollution. In recent decades, consolidation in the industry has intensified as agriculture has undergone what is known as "vertical integration," a transition from small, diverse farms producing a variety of crops and livestock to an industrialised system dominated by big multinational corporations.

Intensification of agriculture (see on page 89)**:** is the increase in agricultural production per unit of inputs. In can be done in sustainable ways e.g. precision agriculture systems, remote sensing implementation, nutrients management based on artificial intelligence, and unsustainable ways: e.g. high production varieties of field crops dependent on the plant protection products, an increasing share of crops grown for energy purposes, high inputs of mineral fertilisers, the poor biodiversity of field crops.

Intensive or Improved grasslands (see on page 89)**:** are high production grasslands with low number of plant species. They are basically the opposite of species-rich grasslands. Fertilisation is part of their management. They are called improved from the perspective of productivity but they are very much degraded from the perspective of biodiversity.

Intercropping (see on page 112)**:** is the system of planting monospecific lines of a certain crop, interspersed with other lines of different crops

Keyline (see on page 54): is a term that comes from the reference to a "keypoint", or point of inflection & deposition in a primary valley, where the lower and flatter portion of a primary valley floor suddenly steepens. Alongside earthen dams and diversion & irrigation channels, the geometry of topography allows effective cultivation lines to be established for more even spread of water in the soil. Plow patterns are generated within the valley limits parallel up and down to the contour of the keypoint, combined with patterning on ridges parallel to the lower contours. This allows non-inversion cultivation to effectively move water out from moist valleys to drier ridges, thus creating a more even distribution of water that traverses through the soil at a slower rate, which at the same time can counteract compaction and promote deeper rooting and soil creation. See more here:
https://www.ridgedalepermaculture.com/keyline-design.html , http://yeomansplow.com.au/8-yeomans-keyline-systems-explained/ and https://www.permaculturenews.org/2013/02/22/before-permaculture-keyline-planning-and-cultivation/

Leaching of nutrients (see on page 53)**:** means in agriculture that water-soluble plant nutrients are lost with rain and irrigation with water runoff due to soil characteristics or intensity of water fall.

Lean farm design (see on page 141)**:** is a process and management system approach which promotes tools for eliminating waste and increasing efficiency, developed and originally applied to industrial production chains, but adapted for farms of different scale by Ben Hartmann. Strategies for minimising waste, increasing efficiency and maximising value, specifically in market gardens are described in the book: "The Lean Farm" and "The Lean Farm Guide to Growing Vegetables"
https://www.claybottomfarm.com/books

Manure management (see on page 17)**:** is how manure is captured, stored, treated, and used. It has important implications for farm productivity and environmental impact.

Mycorrhizal fungi (see on page 102)**:** are fungi species found in soil that form symbiotic relationships with a large number of plant species, through association with their roots. These fungi are especially important for agriculture and forestry, because they provide multiple benefits for the host plant, including: improved nutrition, resistance to soil-borne diseases, resistance to drought, better root structure, tolerance to heavy metals, etc. Intense soil cultivation, excessive use of chemical fertilisers and the use of pesticides and herbicides are known to damage mycorrhizal associations. (Gostling et al., 2006)

Monocropping (see on page 125)**:** is the principle of cultivating the same crop year after year in the same area.

Monoculture (see on page 86)**:** is the practice of growing one crop species in a field or area at a time.

Mulching (see on page 93)**:** consists of the use of organic materials to cover cultivated soils.

Multi-species grazing (see on page 94)**:** refers to grazing by two or more species of grazing animals on the same land unit, not necessarily at the same time, but within the same grazing season. Multispecies grazing provides a great opportunity for optimising use of plant species on a pasture, as different livestock species prefer different plants. This maximises forage utilisation, translating into higher animal production rates per acre, lower costs of production and better returns for producers.

Nitrogen fixing plants (see on page 89)**:** are plant species which through cooperation with microorganisms convert inaccessible atmospheric nitrogen to plant available nitrogen (ex. alfalfa, lupin).

Nutrient cycling (see on page 87)**:** is the process of biomass decomposition by biological agents, which makes nutrients available for absorption by plant roots. Farm animals turn residual biomass and crop byproducts into a fertiliser, and deep rooted plants capture nutrients from the depths and later provide them to surface plants, when they die or shed leaves.

On-farm research (see on page 32)**:** is often the partnership between either one or a group of farmers, and agricultural service providers. Researchers may provide leadership, guidance and assistance. It is a process that uses clearly defined methods of experimental design with replications and data processing. It is conducted on a small part of the farm but uses plots large enough to allow for the use of standard field equipment and practical data collection.

Organic Farming (see on page 97)**:** is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic Agriculture combines tradition, innovation, and science to benefit the shared environment and promote fair relationships and good quality of life for all involved. See more here: https://www.ifoam.bio/why-organic/organic-landmarks/definition-organic

Pattern (see on page page 40)**:** nature has reliable patterns that collect, store and move resources around. Permaculture designs use these 8 basic patterns and we can use those patterns to understand, interact with, and mimic nature, so that our homes, gardens, and lifestyles are more sustainable. The basic patterns are spirals, waves, streamlines, cloud-forms, lobes, branches, nets and scatter. By getting to know the patterns and what they do, we can use less energy to create comfortable living. See more here: https://www.permaculturenews.org/2019/09/25/understanding-patterns-part-1/, https://permacultureprinciples.com/principles/_7/, https://permaculturevisions.com/8-basic-patterns-used-in-permaculture-design/ and https://www.freepermaculture.com/patterns-in-nature/

Peasant vs Small-holder farmer vs family farmer (see on page 20)**:** a peasant farmer is generally considered to be a subsistence farmer, operating on a small piece of land, which he/she might or might not own. A small-holder farmer can be either a subsistence (peasant) farmer or a commercial farmer, operating under a small-scale agriculture model. Finally, FAO defines the family farmer as one who organises agricultural, forestry, fisheries, pastoral and aquaculture production through family management and whose farm is predominantly reliant on family labour. See for more: Graeub et al., 2016, Ricciardi et al. 2018.

PESTEL analysis (see on page 149)**:** is one of several market research methods. PESTEL stands for Political, Economic, Social, Technological, Environmental and Legal analysis and is a tool that helps to gather and structure external circumstances affecting a businesses or a farm's activities. By that it is an important part of data collection as preparation for strategy making.

Permanent Beds (see on page 116)**:** are growing areas which are maintained in the same space over long periods of time. The establishment of permanent beds supports no-till and reduced tillage conversion practices. Cultivation through permanent beds allows building and managing soil fertility, reducing and controlling weed growth, and avoiding soil compaction while also efficiently managing areas manually with simple but effective tools.

Plant root exudates (see on page 101)**:** are organic compounds released by plant roots, comprising approximately 0.4% of the total carbon photosynthesized, but that have a very important role, as they can influence: microrganism populations and diversity affecting plant nutrient availability and plant health, seed germination, and be toxic to roots of neighbouring plants (Rovira, 1969). - Rovira, A. D. (1969). Plant root exudates. The botanical review, 35(1), 35-57.

Positioning (see on page 152)**:** to ensure that the farm and the farm products are recognized by the farm's current and potential customers in a distinctive way, it is recommended to develop a strong position in their mind. The process of doing so is called Positioning. Based on strengths, special skills, values and traditions of the farm the most relevant elements are selected and put together to form a strong brand position in the mind of the target audience. The goal of positioning is to build a unique brand for the farm which will help customers to clearly differentiate this farm from the competitors and make this farm the preferred provider of a given product.

Power relations (see on page 165)**:** are the interrelationships which determine the relative access of a person or group to assets (financial, access to information, financial assets, etc.) based on power within an institution or structure.

Ramial woodchips (see on page 116)**:** are used for mulching (specifically in pathways between growing beds) which are comprised of younger growth, smaller diameter branches and twigs of deciduous trees and woody shrubs and contain a high concentration of essential minerals and nutrients including: nitrogen, phosphorus, potassium and calcium. (Frost, 2021)

Reciprocity (see on page 40)**:** is a process of exchanging things with other people in order to gain a mutual benefit. See more here: https://www.verywellmind.com/what-is-the-rule-of-reciprocity-2795891

Redundancy (see on page 56)**:** is the use of multiple methods to achieve important functions and to create synergies. Redundancy protects when one or more elements fail. To build redundancy into a design, one must always examine the functions of the site and have each important function supported by many different elements. See more here: https://treeyopermacultureedu.com/chapter-2-3-or-the-11-design-principles-from-the-intro-book/each-important-function-supported-by-many-different-elements/ and https://www.permaculturewomen.com/principles-of-presence/

Resilience/resilient (see on page 13-chapter1, page 39-chapter2 and page 89-chapter4)**:** is the ability of a system to maintain its functions in case of disturbance. Ecosystems are dynamic entities—they are subject to periodic disturbances and are always in the process of recovering from some past disturbance. The tendency of an ecosystem to remain close to its equilibrium state, despite that disturbance, is termed resistance. The capacity of a system to absorb disturbance and reorganise while undergoing change so as to retain essentially the same function, structure, identity, and feedback, is termed ecological resilience. In agroecology and Permaculture design the aim is to establish systems with possible maximum resilience.

Rhizobium bacteria (see on page 101) : is a genus of bacteria, composed of many species, that have the ability to create symbiotic associations with leguminous plants, through the plants' root system. The plant provides sugars to the bacterial colonies that inhabit nodules at its root system, and in turn the bacteria captures nitrogen from the air and provides it to the plant. This association is one of the basic ecosystem processes for both agriculture and natural systems (Wang et al, 2018).

Rhizosphere (see on page 56)**:** it is the part of the soil ecosystems where plant roots, soil and the soil biota interact with each other. The rhizosphere represents the volume of soil immediately around plant roots, where microorganisms are most abundant. This occurs because of a process called rhizodeposition, in which plants exude carbonated compounds from the roots, thus feeding microorganisms and increasing their abundance (Lynch et al, 2001).

Rotational grazing (see on page 87)**:** is a blanket term that may refer to several grazing systems (mob grazing, rational grazing, adaptive multi-paddock grazing) where animals are let on a small portion of cordoned-off pasture or paddock, while the other paddocks are allowed to rest.

Social capital (see on page 144-chapter5 and page 165-chapter6)**:** are the relationships that a group of people establish between themselves to live together in a shared territory doing things for one another. A functioning group of people distinguishes itself from other groups by having common characteristics, values, understandings, cooperation agreements, which contribute to build a sense of trust serving as the glue that keeps the group together. The stronger the relationships in a group, the greater is the sense of belonging of its members to the group, the most effective a group can be in supporting each other to achieve individual and collective goals - its social capital (Portes, 1998).

SMART criteria for goal setting (see on page 142)**:** in goal setting it is always useful to make use of clear and measurable objectives. An effective tool that provides the clarity, focus and motivation to achieve goals, is SMART, an acronym for Specific, Measurable, Achievable, Reasonable and Time-Bound. It can improve the ability to reach goals by encouraging the farm owner to define the objectives and set a completion date. The SMART criteria are easy to use by anyone, anywhere, without the need for specialist tools or training.

Start-up (see on page 61)**:** is an embryonic "company", still in the process of defining its customer, with a business model, preferably scalable, disruptive and repeatable. It is usually technology-based, but can appear in a variety of sectors.

Soil aeration (see on page 16)**:** is a process in which soil receives air, by the movement of oxygen and carbon dioxide through the earth pores, between the underground and the atmosphere. It allows a good respiration of roots and aerobic microorganisms as well as other essential reactions.

Soil hydrology (see on page 16)**:** the hydrological function of soil is promoted by the water cycle. These functions include storage, drainage, evaporation, infiltration, redistribution and transpiration.

Soil fertility (see on page 16)**:** it is the capacity of a soil to support plant growth by supplying essential plant nutrients and needed chemical, physical, and biological characteristics for the habitat that plants require for growth.

Soil food web (see on page 113)**:** is the interaction on many levels that occur amongst the great myriad of organisms that inhabit the soil. The soil organisms go from the smaller ones (bacteria, fungi, algae and protozoa) not visible to the naked eye, to bigger more complex organisms (nematodes, micro-arthopods, earthworms, insects, small vertebrates and plants). This web is primarily fueled by the primary producers (plants, lichens, moss, photosynthetic bacteria and algae), which serve, dead or alive, as nutrient sources to the rest of the soil biology. By interacting with each other they cycle nutrients (carbon, nitrogen, and other elements) which all plants - grass, trees, shrubs, agricultural crops - depend on for their nutrition. Soil biology contributes largely for soil health by decomposing organic materials, sequesters and fixes nitrogen, enhances soil porosity and aggregation (increasing infiltration and reducing runoff). See more here: https://www.bostontreepreservation.com/blog/2021/4/1/compost-tea-and-the-soil-food-web-with-dr-elaine-ingham

Soil Organic Carbon (SOC) (see on page 19)**:** is a measurable component of soil organic matter. Organic matter makes up just 2–10% of most soil's mass and has an important role in the physical, chemical and biological function of agricultural soils.

Soil Organic Matter (SOM) (see on page 87 and page 113-chapter4)**:** is the fraction of soil composition that originated from a biological source (animal or plant), and is present at different stages of decomposition. Decomposition is a mainly biological process in which complex molecules are transformed into more stable organic compounds (humus), releasing carbon dioxide, energy and water. SOM affects soil's physical and chemical properties, as it makes the soil darker, increases soil aggregation and aggregate stability, increases the cation exchange capacity (CEC- the ability to store and retain nutrients), increases the fertility of the soil and its capacity to store water (Bot & Benites, 2005).

Soil profile (see on page 16)**:** is a vertical section of soil that enables us to see the structure of soil. A soil profile is composed of layers called horizons.

Soil structure (see on page 16)**: see soil profile**

Solidarity economy (see on page 24)**:** is an alternative framework that allows for different forms of economic exchange in different contexts, open to continual change. The framework is grounded in the principles of solidarity, mutualism and cooperation, equity in all dimensions, social well-being, sustainability, social and economic democracy, and finally pluralism.

Species-rich grassland (see on page 89)**:** is open, grassy habitat that is normally maintained by traditional grazing and cutting methods. A grassland is species-rich if it has:

- more than 15 plant species per square metre
- more than 30% cover of wildflowers and sedges (excluding white clover, creeping buttercup and injurious weeds)
- less than 10% cover of white clover and perennial ryegrass

Each grassland has its own community of plant species, which can be grouped into different types. The type of species-rich grassland depends on location, underlying geology, soil pH, its management and history.

The different types of species-rich grassland are:

- lowland meadows
- upland hay meadows
- lowland calcareous grassland
- upland calcareous grassland

- lowland acid grassland
- purple moor-grass and rush pastures
- calaminarian grassland

Species-rich grasslands is usually found on land that has had little or no exposure to lime, fertiliser and herbicide inputs for at least 10 years. Grazing and mowing at the right level will benefit these grasslands.

Strip cropping (see on page 109)**:** is the system of planting monospecific strips of certain food crops, interspersed with monospecific strips of different crops. A single strip is composed of several lines of the same species.

Succession (ecological) (see on page 56-chapter2, on page 131) **:** is the process of change in the species structure of an ecological community over time. The time scale can be decades (for example, after a wildfire), or even millions of years after a mass extinction. The community begins with relatively few pioneering plants and animals and develops through increasing complexity until it becomes stable or self-perpetuating as a climax community. The "engine" of succession, the cause of ecosystem change, is the impact of established organisms upon their own environments. See more here: https://www.caryinstitute.org/science/research-projects/buell-small-succession-study/what-succession and https://nature.berkeley.edu/biometlab/espm111/ESPM%20111%20Ecosystem%20Succession.pdf

Sustainable development or Sustainability (see on page 20-chapter1, page 39, page 56-chapter2 and page 109-chapter4)**:** is the integration of environmental health, social equity and economic vitality in order to create thriving, healthy, diverse and resilient communities for this generation and generations to come. The practice of sustainability recognizes how these issues are interconnected and requires a systems approach and an acknowledgement of complexity. See more here: https://www.sustain.ucla.edu/what-is-sustainability/

Sustainable livelihoods approach (SLA) (see on page 163): is a method to analyse the assets of people which support and maintain their lives. The SLA is often offered as a framework for enabling people experiencing poverty and disadvantage to see a way to improve the stability and resilience of their lives. It is a participatory approach based on the recognition that all people have abilities and assets that can be developed.

Sustainable Business Model Canvas (see on page 63): is a tool for the development of an idea into a viable business model that follows a holistic approach and focuses on economic, ecological and social aspects of the activity. By extending the Business Model Canvas with two extra building blocks/layers - social and environmental - this canvas becomes applicable to agroecological farms**.**

Swales (see on page 54)**:** a permaculture swale is a shallow trench dug along the land's contour, with a berm on the downhill side created with soil from the trench. All points along a contour line are exactly the same height above sea level. Therefore, a trench along the contour captures water in the landscape, slowing and spreading it across the contour line. This action reduces erosion and retains water where it is needed. See more here: https://www.tenthacrefarm.com/permaculture-swale/ and https://www.permaculturenews.org/2015/07/24/how-to-build-a-swale-on-contour-successfully/

System (see on page 40-chapter2 and page 87-chapter4)**:** is a sum of interacting elements where the interactions outline and make identifiable the boundary part or process. In permaculture the same as in agroecology, system thinking means that we understand our site and systems as subsystems of a bigger system (e.g.: our farm subsystem as part of the landscape system), with a global perspective meaning after all our site is a small particle of the overall global ecosystem. At the same time, we also approach our system as a sum of smaller subsystems and particles-elements which are interacting to best perform their functions, and we aim to help to increase those beneficial interactions. See more here: https://en.wikipedia.org/wiki/Systems_theory

Traditional cultivation methods (see on page 117)**:** are the agricultural methods that result from a coevolutionary process between natural and social systems, through a long and generational experimental process and interactions between farmers and their ecosystem, without access to external inputs, financial means or scientific knowledge (Altieri, 2004). - Altieri, M. A. (2004). Linking ecologists and traditional farmers in the search for sustainable agriculture. Frontiers in Ecology and the Environment, 2(1), 35-42.

Traditional or indigenous farming (see on page 13-chapter1 and on page 94)-chapter4)**:** can be described as a natural style of farming that involves the exhaustive use of inherent knowledge, traditional tools, natural reserves, organic compost, as well as social and cultural beliefs of the farmers.

Transdisciplinarity (see on page 20)**:** is the inclusion of non-academic stakeholders in the process of knowledge production, recognising the existence of different knowledge systems, like the indigenous or the professional, of equal value as the scientific. Its goal is the understanding of the present world, of which one of the imperatives is the overarching unity of knowledge.

Transition or transformation of the food systems (see on page 24-chapter1, page 42-chapter2 and page 111-chapter4)**:** means the active changing of food systems from a non-desirable status quo (i.e., highly industrialised and verticalized farming) to a more ecological, bio- and socio-diverse, fair and healthy state. Agroecology is considered to be a key science, set practices and philosophy that can help this transformation.

UN Special Rapporteur on the Right to Food (see on page 22)**:** is person appointed by the United Nations Human Rights Council to monitor issues related to the Right to Food.

Vermicompost (see on page 116)**:** is the result of a controlled decomposition process - that reduces the volume and weight - of organic matter, made through the action of epigeic worms, reducing the contaminating effect of the residue, and producing an organic amendment that can be used in farming (Lourenço, 2014). Epigeic worms are the worms that inhabit the soil surface, feeding on organic residue. Species such as *Eisenia fetida* and *Eisenia andrei*.

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