PATHWAY TO ORGANIC FARMING

Selected topics to facilitate conversion

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Introduction

The conversion to organic farming represents a transformative process that involves rethinking agricultural practices, economic strategies, and environmental responsibilities. As the European Union decided to increase the organic area of agricultural land to 25 % till 2030 there is a lot of effort and conversion necessary, so does the need for educated professionals who can navigate the complexities of the conversion. The Erasmus+ Cooperation partnership project "Education, Training and Innovations in Conversion to Organic Farming – ETICOF" aims to strengthen the growth and development of organic farming (OF) in accordance with the European policy, as well as the national policies of the participating countries. The partnership of the project is created by 5 partners from 4 European countries:

- Slovak University of Agriculture in Nitra, Slovakia (project coordinator)
- University of South Bohemia České Budějovice, Czech Republic
- Hungarian University of Agriculture and Life Sciences, Hungary
- Thüringer Ökoherz e.V., Germany
- University of Applied Science Erfurt, Germany.

This educational material as one of the main results of the ETICOF project aims to equip higher education students with the knowledge and skills necessary for a successful shift to organic farming systems. It is designed to provide comprehensive insights into key aspects of organic farming conversion, offering a structured approach to understanding the challenges and opportunities in this field. Through five distinct chapters, the material explores fundamental topics such as assessing farm suitability for organic conversion, effective weed management strategies, and the economic considerations involved in making the conversion. Additionally, the resource delves into the role of communication in driving change within the agricultural sector and examines the impacts of climate change on organic farming systems.

Chapter 1 introduces the concept of farm suitability analysis to be performed for organic conversion. Chapter 2 covers the essential practice of weed management in organic systems, while Chapter 3 discusses the economic factors that influence the viability of organic conversion, highlighting the challenges not only in terms of economic demands due to its specifics from an agricultural point of view, but also from a marketing point of view. Chapter 4 highlights the importance of communication and advocacy in promoting organic farming, aiming to equip learners with useful knowledge and skills that enable them to solve difficult interpersonal challenges that might occur during a conversion process. Chapter 5 examines how organic farming is engaging in climate change adaptation, what effects and challenges

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do we have to consider, how can organic farmers contribute to the mitigation of climate change and achieve sustainability, and how can organic farming go hand in hand with other alternative farming approaches to combat climate change.

This material is intended for broader educational contexts in higher education, aiming to support a new generation of professionals who will contribute to the advancement of organic farming. By engaging with this content, students will be better prepared to address the multifaceted challenges of organic farming conversion and contribute meaningfully to sustainable agricultural practices.

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1. Analysing farm suitability when converting to organic farming

Educational material for module 1, “Conversion to Organic Farming in Theory and Practice”

Opening

“What if the land beneath your feet could share its story? Would it speak of rich soil and resilient ecosystems, or would it reveal the struggles of overuse and imbalance?”

In this chapter, we will explore how to analyse a farm’s suitability for organic conversion. Think of it as a detective’s investigation, where the clues lie not just in what is visible, but also in what is hidden beneath the surface. From the soil’s health to the farm's economic and social context, it can be assessed whether a farm can make the leap to organic and thrive in the process.

Before diving into the practicalities of converting a conventional farm to organic, it is crucial to first understand what makes a farm truly suited for such a transformation. Converting to organic farming involves transitioning from conventional agricultural methods to practices that prioritize sustainability, soil health, and natural inputs. It is not just about switching inputs or farming methods. The land, the climate, and even the surrounding community all play vital roles in shaping the success of organic farming.

This shift also requires a period of adaptation, during which farmers replace mineral fertilisers, and pesticides with organic alternatives like compost or manure, diverse crop rotations, and biological pest control. During the conversion period (the length depends on the culture), the focus is mainly on rebuilding soil fertility, enhancing biodiversity, and adopting techniques that align with organic certification standards. While the conversion to organic farming can offer long-term benefits such as improved ecosystem health and access to premium markets, it presents challenges like reduced yields, increased labour, and the need for technical knowledge during the initial phase. Overcoming these challenges requires key methods and approaches.

In this chapter, we selected topics (as subchapters) for consideration that are briefly described when converting the farm to organic. For each topic, a general question is provided, and at the end of each subchapter, you find reflective questions designed to help you analyse your options and practices that require reflection.

At the end of this chapter, you will find a practical example of an identified problem that can be solved with an amendment of practice.

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Key words

[FARMING PRACTICES] [SOIL HEALTH AND FERTILITY] [WATER MANAGEMENT] [BIODIVERSITY] [PEST AND DISEASE MANAGEMENT] [ENVIRONMENTAL IMPACT] [ECONOMIC VARIABILITY] [STRUCTURE, INFRASTRUCTURE AND EQUIPMENT]

1.1 Soil health and fertility

What practices can farmers implement to improve soil health when converting to organic farming?

Healthy soil is crucial for both the environment and farming productivity. It contributes to healthier and more productive crops by enhancing biological activity, improving soil structure, moisture retention, and drainage. Healthy soil reduces the negative environmental impacts of agriculture, such as nitrate leaching and erosion, while boosting land productivity and profits year after year. This is especially true in organic farming, where soil is a vital condition for success. Therefore, it is worth examining which of the following practices were already in place before converting to organic farming. Although certain soil properties, such as its mechanical composition, cannot be altered, the overall productivity of the soil can be enhanced through various practices. One of the key factors is soil aggregation. Aggregates form when sand, silt, and clay particles bind together, allowing Soil Organic Matter (SOM) to combine with minerals in both clay and sandy soils. Good aggregate stability helps maintain interconnected pores that allow the movement of soil air, which in turn supports an aerobic soil environment. This circulation of oxygen promotes soil biological activity and releases vital nutrients to plants. Since plant roots require oxygen for respiration, maintaining adequate air, particularly oxygen, in the soil is crucial for supporting soil life.

No matter the soil type, a well-thought-out soil-building plan is essential for improving soil health. This plan should include careful tillage practices, attention to SOM, and the use of diverse crop rotations and cover crops, along with soil amendments and compost. By focusing on these integrated farm management, farmers can ensure more predictable yields, higher quality products, and greater returns. To boost soil structure and fertility, the following practices are highly effective in increasing soil organic matter:

- Residues from cash crops that can be used to cover the soil surface to reduce the soil moisture loss and to prevent erosion
- Cover crops are grown in the crop rotation to prevent erosion and build organic matter
- Animal manures, applied with organic bedding materials like straw, to enrich the soil
- Compost, which increases organic matter more quickly than manure alone due to its decomposition process, making it longer-lasting and more stable in the soil (innovative solutions for large-scale composting are also available, see figures 1.1. and 1.2).

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- Perennial hay or sod crops, grown for several years as part of crop rotation to naturally enhance soil quality.

Figure 1.1. *Compost turner. Source: Apolka Ujj.*

Figure 1.2. *Compost turner during work. Source: Tibor Petró.*

Questions for farm suitability analysis:

What organic soil management practices can be implemented to improve soil structure and fertility during the conversion?

What role do crop rotation, cover cropping, and composting play in enhancing soil health during the conversion?

1.2 Organic fertilisers

What are the considered nutrient amendments in organic farming?

When converting a farm to organic farming, assessing the suitability of organic fertilisers is crucial for maintaining soil fertility and ensuring sustainable crop production. Unlike mineral fertilisers, organic fertilisers are derived from natural sources such as compost, manure, green manure, and plant residues. These fertilisers not only provide essential nutrients but also enhance soil structure, promote microbial activity, and improve moisture retention—key factors in preventing soil erosion and degradation.

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The suitability of organic fertilisers depends on factors such as soil type, existing nutrient levels, climate, and crop requirements. For example, farms with sandy soils benefit from compost and well-rotted manure, which increase water retention and organic matter content. In contrast, clay soils require well-balanced organic inputs like green manure and biochar to improve aeration and drainage. Additionally, the availability of on-farm organic matter (e.g., animal manure or crop residues) influences the feasibility of organic fertilisation, as farms with integrated livestock systems have a more accessible and cost-effective source of nutrients.

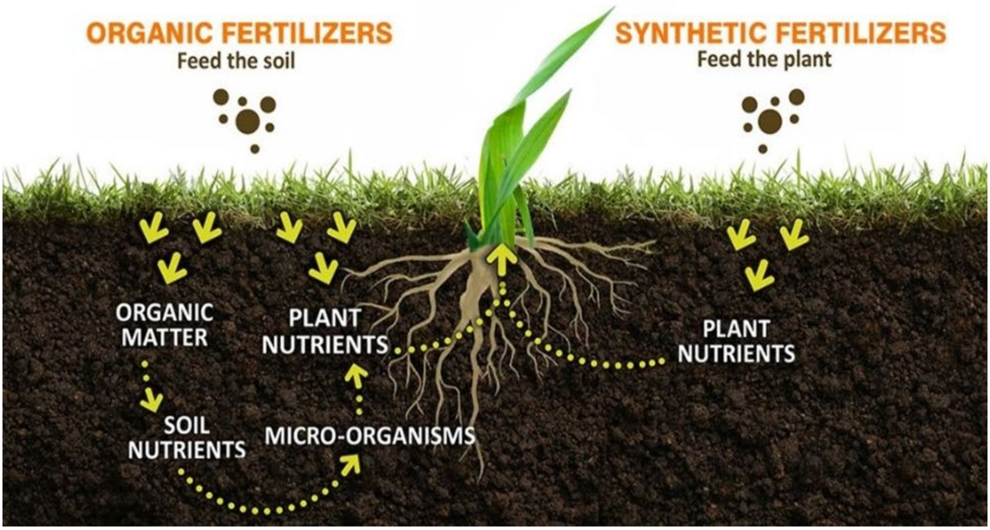

Figure 1.3. *Differences between organic vs. mineral fertilisers. Source: Jaime Staufenbeil.*

Another critical factor in farm suitability is the nutrient balance and replenishment strategy. Organic fertilisers typically release nutrients slowly as they decompose, requiring strategic application timing to match crop growth stages. Cover crops like clover and vetch can be incorporated as green manure to naturally fix nitrogen in the soil, reducing the need for external inputs. Moreover, rotational grazing and composting animal manure can provide a sustainable nutrient cycle that minimizes environmental impact while maintaining soil fertility.

Soil testing and nutrient management planning are essential to ensure effective fertilization in an organic system. These practices help determine the type and quantity of organic fertilisers required, preventing nutrient imbalances that could affect crop yields. Additionally, compliance with organic certification standards requires farms to source fertilisers that meet organic regulations, avoiding prohibited synthetic additives or contaminants.

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Questions for farm suitability analysis:
What strategies can be used to improve soil fertility in varying conditions?
Do I already have any existing practices that help replace mineral fertilisers in organic farming?
Do I have access to manure or compost?
What are the benefits and challenges of using on-farm organic fertilisers?
How does soil type affect the choice of organic fertilisers on a farm?

1.3 Livestock on the farm

W*hat are the key factors to consider when converting to organic animal husbandry?*

The presence of animals on a farm brings both advantages and challenges. The advantages include the multifunctional role many farm animals play, such as producing dung, which is important for soil fertility; providing products like meat, milk, eggs, and wool; recycling by-products like straw; grazing of arable land to terminate cover crops while fertilization is being carried, and even serving as draught animals for tillage. However, there are challenges to consider, such as ensuring there is enough space for grazing, providing the right feed or by-products, having the knowledge to properly care for and feed animals, and finding a market for the products they produce. It is also important to consider animal health, the potential risks and costs of disease, and how to ensure their overall well-being.

If you decide to include animals in your farm operations or if you already have animals, here are some important considerations: the origin of the animals is crucial. If you want to establish organic animal husbandry, you can either convert your current livestock to organic management (after the appropriate conversion period) or purchase animals from an organic farm (no conversion period required). If neither of these options is feasible, you can purchase animals from conventional farms, but the conversion period must be adhered to (See: Further resources).

Animal housing is another key factor. Animals should be kept in buildings with enough space to meet regulations for animal/m^2 and the number of animals per building. They should also be able to engage in their natural behaviours, such as rooting or taking dust baths. It is important to ensure that yards or pastures are available for the animals, with regulated ranges for each animal.

Feeding is an important consideration as well. Generally, animals should be fed organic feed from organic farming, though feed grown on land in conversion to organic farming may also be used (with limits). Ideally, you should produce your own feed from fully organic land. Non-organic fodder from conventional farms is allowed in small amounts, but only for pigs and poultry, and only as protein feed. It is not permitted for other animal species.

Veterinary care is essential to maintaining animal health. This includes preventive measures such as carefully selecting breeds suitable for extensive rearing or traditional breeds,

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providing high-quality feed, ensuring regular outdoor activities, and maintaining an appropriate number of animals. If an animal becomes sick, it should be isolated, and a veterinarian should be consulted immediately.

Questions for farm suitability analysis:
How can feed sources be converted to 100% organic while ensuring nutritional balance and sustainability?
What strategies can be used to manage parasites and disease in livestock organically?

1.4 Water management

How do organic farming practices manage water resources?

Converting farmers also need to reassess water sources, ensuring they are sustainable and free from contamination by chemical residues. Organic farming relies heavily on soil health to improve water retention and reduce dependence on irrigation, making soil improvement a key focus during the conversion period. Initial adjustments may be required to address reduced efficiency due to legacy soil conditions. Still, over time, the improved soil structure and ecosystem balance in organic systems can lead to greater water-use efficiency and resilience to drought. Practices such as mulching, cover cropping, and building Soil Organic Matter enhance water retention and reduce evaporation, ensuring more efficient use of rainfall and irrigation. Although ploughing is generally not recommended in farming, some farmers still use it as a method for weed management, avoiding synthetic chemicals. This reduces the competition for nutrition and water for the crops. However, ploughing can also contribute to soil drying, which makes it less ideal from a soil moisture and sustainability perspective. A new approach, called regenerative organic combines two principles: not to disturb the soil and not to use any chemicals to terminate cover crops or weeds. But instead it applies physical or other methods of termination such as using frost-prone cover crops, or using roller crimper.
Organic systems also promote the use of sustainable water sources, such as harvested rainwater and treated wastewater, while discouraging over-extraction from aquifers.

Questions for farm suitability analysis:
What are the challenges organic farmers face in managing water during periods of drought or water scarcity?
How does organic farming influence the efficiency and sustainability of water use?
How can cover crops, mulching, and compost play a role in improving water retention and reducing runoff?

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1.5 Biodiversity

How can biodiversity be enhanced on the farm, and what are the benefits of doing so?

Biodiversity can be understood in a broad sense, and enhancing it brings several positive benefits, such as improvements in pest control, animal and soil health, etc. The presence of animals on the farm contributes to biodiversity just as much as the application of a diverse crop rotation. The more plant species and varieties you grow, the greater your contribution to strengthening biodiversity. Native breeds and local varieties should be prioritized, as they are better adapted to the environment and support a healthy ecosystem.

Figure 1.4. *Intentional design of arable field margins, integrating trees, flowering strips, and bird nest boxes. Source: Apolka Ujj.*

One effective way to enhance biodiversity is by implementing crop rotation or mixed cultures, which help to diversify the farm's ecosystem and prevent the depletion of soil nutrients caused by monocultures. Additionally, protecting and/or establishing natural ecological areas — such as

specimen trees, tree rows, grass belts, wildflower rows, bushes, hedgerows, and water habitats — significantly contribute to increasing biodiversity on the farm, along with other benefits such as reducing wind erosion, attracting pollinators, and decreasing surface water runoff. The preservation and maintenance of nesting and refuge sites, such as hollow trees, bird nests, stone piles, and wood piles, further support species diversity by providing shelter for various forms of life. It is crucial to avoid the use of chemical plant protection products, as they destroy many forms of life indiscriminately, negatively impacting the entire ecosystem.
Furthermore, practices like reduced tillage and replacing mineral fertilisers with organic materials also enhance soil-dwelling organisms' biodiversity. These soil organisms play a critical role in nutrient transformation, which can result in tangible economic benefits for the farmer. By fostering biodiversity on the farm, farmers can create a more resilient, productive, and sustainable agricultural system.

Questions for farm suitability analysis:
How can the loss or absence of biodiversity limit the effectiveness or success of converting to organic farming?
How can livestock, crops, and natural ecosystems be integrated to support a diverse and balanced organic farm ecosystem?

1.6 Pest and disease management

How does the ecological approach in organic farming help manage pests and diseases without chemicals?

In organic farming, plant protection focuses on preventive measures rather than chemical interventions. The ecological approach goes beyond traditional pest control, aiming to avoid the use of chemical plant protection products. Instead, the focus is on fostering healthy ecosystems where pests and diseases are suppressed naturally rather than eradicated.
Key strategies for managing pests and diseases include planting varieties adapted to local conditions or resistant to specific pests, establishing diverse crop rotations, and incorporating mixed crops. These practices reduce pest pressure and enhance plant resilience. Protecting and creating habitats for beneficial organisms, such as tree rows, wildflower strips, hedgerows, grass belts, strip cropping and water habitats, also plays a critical role in increasing biodiversity. These natural areas provide shelter and resources for pollinators, beneficial insects, predators, and other beneficial wildlife that help control pests and maintain ecosystem balance while reducing, at the same time, wind erosion and surface water runoff.
Crop rotation, diverse cover crops, and composting also help improve soil health and prevent pest build-up.

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When direct intervention is necessary, only materials from approved "positive lists" should be used. These can include pheromone traps, beneficial organisms, and products containing microorganisms. Copper and sulphur may also be used under certain restrictions, but it is essential to seek guidance from experienced organic farmers or advisors before applying these treatments.

Healthy, diverse ecosystems allow plants to better withstand pests and diseases, and vigorous plants are often more capable of defending themselves when issues do arise.

While this ecological approach may take years to fully develop, it builds a foundation for long-term sustainability, reducing reliance on chemicals, improving yield quality, and fostering more resilient farming practices.

Questions for farm suitability analysis:

How will the absence of synthetic insecticides, pesticides, and herbicides impact pest and weed management on the farm?

Based on my experience, do I already apply any practices that contribute to natural pest control?

1.7 Environmental impact

What are the environmental impacts associated with converting to organic farming?

Positive environmental impacts

Converting to organic farming brings a range of positive environmental impacts that contribute to the long-term sustainability of agricultural ecosystems. One of the most significant benefits is the improvement of soil health, as organic practices emphasise the use of compost, green manures, and crop rotations to enhance soil fertility and structure, leading to increased organic matter content and microbial biodiversity. This improves nutrient cycling and enhances the soil's ability to retain water, reducing the risk of erosion and runoff.

Additionally, organic farming eliminates the use of synthetic pesticides and fertilisers, which helps prevent the contamination of nearby water bodies and protects aquatic ecosystems from nutrient overload and chemical toxicity. By avoiding harmful agrochemicals, organic farms support greater biodiversity above and below ground, providing habitats for pollinators, beneficial insects, birds, and other wildlife. Furthermore, organic systems promote crop diversification, strengthening ecosystem resilience and reducing the risk of pest outbreaks. Organic farming can also play a role in mitigating climate change by reducing greenhouse gas emissions associated with mineral fertiliser production and increasing carbon sequestration in healthy soils.

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Negative environmental impacts

Despite its benefits, converting to organic farming can pose environmental challenges, particularly during the initial phases. Organic systems typically yield less in the short term, requiring more land to produce equivalent outputs, which could lead to habitat conversion if not managed sustainably.

Organic farming may also rely on mechanical weeding and tillage to control weeds, which can lead to soil compaction and erosion if overused. Furthermore, the reliance on organic manure and compost could create localised nutrient imbalances or pollution if not managed correctly. Pest outbreaks may also pose challenges as organic methods may not offer immediate control compared to synthetic pesticides, potentially affecting surrounding ecosystems. These negative impacts can be mitigated or reduced by adopting different strategies. One key strategy is implementing diversified crop rotations, which help break pest and disease cycles, improve soil structure, and enhance nutrient availability.

Incorporating cover crops and green manures not only prevents soil erosion but also adds organic matter, improving soil fertility and water retention.

Farmers should be cautious with compost and manure applications, ensuring they are well-composted and applied at appropriate rates to avoid nutrient runoff into nearby water sources. Establishing buffer zones or vegetative barriers around fields can help protect surrounding ecosystems from unintended drift or contamination. Additionally, using non-chemical pest control methods, such as introducing natural predators, using trap crops, or installing physical barriers, can reduce the need for interventions that may harm beneficial species. Regular soil testing and careful record-keeping during the transition period can guide informed decisions, helping farmers balance productivity with ecological responsibility.

1.8 Economic viability

1.8.1 Costs of conversion

Converting to organic farming can entail significant upfront costs. Farmers may need to invest in organic-certified inputs, such as seeds, compost (which is not exclusively compulsory to be of organic origin). Some farmers may use compost derived from conventional sources, as long as it meets organic certification standards and bio fertilisers. Other expenses that might be faced are to improve the farm infrastructure to adapt for organic storage and processing or the adaptation of stables to organic requirements. Additionally, yields often decline during the conversion period, typically three years, as soils rebuild fertility and adapt to organic practices. These lower yields can temporarily reduce

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income, especially if the produce cannot yet be sold as organic. However, in the European Union, plant products harvested 12 months after the start of the conversion period may be marketed as in-conversion products, provided that such products contain only one crop ingredient of agricultural origin. It is essential to consult the specific organic regulations applicable in your region and for your particular crops to determine when and how products can be marketed as 'in conversion' during the conversion period. Labour costs may rise for small farms converting to organic farming due to increased manual work like hand weeding and pest management. However, larger companies with access to modern technology and machinery can often offset these labour demands, keeping their costs relatively lower.

1.8.2 Long-term profitability

In the long term, organic farming can be economically viable and profitable. Certified organic products often command higher market prices, which can offset lower yields. Organic farming also reduces dependence on expensive synthetic inputs, potentially lowering production costs over time. Improved soil health from organic practices leads to more resilient crops, reducing losses from extreme weather or pest outbreaks. Furthermore, organic farmers may qualify for government subsidies, grants, and support programs aimed at encouraging sustainable agriculture, helping to ease financial burdens during the conversion.

Yield differences between organic and conventional farms decrease over time and especially under dry conditions or other climate-related issues as well-managed organic land might even surpass conventional yields thanks to their natural robust system.

Figure 1.5. *A soil with the same properties can behave differently when we consciously aim to improve its structure within organic farming. Source: trAEce project YouTube video, Grand Farm, Austria.*

1.8.3 Market access and consumer demand

The growing consumer demand for organic products offers a lucrative market for farmers who complete the conversion. Establishing relationships with organic buyers, local markets, and cooperatives can secure a stable income. Crop diversification, often emphasized in organic farming, also provides multiple revenue streams, reducing risk. However, market access may require additional investment in marketing and certification, and farmers must ensure their practices meet organic standards to maintain credibility and marketability.

Possibly the most important factor is the availability of marketing options for organic products. Especially in countries where there is still little self-consumption of organic products, sales opportunities for the domestic market are often scarce. Production is therefore often focussed primarily on exports. Foreign importers are interested in fully converted organic products of good quality. Clear and good purchase contracts for conversion and organic products are therefore an important basis for an economically sound conversion. For the domestic market, the development of structures for direct marketing (also in cooperation with other organic farmers) can be an option, especially for farms close to urban areas (Dierauer, 2021).

Overall, while the initial conversion phase poses economic challenges, long-term benefits like premium pricing, reduced input costs, and sustainable productivity can make organic farming an economically viable choice for many farmers. Strategic planning and access to resources are key to navigating the conversion successfully.

1.8.4 Subsidies and regulatory compliance

Subsidies play a crucial role in supporting farmers converting from conventional to organic farming by providing financial incentives and support measures. Farmers converting to organic farming receive area-based payments, which help compensate for the higher production costs, lower initial yields, and additional requirements of organic certification. Subsidies not only help farmers overcome economic barriers but also contribute to environmental benefits and biodiversity conservation. Farmers can also access other resources such as investment grants for infrastructure, research funding, and advisory services to facilitate the conversion. Organic farmers are governed by strict regulations that require organic farmers to undergo certification by an approved body and comply with annual inspections to maintain their organic status. The information on available subsidies and regulations can be found accessible by farming on the official web pages of the European Union, national agricultural ministries and rural development agencies. Farmers can utilise other informational sources, such as farmer organisations and advisory boards.

1.8.5 Farmer knowledge and skills

When converting to organic farming, farmers will need to develop a range of new skills and knowledge areas to ensure a successful conversion. One key area is **soil health management,** as organic farming relies heavily on natural methods like composting, crop

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rotation, and green manure to maintain fertility. Farmers must also become proficient in **natural pest and disease control,** using techniques such as beneficial insect introduction and botanical pesticides instead of synthetic chemicals. Additionally, understanding organic **certification standards and maintaining detailed records** is essential to meet regulatory requirements. **Marketing and business skills** are also important, as organic products often target niche markets that require strategic branding and customer outreach.

Questions for farm suitability analysis:
How will the conversion to organic farming affect short-term and long-term farm income?
What are the initial costs of converting to organic farming, and how can they be managed?
How will market demand and pricing for organic products impact farm profitability?
What financial support, grants, or incentives are available to assist with the conversion?
What would be my first step during the conversion to minimize income loss?

1.9 Structure, infrastructure and equipment

What are the main challenges in infrastructure and equipment during the conversion to organic farming?

The conversion to organic farming involves adapting both practices and infrastructure to meet the unique requirements of ecological production, such as the abandonment of herbicides or the establishment of buffer zones. This conversion can be approached in two ways: relying on commonly-used methods (e.g. machine-based weed control) or with more innovative solutions that integrate new technologies and techniques. Both approaches can lead to successful outcomes, but it's essential to understand the balance between cost, practicality, and environmental sustainability when designing the organic farm's structure and equipment.

Weed control is a significant consideration in organic farming. While some methods, such as using specialized equipment such as flame weeders, can be effective, they also have relatively high costs. However, good results can also be achieved through low-input solutions. Maintaining continuous soil cover through appropriate crop rotations can significantly reduce weed growth. Reducing tyre pressure on machinery can help minimize soil compaction, which is a common issue also in conventional farming. These low-cost measures can contribute to sustainability without relying on expensive or complex machinery.

In terms of tillage practices, organic farming can also benefit from no-till systems, which are designed to protect the soil and reduce the need for soil cultivation. In such systems, grazing livestock can help manage land without disturbing the soil, or tools like roller-crimpers can be used to terminate cover crops without tilling. This process is followed by planting in a relatively thick mulch layer, which provides protection to the soil and reduces weed pressure. While these practices require specialized equipment, they offer long-term benefits in terms of soil health and weed control.

When switching to organic farming, the principle of gradual conversion must be considered. Immediate large investments in machinery or infrastructure are not always necessary. It takes time to adjust to the new system and understand how to best manage organic practices. Incremental changes allow farmers to experiment with new techniques, learn from experience, and ensure that investments are made wisely over time.

A critical consideration when establishing an organic farm is ensuring that farm activities do not pollute the environment or the products the farmer produces. This commitment to non-pollution extends beyond farm management to the risk of nearby conventional farms using non-organic methods that could inadvertently affect the organic land. For instance, there is the potential for spray drift from pesticides or mineral fertilisers to contaminate the farm. To mitigate this risk, establishing natural barriers, such as hedgerows or isolation zones, can protect the crops and maintain organic integrity.

Figure 1.6. *Germination in the mulch layer after using a roller crimper. Source: Apolka Ujj.*

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One common concern among farmers is the fragmentation of property ownership. Many farmers who conversion to organic farming may face challenges due to scattered, smaller plots of land. Maintaining proper isolation distances between organic and conventional farming areas becomes more complicated when the property is fragmented. Not all areas need to be converted to organic farming immediately; activities can be converted gradually, and parallel farming (organic and non-organic) is also possible, although it involves extra administration.

Questions for farm suitability analysis:
How can the farm remain financially stable during the conversion period before achieving organic certification?

1.10 Practical example: How to change the crop rotation if there is a problem with soil erosion

If soil erosion becomes a problem in organic farming, adjusting the crop rotation can be an effective solution to improve soil stability and health. Farmers can introduce deep-rooted cover crops, such as clover, rye, or alfalfa, into the rotation to help hold the soil in place and improve its structure. These crops protect the soil surface from wind and water erosion while enhancing organic matter and nutrient content. Including perennial crops or reducing the frequency of soil-disturbing crops can also minimize erosion risks. Rotating with legumes not only stabilizes the soil but also naturally adds nitrogen, reducing the need for external inputs. By carefully planning rotations that prioritize ground cover and soil regeneration, farmers can prevent erosion while maintaining productive and resilient organic systems.
Here are four steps to guide your crop rotation:

1) Identify and prioritise your goals for the crop rotation and choose the crops that serve your aim the best (e.g., weed control, disease control, soil structure, **erosion control,** and organic matter).
2) List your crops per family," grouping crops based on their botanical families rather than individual crops", and the covered area that you deal with in general.
3) Identify crop sequences that work on your farm (including cover crops).
4) Make a crop-rotation planning map, noting which fields are problem areas that might affect certain crops. Conducting soil testing can serve as a helping tool to identify soil deficiencies.

Below (Table 1.1), there is an example of a 4-year crop rotation with the aim of preventing soil erosion. Let us not forget that sowing and harvesting times may vary; the ones provided in the table are only applicable to the conditions of Central and Eastern Europe, but they can change depending on the growing region.

Table 1.1. *Example of a 4-year rotation. Source: Apolka Ujj and Emmanuel Mukosha Chisenga.*

Year	Main crop	Cover – secondary crop	Sowing – harvest timing	Erosion-control strategy and other 'extras'
Year 1	Maize	Intercropped with buckwheat at the same time	May – September	Buckwheat between rows suppresses weeds and protects soil.
Year 2	Winter barley – pea mixture		October – June	The two plants' seeds are sown as a mixture. The mixed crops then the crop residues left on the soil surface suppress weeds and protect the soil.
Year 2	–	Tillage radish + phacelia + white mustard + oil flax + spring vetch + persian clover + sand oat	September – frost	The ratio of the mix can be adjusted. It provides good weed suppression and soil coverage, as well as soil loosening. It leaves a relatively large amount of mulch but is easy to manage. The mixture dies off in winter after frost.
Year 3	Potato		April – August	Although potatoes are not the best for erosion control, the revenue they generate make them important. The cover crops in the crop rotation help ensure soil erosion control.
Year 3	Winter rye – hairy vetch mixture		September – May	The two plants' seeds are sown as a mixture. Rye develops a deep, fibrous root system that holds soil particles together, preventing surface runoff. For green fodder, mowing can be started when the rye is before heading.

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Cover Cropping: These crops are grown primarily for their environmental benefits rather than for harvest. Planning which cover crop to use in organic farming requires a strategic approach based on the farm's goals, soil conditions, climate, and cropping system. This should also include how the cover crop will be terminated, which should also be part of the planning process. Here are a few examples of cover crops and their beneficial use.

1) Leguminous Cover Crops
    - Examples: Clover (red, white, crimson), alfalfa, hairy vetch, and field peas.
    - Why they are used: These crops fix atmospheric nitrogen through symbiotic relationships with soil bacteria, enriching soil fertility and reducing the need for external fertilisers. They also provide organic matter and improve soil structure.
2) Grass Cover Crops
    - Examples: Rye, oats, barley, sorghum-sudangrass, and annual ryegrass.
    - Why they are used: Grasses, due to their extensive root systems, are excellent at preventing soil erosion. They also scavenge leftover nutrients, reducing nutrient leaching and suppressing weeds with their dense growth.
3) Brassica Cover Crops
    - Examples: Mustard, radish (e.g., tillage radish), rapeseed.
    - Why they are used: Brassicas help suppress soil-borne pests and diseases by releasing biofumigants. With their deep taproots, radishes break up compacted soil layers, improving aeration and water infiltration.
4) Mixtures of Cover Crops
    - Examples: Legume-grass mixes (e.g., clover- rye; rye-hairy vetch; barley-pea)
    - Why they are used: Mixed cover crops provide complementary benefits, such as nitrogen fixation, erosion control, and weed suppression. They support diverse soil microbiota and enhance overall soil health.

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Further resources

Books:

Chandran, S., MR, U., Thomas, S., & Meena, D. K. (2023). *Organic farming: Global Perspectives and Methods*. https://doi.org/10.1016/C2021-0-01532-7.

Gliessman, S. R., Rosemeyer, M. (Eds.). (2009). *The Conversion to Sustainable Agriculture: Principles, Processes, and Practices*. CRC Press. ISBN: 9780849319174.

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https://www.bio-garancia.hu/docs/transfer/2000745HU.pdf (Requirement of conversion in organic animal husbandry - in Hungarian) https://www.ceres-cert.de/docs/transfer/3-2-2_EN.pdf (Requirement of conversion in organic animal husbandry - in English) (https://www.bio-garantie.it/docs/transfer/2000745DE.pdf - Requirement of conversion in organic animal husbandry - in German) (https://www.kez.cz/sites/default/files/aktuality/metodick%C3%A9%20pokyny-2014.pdf Requirement of conversion in organic animal husbandry - in Czech)

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2. Weed management

Educational material for module 2 "Converting Technological Practices"

Opening

One of the main challenges in conversion from conventional to organic farming of field crops is the issue of weeds. For weed control to be successfully managed on a farm, herbicides must be replaced by an entire system of measures, including crop rotation, fertilization, soil cultivation, non-chemical methods of weed control, etc.

The goal of organic farming is not to completely eliminate weeds, but to keep them below the threshold of harm, so their presence serves more as a support rather than as a factor that reduces the yields of cultivated crops. Successful organic weed control aims to minimize weed competition with crops, enhance soil fertility, and promote a balanced ecosystem that supports diverse plant, animal, and microbial life.

Key words

[PREVENTIVE AND CULTURAL METHODS] [DIRECT METHODS] [REGULATION OF SELECTED PERENNIAL WEEDS]

2.1 Methods of weed management

Non-chemical weed control methods are at the heart of organic farming practices. This approach acknowledges that certain weed species may provide benefits, such as preventing soil erosion, contributing to soil organic matter, and serving as habitats for beneficial insects. Effective weed management in organic farming, therefore, involves understanding the ecology of weed species and using integrated methods that promote crop health, support biodiversity, and reduce the need for labour-intensive interventions. In the following sections, we will explore various non-chemical weed control methods, including crop rotation, cover cropping, soil tillage practices, mulching, and mechanical methods, among others. Each method offers unique advantages and challenges, and when used together, they create a comprehensive, sustainable approach to weed management that is both economically and environmentally viable for organic farmers.

Weeds play a specific role in maintaining soil fertility, controlling pests, and providing food for animals. The positive impacts of weeds in arable land include:

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- they are part of the ecosystem, with many species having medicinal properties,
- they serve as forage for bees and as fodder for livestock,
- they act as green manure,
- they reduce soil erosion,
- they capture nutrients and prevent their leaching,
- they make nutrients accessible,
- they improve soil structure,
- they loosen compacted soil and break up the subsoil compaction layer,
- they improve the storage quality of root crops,
- they act as indicators of soil properties.

Despite these examples of weed usefulness, they still pose a serious problem. Intensive and selective suppression of weeds can lead to a disproportionate spread of more resistant species. Some plants appear more frequently as weeds because their characteristics make them better suited to recolonizing bare soil. The most dangerous weeds are those adapted to the life cycle of the cultivated crop. Weed control in organic systems must be addressed comprehensively, from a broader perspective, and involves the following measures:

- understanding weed species in all growth phases,
- identifying sources of weed infestation and their spread,
- understanding biological characteristics, especially reproduction,
- implementing control measures based on preventive, indirect, and direct methods (Lacko-Bartošová et al., 2005).

2.2 Preventive and cultural methods

Preventive and cultural (indirect) weed regulation methods – tactics aimed at three objectives:

A. Reduction of weed density
B. Reduction of damage by surviving weeds against crops
C. Prevention of changes in weed population and weed community

Practices and approaches that can be applied for achieving synergistic effect and complementarity in weed regulation are:

D. Crop rotations, soil tillage, mulching, cover cropping
E. Crop spacing, timely planting, crop density, mowing, grazing, nutrient management, variety selection
F. Strengthen diversity, use of several practices, methods, diverse crop rotations, targeted eradication (Lacko-Bartošová et al., 1995)

2.2.1 Crop rotations

Weeds, in terms of their germination, growth rate, development, and reproduction, are similar to certain cultivated plants. For example, in winter cereals, winter weed species are common, such as *Apera spica-venti, Tripleurospermum perforatum, Galium aparine, Papaver rhoeas*; in spring crops, spring weeds such as *Sinapis arvensis, Raphanus raphanistrum, Avena fatua*; and in row crops, late species such as *Chenopodium ssp, Amaranthus ssp, and Polygonum ssp.* are common.

Creating a diverse and well-thought-out crop rotation plan is an effective preventive weed management measure. Alternating cereals, forage crops, root crops, winter and spring crops, and early and late root crops reduces the occurrence of individual weed species. Monocultures encourage the selective spread of certain problem weed species, while diverse crop rotations support biodiversity, reducing the dominance of any single weed species. In such diverse rotations, weed control through mechanical means is easier. Crop rotations should include perennial forages (like alfalfa, clover, and clover-grass mixes), as their weed-suppressing effect comes from:

- Shading weeds and suppressing them through multiple cuttings; the stands should be dense and exhibit good regrowth.
- Annual cultivation of perennial crops reduces annual weeds, while biennial cultivation, under suitable conditions, can suppress perennial weeds.
- In later years of cultivation, the stands of perennial crops may become sparse, reducing their weed-suppressing effects.

In diverse crop rotations, weeds adapted to one crop type or season are less likely to dominate because they encounter different competitive pressures from year to year. For example, rotating between shallow-rooted and deep-rooted crops creates variations in light availability, soil disturbance, and nutrient uptake that make it harder for specific weed species to establish themselves consistently. Rotations that include cover crops or nitrogen-fixing legumes not only help suppress weeds by outcompeting them for resources but they also improve soil fertility and structure, which further supports healthy crop growth (Freyer, 2003).

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Additionally, certain crop species release natural biochemicals into the soil that can inhibit weed germination and growth, a process known as allelopathy. By incorporating these allelopathic crops, such as rye or buckwheat, into rotations, organic farmers can gain an additional tool for suppressing weeds without chemicals (e.g. rye may reduce the growth of *Amaranthus retroflexus*, while buckwheat residues may reduce biomass of *Echinochloa crus-galli, and Galium aparine*). Overall, crop rotation promotes a dynamic and competitive crop environment that naturally limits weed growth, reduces pest and disease pressure, and builds soil resilience over time. Well-designed crop rotation can create a diversity of soil disturbance, sowing, planting, harvesting patterns that disrupt weed life cycles and prevent any weed species to become highly dominant (Mushtaq et al., 2024).

2.2.2 Cover crops

Cover crops, often referred to as "green manure" non cash-crop are plants grown specifically to cover and protect the soil between two cash-crops. In organic farming, cover crops serve multiple purposes, one of the most important being weed suppression. By quickly establishing ground cover, these crops reduce the space, sunlight, and nutrients available to weeds, effectively smothering them and preventing germination. Cover crops such as clover, vetch, and rye are commonly used for this purpose because of their dense growth habits and fast ground coverage. Beyond suppressing weeds, pest and pathogens, cover crops improve soil health by adding organic matter, fixing nitrogen (in the case of legumes), and enhancing soil structure. This results in a more fertile and well-structured soil that promotes vigorous crop growth, further aiding in weed suppression. Additionally, cover crops help protect against soil erosion, retain soil moisture, and provide habitats for beneficial organisms such as pollinators and natural pest predators. Timing and selection are critical in cover crop management for effective weed control. Farmers may choose fast-growing annual cover crops for short-term coverage or perennial species for longer-term soil improvement. In some cases, farmers may "terminate" cover crops through mowing or rolling them before planting the main crop, creating a natural mulch layer that continues to suppress weeds as it decomposes. This practice, known as a "cover crop mulch," not only prevents weeds from emerging but also conserves soil moisture and reduces the need for additional interventions. In temperate zone, cover crops are mostly grown in the colder season, but when used as a living mulch they are used in late-spring sown crops. The main winter cover crop is **Rye**, which germinates quickly and grows even in cooler conditions, providing good ground cover even in winter. Has a strong root system that improves soil structure and reduces erosion. Rye also has allelopathic properties, meaning it produces chemical compounds that can suppress weed germination. It reduces seed – bank density in e.g. maize. Another excellent nitrogen fixer is **Hairy vetch**, often used in combination with rye for fall planting. Forms a dense cover that effectively suppresses weeds and protects the soil from erosion, supresses winter weeds. When used as mulch, it supresses the weeds in the cash crop. Easily incorporated into the soil in spring as green manure. **Clover** includes various types, such as red or white clover, which fix nitrogen in the soil, increasing its availability for subsequent crops. Grows quickly and covers the soil, preventing weed spread. Provides food for pollinators and supports biodiversity. **Buckwheat** is a fast-growing summer cover crop that can suppress weeds within just a few weeks. Ideal for summer planting between main crops when quick weed control is needed. Also supports pollinators with its flowers.

2.2.3 Soil tillage practices

Soil tillage is a traditional method for weed control that involves physically disturbing the soil to uproot or bury weeds. Tillage practices can be carefully managed to control weeds while also minimizing harm to soil structure and beneficial organisms. The type and timing of tillage are critical for effective weed control, and organic farmers often use a combination of shallow and deep tillage based on weed types and crop needs. **Shallow tillage** is often done with tools like harrows or rotary hoes, targets the upper layers of soil to disrupt young weeds before they establish deep roots. This method is particularly effective for annual weeds that germinate close to the soil surface. By disturbing the top few centimeters of soil, shallow tillage exposes weed roots to air and sunlight, causing them to dry out and die. This approach helps to preserve soil structure and reduce erosion compared to deeper tillage methods. Shallow tillage is often used before planting a new crop or during the early growth stages of crops to give them a head start over weeds. However, repeated shallow tillage must be carefully managed to avoid creating a compacted soil layer, which could limit root growth. **Deep tillage**, often done through plowing, can bury weed seeds and perennial weed roots deeper in the soil, making it harder for them to re-sprout. This method is commonly used for managing persistent perennial weeds, like thistles or bindweed, whose roots can survive shallow tillage. Deep tillage should be done less frequently to avoid excessive soil disturbance, which can lead to erosion and loss of soil organic matter. Farmers might use it at the start of a new rotation or every few years to reset fields heavily infested with deep-rooted weeds. Timing deep tillage during dry periods is advantageous, as it can help expose weed roots to air, reducing their chances of survival.

No-till and reduced tillage practices are used to preserve soil health while managing weeds. While no-till is more challenging in organic systems due to limited chemical options, it can be effective when combined with other weed control strategies, such as cover cropping and mulching. In reduced tillage, minimal soil disturbance is achieved by only working the soil in rows where crops will be planted, leaving the rest of the field undisturbed. This helps prevent weed germination while maintaining soil structure, water retention, and organic matter content.

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No-till organic systems may use cover crops and residue management to suppress weeds, creating a mulch-like effect on the soil surface that inhibits weed growth (Mäder, Berner, 2012). Placement of weed seeds in the soil profile depends on various forms of tillage practices, with the effect on seed survival and seedling emergence ability. Vulnerability of weed seeds to different mortality factors and seed predators is the highest on the soil surface. On the other hand, seedling emergence usually decreases with increasing seed burial depth. If production of new weed seeds can be prevented, no-till and zero-till systems can lead to higher losses and mortality of weed seeds. On the other hand, when production of new seeds is great, deep inversion tillage – ploughing can reduce weed density by inhibition of seedling emergence. Overall, soil tillage practices are tailored to the specific weed challenges and crop requirements of each farm. By balancing shallow and deep tillage, organic farmers can control weeds effectively while promoting soil health and reducing the risk of erosion and compaction (Jensen, 2009; Pecrun, Claupein, 2006).

2.2.4 Mulching

Mulching is an effective organic weed control method that involves covering the soil surface with a layer of material to suppress weed growth. Mulch blocks sunlight, preventing weed seeds from germinating, and also helps retain soil moisture, regulate soil temperature, and improve soil fertility as it decomposes. Mulching is a versatile method suitable for many crops and can be adapted to specific field and climate conditions. **Organic mulches** include materials like straw, hay, compost, wood chips, and shredded leaves. These materials are biodegradable, meaning they break down over time, enriching the soil with organic matter and nutrients as they decompose. Applying a thick layer of organic mulch (2–4 inches) can smother weeds effectively while also promoting microbial activity and improving soil structure. Straw is a popular choice in vegetable gardens, while wood chips are often used around perennial crops like fruit trees. As organic mulch decomposes, it will need to be replenished periodically, especially in warm, moist climates where decomposition happens faster. The decomposing mulch not only prevents weed growth but also adds valuable organic matter to the soil. **Living mulches** are cover crops, like clover or alfalfa, grown between crop rows to cover the soil and suppress weeds naturally. They provide weed control while also enhancing soil health through nitrogen fixation (in the case of legumes) and protecting against erosion. Living mulches are typically mowed or trimmed periodically to prevent competition with the main crop. They also support beneficial insects and improve soil biodiversity by providing habitat for a range of organisms. Living mulches work well in orchards and vineyards, as well as row crop systems where they can be interplanted. They offer a sustainable, low-maintenance option for weed control, especially in systems focused on long-term soil health (Rifai et al., 2002; Moudrý, 2007; Khalid et al., 2023; Campiglia et al., 2012).

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2.2.5 Grazing

Grazing uses livestock, such as sheep, goats, or cattle, to naturally manage weeds by feeding on them. Grazing is especially useful in organic farming systems because it integrates livestock into crop rotations, contributing to nutrient cycling, improving soil fertility, and providing a source of organic matter through manure. Grazing is an ecologically sound method that benefits both weed management and farm productivity.

Selective grazing. Different livestock species prefer different types of plants, so selective grazing can be used strategically. For instance, goats are known to eat a variety of broadleaf weeds and shrubs, while sheep prefer grasses. This allows farmers to tailor grazing to target specific weed species and manage weed diversity effectively. In orchards and vineyards, controlled grazing by sheep or goats can help keep weeds under control without damaging the primary crops.

Post-harvest grazing – Stubble grazing: After crops are harvested, fields are typically left with stubble—residual crop material that includes stems, leaves, and sometimes seeds. Weeds often thrive in these stubble fields, taking advantage of the open space and residual moisture. By introducing livestock to graze on these fields, farmers can effectively reduce weed biomass. Beyond just eating the weeds, the trampling by livestock can also physically damage weed plants, reducing their ability to regrow. This trampling can also help to break down stubble, aiding in the decomposition process and returning nutrients to the soil. Some of the weed species that are effectively controlled through stubble grazing include **wild radish, wild oats, and certain types of annual ryegrass,** or **johnsongrass**. These weeds are palatable to livestock like sheep and cattle, which helps reduce their prevalence in the fields.

Timing and stocking rate. Timing is key to effective weed management through grazing. Grazing during the early stages of weed growth, particularly before weeds go to seed, helps reduce the weed seed bank and lowers weed pressure in subsequent years. The stocking rate (the number of animals per unit area) should be adjusted to ensure that weeds are consumed without overgrazing. Overgrazing can lead to soil compaction, erosion, and loss of soil health, so rotational grazing is often used to move livestock between different areas, allowing for rest periods that help regenerate vegetation.

Mob grazing involves grazing a high density of animals in a small area for a short period, forcing livestock to eat all vegetation, including weeds, evenly. This method prevents selective grazing and encourages uniform consumption, making it effective for weed suppression. In **intensive rotational grazing**, livestock are moved through a series of paddocks, allowing each section to recover and regrow before being grazed again. This method maximizes pasture health and ensures that weeds don't dominate any one area.

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2.2.6 Mowing

Mowing involves cutting weeds close to the ground, typically with mechanical equipment such as mowers or trimmers. This approach is especially useful in managing taller weeds in fields, orchards, and along field edges, where they might compete with crops for light, nutrients, and moisture. **Timing and frequency**. The timing of mowing is critical for maximizing its effectiveness. Mowing weeds before they flower and set seed can significantly reduce the seed bank, leading to fewer weeds in future growing seasons. Early and frequent mowing during peak weed growth phases is particularly effective in preventing weeds from reaching maturity. The frequency of mowing depends on the growth rate of the weeds and the crop type. Fast-growing annual weeds may require repeated mowing to keep them from regrowing, while slower-growing or perennial weeds might need only one or two mows during the season. **Benefits to crop health**. By removing the upper parts of weeds, mowing reduces competition for sunlight, water, and nutrients, giving crops a better chance to thrive. It also allows for better air circulation around the crops, which can help reduce the risk of fungal diseases by lowering humidity in the canopy.

Types of mowing: Flail mowing: This type of mowing uses a series of small blades that shred weeds into fine pieces, which are then left on the field as mulch. Flail mowing is beneficial in orchards and vineyards, as the mulched weeds suppress future weed growth and add organic material to the soil. **Rotary mowing**: Rotary mowers use a high-speed spinning blade to cut weeds and are commonly used in pastures and larger open areas. This method is less precise than flail mowing but works well for quickly managing large weed populations. **Selective mowing**: In some cases, farmers use selective mowing to target specific weeds that grow taller than the crop, allowing the crop to grow without interruption. This method is particularly useful in mixed cropping systems or fields with varied weed heights.

Both mowing and grazing offer low-cost, environmentally friendly options for weed control in organic farming. When used together or in rotation with other practices like cover cropping and mulching, they provide a powerful, integrated approach to managing weeds while enhancing soil health, biodiversity, and farm sustainability (Urban, Šarapatka, 2003; Van der Weide et al., 2008).

2.2.7 Balanced nutrient management

This approach helps crops grow more vigorously, enabling them to better compete with weeds. When nutrients are precisely tailored to crop needs, weeds are often less competitive, as there is less nutrient excess for them to exploit. For example, nitrogen promotes rapid vegetative growth; if applied in excess, it can favor fast-growing weeds over the intended crop. By optimizing nutrient ratios, farmers can support the crop's competitive advantage over weeds. **Specific nutrient ratios**: Different weed species respond to various nutrient levels.

For instance, grasses and broadleaf weeds tend to proliferate in nitrogen-rich soils, so avoiding excessive nitrogen can prevent a significant weed issue. Balanced nutrient management tailored to specific crop requirements can limit certain weed types. **Slow-release nutrients**: Organic fertilisers and compost break down slowly, releasing nutrients gradually. This slow release aligns better with crop growth rates, reducing nutrient spikes that fast-growing weeds could otherwise capitalize on. Organic matter can also increase soil's water retention, reducing conditions that favour weed proliferation, as weeds often thrive in disturbed, nutrient-saturated conditions (Lacko-Bartošová, 2006; Lacko-Bartošová et al., 2023).

2.2.8 Timely planting

Early planting to outcompete weeds: Planting crops early in the season, before weeds typically emerge, can give crops a head start on resources like sunlight, water, and nutrients. This strategy is particularly effective for crops that establish quickly, as they can shade out weeds and reduce weed seed germination. Early planting may also avoid peak weed emergence periods, creating a competitive disadvantage for weeds. **Adjusting planting dates**: In regions with multiple planting windows, adjusting the planting date to either before or after the main weed emergence period can minimize weed pressure. For instance, a winter crop can be planted when many weed seeds are dormant, or a spring crop can be planted slightly later to avoid early weed species. By adjusting planting times based on local weed cycles, farmers can reduce weed densities and lessen the need for additional control measures. **Cover crops in fallow periods**: During times when the main crop isn't growing, cover crops can prevent weeds from establishing by occupying the space and using available resources. Fast-growing cover crops, like rye or clover, can quickly form a dense canopy, suppressing weed seed germination and growth. When planted at the right time, cover crops reduce weed populations and improve soil health (Šarapatka, Urban, 2009; Miština, 2003).

2.2.9 Optimized crop spacing

Dense spacing to shade weeds: By spacing plants closer together, crops can form a canopy that shades the soil, blocking sunlight from reaching weed seeds. This reduced light availability inhibits weed germination and growth, as most weeds require full sunlight to establish. Crops with broad leaves or tall, dense foliage, such as corn or soybeans, can effectively create a shaded environment unfavourable to weeds. **Strategic row spacing**: Narrowing row spacing can further help the crop canopy close faster, depriving weeds of resources. For instance, reducing row width in crops like wheat or barley has been shown to reduce weed biomass significantly, as the crops intercept more sunlight and outcompete weeds for space. **Intercropping and companion planting**: By growing multiple crops together or planting companion species, farmers can create a dense, multi-layered canopy

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that suppresses weeds. For example, intercropping legumes with cereals can utilize vertical space and soil resources efficiently, reducing the available area for weeds. Companion plants can also serve as “living mulch,” further deterring weeds.

2.3 Direct weed control methods

Direct weed control interventions are considered the last step in the entire organic farming system.

Many mechanical interventions, like blind harrowing, are based on long-standing practices. The development of new tool types has also brought undeniable progress. Although these tools may be more expensive, their use can be more cost-effective than herbicides due to higher efficiency and better quality of work compared to traditional equipment (like harrows). Additionally, soil cultivation offers advantages over herbicides, such as aeration and loosening of the soil, easier root penetration, increased mineralization, and faster soil warming in spring. However, disadvantages of cultivation include dependency on weather conditions and soil moisture, increased labour costs and machine use during peak times, difficulties on sloping land and rocky soils, and the potential for soil compaction and increased fossil fuel consumption from excessive mechanical interventions. The decision to carry out mechanical soil intervention should always consider both the advantages and disadvantages.

2.3.1 Mechanical weed control in dense-sown crops

The first commonly used mechanical intervention against weeds is blind harrowing. The ideal timing is 24 hours before the crop emerges on the soil surface. The optimal timing is also when weed seeds have started to germinate, visible as thin white roots. If this is not the case, harrowing may stimulate weeds to germinate at a time when mechanical intervention against weeds is unsuitable due to the crop's growth stage, leading to greater weed problems. Blind harrowing is generally more effective in spring cereals than in winter cereals. The recommended harrow types for this purpose are tine harrows, chain harrows, and classic spike-tooth harrows (for heavier soils). After crop emergence, harrowing is effective only at the 2–3 leaf stage (beginning of tillering). In earlier stages, harrowing may seriously damage the crop. Once weeds are well-rooted, harrowing has low efficacy. When a soil crust forms, rolling before harrowing improves its effectiveness.

Higher working speed enhances the burying effect of harrows. The pressure adjustment of the tines depends on the crop's sensitivity, growth stage, and soil type. The most popular tools for weed control are tine harrows. Success depends on timely intervention, the type of weeds present, degree of weed infestation, weather conditions, soil properties, and tool settings. Common harrowing timings after crop emergence are as follows:

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- Cereals: from 2 true leaves
- Maize: from 3 true leaves
- Sugar beets: from 4 true leaves
- Rapeseed: from 6 true leaves
- Beans, peas: from 2 true leaves
- Soy, sunflower: from 4 true leaves
- Buckwheat: from 4 true leaves.

Figure 2.1. *Tine harrows. Source: Magdalena Lacko-Bartosova.*

In cereals, later use of tine harrows between tillering and heading is recommended for weeds with weak root systems. Tool settings and the number of passes must be adapted to specific conditions. In spring cereals, the risk of crop damage is higher than in winter cereals. Among winter cereals, winter barley typically has better rooting than winter wheat. Mechanical weed control is easier on light to medium-heavy soils; heavy soils require more aggressive harrow settings (Lacko-Bartošová et al., 2005; Húla et al., 2010).
A main limitation of mechanical weed control is its high dependence on weather conditions. Therefore, there is no universal recipe for mechanical weed control. Harrowing can control about 50-60% of weeds, so repeated interventions are necessary. Proper tool settings and use require sufficient knowledge and experience to achieve the desired level of weed management.

2.3.2 Mechanical weed control in row crops

The use of inter-row cultivators (hoes) is standard practice for crops sown in wide rows. These cultivators are typically equipped with protective devices to shield the crop and maximize the width of cultivation between rows. Some tools are fitted with ridging plates that cover weeds within the row. Certain crops, such as carrots, are grown on ridges to

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facilitate this process. The sooner the intervention, the more effective it is. Larger weed plants are cut, while smaller ones are buried.
During the first hoeing, there is a risk of covering the crop itself. This risk is mainly due to the desire to hoe as close to the row as possible and as early as possible after crop emergence. To prevent damage, protective discs are typically used during the first pass to shield young plants. Under favourable conditions, the crop's protective band width can be reduced to just 30mm.
In the second hoeing pass, without protective discs, soil is mounded into the row, covering germinating weeds. A combination of hoes and tine harrows can achieve up to 75% or higher weed control. Hoeing alone, in comparison, provides around 50% effectiveness. This effectiveness is highly variable, depending on current weather and tool settings. Good results are not achievable on either overly dry or overly wet soil. After hoeing, a day of dry weather is ideal, allowing uprooted weeds to wither.
Weeds within crop rows pose a bigger challenge than those between rows. New types of tools, including thermal weeders, are increasingly used in this context.
Specialized machinery designed to target weeds between rows of crops and within the rows can be used for weed regulation for row crops. These machines use various mechanical components that selectively disturb or remove weeds without harming the primary crops. Several popular types of powered inter- row and intra- row weeders and related systems are presented.

Inter-row and intra-row weed control systems

Disc cultivators with protective shields: these cultivators use angled discs to uproot weeds while protective shields prevent soil from spilling onto the crop. They are beneficial in situations where soil cover is limited or where crops are close together.
Strip rotary cultivator: this tool uses rotating blades or discs to cut or bury weeds within narrow strips between crop rows. The rotary cultivator's blades are designed to work at different angles and depths, disturbing the soil surface while avoiding the crop rows. Often used for larger farms, as it covers a significant amount of ground quickly. It's effective for shallow and mid-rooted weeds and can work in various soil types. The machine is adjustable, allowing it to work effectively in different row spacings. It is also efficient for weeds in their early stages of growth.
Pneumat (Air-Powered Weed Control): This machine uses high-pressure air to blast soil and uproot weeds. The Pneumat machine directs a jet of compressed air onto weeds, breaking them apart and removing them from the soil. Suitable for delicate plants and young crops, where mechanical tools might cause damage. It's also effective in wet or dense soil conditions. Air pressure does not disturb crop roots as much as physical tools, and it works well on very small, young weeds. However, its usage can be limited by soil type and moisture levels.

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Brush weeder: The brush weeder uses stiff rotating brushes to scrape or brush out weeds in the soil. Brushes are usually made from synthetic materials or steel bristles and are rotated at high speeds to uproot or damage weeds. It's particularly useful in crops where soil coverage is less dense or where weeds are small. The brush weeder is effective for shallow-rooted weeds and young seedlings, as it doesn't penetrate deeply into the soil. It's gentle enough to minimize damage to crop roots but tough on small weeds in close proximity to the crops.

Finger weeder: use flexible, star-shaped "fingers" made from rubber or plastic that disturb weeds close to the plant. The fingers rotate as the machine moves, reaching around plants to uproot small weeds without harming the crop. Commonly used for crops with delicate stems or where weeds grow very close to the crop, such as vegetables. Highly effective for targeting weeds close to the plant base, especially for crops with rigid stems. It's particularly useful for young weed control and reduces the need for hand weeding.

Figure 2.2. *Finger weeder (Kress). Source: Kress.*

Torsion weeder: This tool uses flexible metal rods that rotate and press against the soil, uprooting weeds and breaking their roots. The torsion weeder's rods are angled to reach near the base of the crop, allowing it to effectively target weeds without damaging the main plants. It is often used in vegetable crops or organic farming where precision is essential, and chemical herbicides are avoided. Works well on delicate crops, with adjustable pressure settings to prevent crop damage. The torsion weeder is effective against small, shallow-rooted weeds.

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Weed fix: This implement targets weeds specifically in the inter-row area, using a series of rotating discs and hoes that cultivate the soil and disrupt weed growth. The Weed Fix system operates by moving soil around the crop base, disrupting weed germination and growth in both intra-row and inter-row areas. It is best suited for uniform row crops. The machine is often paired with guidance systems for precision in targeting weeds close to the crop. This system provides high precision and minimizes damage to the crop roots, making it ideal for delicate crops (Lacko-Bartošová et al., 2005; Lacko-Bartošová et al., 2023; Kolb, Gallandt, 2012).

Figure 2.3. *Torsion weeder. Source: Magdalena Lacko-Bartosova.*

Intra-row rotary hoes: Often used with guidance systems, intra-row rotary hoes are designed to cultivate both between and within rows. They are highly adjustable, making them suitable for young crops where weeds grow very close.

Robotic weeders: Autonomous robots equipped with cameras, AI-driven navigation, and precision tools (e.g., laser or cutting implements) can selectively target weeds between rows. They are highly precise, but currently more expensive.

Camera-guided hoes: These systems use cameras and sensors to detect crop rows and guide hoeing implements precisely between rows. They can work in tandem with GPS or other guidance systems for added accuracy, minimizing crop damage.

Each of these systems has unique benefits for different crop types, soil conditions, and weed growth stages. When choosing an inter-row or intra-row cultivator, farmers often consider their specific crop spacing, soil type, weed types, and the overall scale of their operation. Combining various types of weeders within an integrated weed management plan is often the most effective approach.

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The robotic and camera-guided weeding systems are developing, they vary in technology and scale, but all aim to reduce manual labor, limit chemical usage, and offer precision in weed control.

Naio Technologies – Oz and Dino: Naio Technologies offers autonomous weeders designed for small to large farms. More details can be found on their website: Naio Technologies.

FarmDroid: This is a fully autonomous solar-powered robot that weeds and plants simultaneously. Learn more about it here: FarmDroid.

Garford Robocrop: Garford offers camera-guided inter-row hoes such as the Robocrop InRow Weeder, which uses vision technology to distinguish crops from weeds within rows, enabling precise weed removal. More about Garford's solutions can be found here: Garford Farm Machinery.

Earth Rover – CLAWS is a robotic weeder equipped with light-based weeding technology, which uses concentrated light to eliminate weeds without chemicals. Visit Earth Rover for further details.

2.3.3 Thermal weed control

Thermal weed control, or flame weeding, involves applying heat to weeds, typically through a propane flame, to disrupt their cellular structure. This method is most effective on small, tender weeds and is commonly used in organic farming systems where herbicides are not permitted. Flame weeding can be especially useful for managing weeds in early crop growth stages when weeds are not yet robust. Thermal weeders work by exposing plant tissue to high temperatures for fractions of a second. This process dehydrates the tissue, causing cell contents to expand, rupture cell membranes, and coagulate proteins.

Thermal weeders can be used as: **Pre-emergence treatment**, primarily used in economically valuable crops with long germination periods, such as carrots, parsley, onions, and beets. Crop rows are treated just before emergence, with weeds in the inter-row mechanically controlled. Timely treatment is critical for effectiveness. **Post-emergence treatment** can be selective or non-selective. Non-selective treatment is used with flame-tolerant crops. For instance, onions have a waxy layer that provides tolerance. Post-emergence treatments are applied when plants reach 0.15 m in height. Monocots are generally less sensitive to thermal shock, which can be beneficial. Maize, for example, is treated initially at the 2-leaf stage, then again at the 4–6 leaf and 8–10 leaf stages, with sub-leaf treatment complemented by inter-row cultivation. Selective treatment can be used with crops like sugar beet, where a protective cover lifts crop leaves, directing the flame below the leaves. Pre-harvest defoliation, for example, potatoes or onions (Lacko-Bartošová, 2003; Vanhala et al., 2004).

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Figure 2.4. Thermal weeder. Source: Magdalena Lacko-Bartosova.

2.3.4 Regulation of important perennial weeds

Couch Grass (Elytrigia repens L.)

Non-chemical methods of couch grass control are more complex and time-consuming than chemical methods. In cases where couch grass is overgrown in a field, a combination of control measures will be required.

Figure 2.5. Thermal weeder. Source: Magdalena Lacko-Bartosova.

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Figure 2.6. *Thermal weeder. Source: Magdalena Lacko-Bartosova.*

Preventive methods

Preventive measures focus on limiting couch grass spread, especially by preventing seed ripening and dispersal on arable land, as well as spread through contaminated seed, manure, compost, etc. Preventing Seed Set and Spread of Couch Grass: in crop rotations with a high share of winter crops (e.g., winter barley, winter oilseed rape, winter wheat), couch grass can readily produce reproductive organs. In cases of short fallow periods and shallow tillage, couch grass seeds can readily germinate in winter crop rotations, making these rotations less suitable for couch grass control.

Direct methods of controlling couch grass

Primary Tillage and Additional Cultivation Interventions

Properly executed deep plowing is a fundamental factor in controlling the spread of couch grass, as it weakens the plant significantly by burying it deep in the furrow. However, a single deep plowing event is usually insufficient for effective suppression, especially on heavily infested land. Deep plowing is more effective when couch grass has already been weakened by prior interventions (e.g., shallow cultivation) or suppressed by a dense cover crop or intermediate crop. A three-plowing system is recommended, particularly when growing root crops. After the cereal harvest, the following approach is recommended: shallow cultivation with a disc harrow or cultivator with sharp-edged discs, ideally in two perpendicular directions.

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The depth should be such that a substantial part of the rhizomes is affected. This discing process cuts the rhizomes into short 50–80 mm pieces. When shoots start to emerge en masse from the cut rhizomes (3-4 leaf stage), the shallow cultivation is repeated. After another wave of couch grass emergence, deep plowing with a plow equipped with a skim coulter is performed. The plowing depth should be at least 0.15 m deeper than the shallow cultivation depth. The weakened rhizomes, turned over by the skim coulter, are unable to regrow and will die. This intervention can be supplemented by sowing a dense cover crop mixture.

Utilizing stubble intermediate crops
This method relies on creating favorable conditions for the establishment of an intermediate crop (such as white mustard or rape), which competes with regenerating couch grass rhizomes. The best results on heavily infested land have been achieved with the following procedure: Deeper shallow cultivation with a blade cultivator to loosen the soil layer containing the rhizomes. Cutting the rhizomes with a sharp disc cultivator (to promote regeneration) and simultaneously incorporating white mustard seeds. Rolling the soil afterward. The regenerating, weakened couch grass rhizomes are significantly suppressed by the stubble intermediate crop. The greatest suppression occurs in moist weather, shortly after cereal harvest, and during a longer period between crops.

Growing annual fodder crops for green biomass
Annual fodder crops (winter and spring legume-cereal mixtures) have proven effective in couch grass control when followed by intensive cultivation. After harvesting the first mixture in May or June, the field should be cultivated with a disc harrow to cut the couch grass rhizomes. Another annual fodder crop should be sown while soil moisture is sufficient to repeat the suppressive effect of the crop.

Removal of couch grass rhizomes on light soils
Couch grass rhizomes can be removed during pre-sowing soil preparation, in the period between crops, or after the harvest (especially after potato crops). The best results are achieved during a dry summer period (Rasmussen et al., 2014; Melander et al., 2012).

Canada Thistle (Cirsium arvense)
Canada thistle is most problematic in cereals, root crops, and legumes, and it often forms concentrated patches in fields. It also serves as a host for certain pests, with nematodes and some aphid species overwintering in its rosettes. Its root system releases allelopathic substances that inhibit the growth of other cultivated and weedy plant species.

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Preventive control methods

Soil tillage: Primary and pre-sowing tillage are basic methods for controlling perennial weeds like Canada thistle. Shallow cultivation destroys the emerging leaf rosettes, stimulating new bud sprouting and the formation of additional rosettes. The first cultivation should be shallow (around 0.1 m), while the second should be deeper (up to 0.18 m) to bury the newly sprouted rosettes. Disc cultivators are not recommended, as they contribute to the spread of Canada thistle. Subsequent deep plowing should effectively limit Canada thistle growth. It is crucial to allow the root system to dry and freeze during the winter.

Crop rotation: Including deep-rooting perennial fodder crops in the rotation is essential for controlling Canada thistle. Frequent mowing can effectively suppress thistle under suitable conditions, with 6 cuttings recommended over two years. In the third year, perennial fodder crops typically thin out, reducing their suppressive effect on weeds. Mowing should be done during dry weather to avoid soil compaction, which would otherwise encourage Canada thistle growth. Growing cover crops also helps to suppress Canada thistle, with winter and spring mixtures proving suitable. Double tillage controls thistle growth, while undersown crops are less effective. In spring, mechanical intervention disrupts the generative development of Canada thistle, promoting its vegetative growth.

Harvesting technique: In small areas or patches, plants (or at least their flowering parts) should be removed before seed maturation. On weedy land, increasing the drum speed and reducing fan speed during combine harvesting can help retain some flower heads and seeds in the crop, rather than letting them fall to the ground. However, this approach increases the need for subsequent cleaning.

Direct control methods

In row crops, Canada thistle can be controlled through inter-row cultivation during the growing season. Although this promotes vegetative reproduction, frequent removal of leaf rosettes depletes the root system. The recommended approach is to perform the first hoeing after leaf rosettes have sprouted (at a depth of 0.1 m). The second hoeing is done approximately 10 days after regrowth, with additional interventions every 21–28 days to prevent the aerial parts from building up storage reserves.

In **cereals**, the first intervention against Canada thistle (pulling or cutting) should occur at the heading stage. Loosening the soil, especially in thistle patches, is not advisable. Mechanical intervention is most effective just before flowering. Flowering parts should be removed just before blooming or, at the latest, 9–10 days after flowering and then burned. After cereal harvest, shallow cultivation is followed by deeper cultivation and then deep plowing when thistle regrows to a height of 50–100 mm. The excavated vegetative parts will dry out and freeze over the winter (Lacko-Bartošová et al., 2023; Šarapatka, Urban, 2009).

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Further resources

www.kult-kress.com
www.hatzenbichler.com
https://ien.kverneland.com
www.einboeck.at
www.fibl.org
Grazing For Weed Control
GCTV10: Grazing Stubbles and Water Use Efficiency

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3. Economic aspects of conversion to organic farming

Educational material for module 3 "Mastering Economics in Conversion and Beyond"

Opening

The economic aspects of conversion to organic farming can be compared to planting a new seed - initial costs and uncertainties are inevitable, but the potential for long-term growth and resilience is vast. Organic certification can unlock premium market prices, government subsidies, and consumer goodwill. On the other hand, the journey requires careful financial planning to navigate reduced yields during conversion, increased labour needs, and the investment in soil regeneration. Conversion is therefore a period that is a challenge not only in terms of economic demands due to its specifics from an agricultural point of view, but also from a marketing point of view. During the conversion, marketing is adapted to the situation where farmers already operate in accordance with the rules for organic farming, but at the same time they are not yet certified and authorized to fully use logos marking organic farming products. This requires a specific, vision driven approach to marketing, which is not just about selling a product or service for today's needs but positioning farmers' offering as part of the customer's journey into the future.

Key words

[FARM ECONOMICS] [BUSINESS PLAN] [MARKETING PLAN] [DIVERSIFICATION] [CHANGE MANAGEMENT]

3.1 Farm economy-basic concepts

The farm economics of conversion to organic farming includes the analysis of costs and benefits, besides the risks associated with converting from conventional to organic agricultural practices both short term and long term. The farm economics of converting to organic farming involve both short-term challenges and long-term opportunities. During the initial conversion period, farmers may face reduced yields and increased labour costs due to the elimination of synthetic inputs and the need to adopt new management practices. This period can strain profitability, as products cannot yet be sold at organic premiums while costs often rise.

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However, over time, organic systems can lead to improved soil health, reduced input costs, and access to higher-value markets. Financial performance often stabilizes or improves after certification, especially when farmers effectively manage resources, diversify income streams, and take advantage of government incentives or support programs designed to ease the conversion. Ultimately, the economic viability of conversion depends on careful planning, market access, and the ability to adapt to new production systems. This process typically involves several key economic concepts and definitions that are essential to understand and are presented below.

Factors of production on a farm are the essential resources used to produce agricultural goods. These factors are typically divided into three categories: natural resources, labour and capital.

1) Natural resources such as land, water, soil, rainfall are essential inputs of agricultural production.
2) Labour is the human effort (people employed, human capital) that can be applied to the production of goods and services.
3) Capital is a factor of production that has been produced for use in the production of other goods and services, e.g. buildings, machinery, and tools. Capital is often referred to as cash and physical (man-made) assets.

Farm enterprises refer to the different products produced, or activities undertaken by the farmer, each of which uses inputs to produce outputs. Farmers often manage multiple enterprises on one farm to diversify income, reduce risks, and make better use of resources like land, labour, and capital. Analysing each enterprise separately helps in identifying which parts of the farm are most profitable or efficient. These enterprises can be categorized into three types based on their interaction with one another: competitive, supplementary, and complementary.

1) Competitive enterprises: compete for the same resources — such as land, labour, or capital—so increasing the output of one results in a decrease in the output of the other. For example, growing wheat and corn on the same plot of land means more of one leads to less of the other.
2) Supplementary enterprises: do not significantly affect the main enterprise because they use resources that would otherwise go unused. For instance, raising chickens on a farm primarily focused on crop production may utilize excess labour or space without reducing crop yield.
3) Complementary enterprises: support and enhance one another, such that the output of one can improve the output or efficiency of another. An example is integrating livestock with crop farming, where animal manure can be used to fertilize fields, benefiting both enterprises.

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Cost of production refers to the total monetary value of all inputs required to produce crops or livestock on a farm. These costs are generally divided into two categories: variable costs and fixed costs.

1) Variable costs are expenses that change directly with the level of production and are specific to each enterprise. For example, the more crops planted or animals raised, the more seeds, feed, fertilisers, fuel, and seasonal labour will be required. These costs fluctuate depending on the scale and intensity of the activity.
2) In contrast, fixed costs are ongoing expenses that do not vary with short-term changes in production levels. They are associated with the overall operation and management of the farm and remain relatively constant regardless of how much is produced. Examples include the salaries of permanent staff, depreciation of equipment and buildings, land taxes, loan interest, and administrative expenses. These costs must be covered even if production is temporarily reduced, making them critical to the long-term sustainability of the farm business.

Opportunity cost can be defined as the forgone benefit that would have been derived from an option other than the one that was chosen or as the income lost by using scarce resources for one purpose instead of another. Using a scarce resource (e.g. land) in one enterprise cancels the opportunity to be used in another. Also, time spent on a farm enterprise reduces the opportunity for social or leisure activities.

Value of production (or gross income or value of output) includes the money received from the sold and unsold (i.e. stored and consumed) produce. In other words, it means the total receipts which depend on yield and current prices.

Gross margin is the difference between the value of production and variable costs (such as those of fertilisers, fuel, seed etc.). This term indicates what an enterprise can add to total farm profits. By calculating gross margins farmers can make the right decision whether to change one enterprise with another.

Farm profit refers to the money left over after total costs (variable and the fixed) costs are paid. It also can be defined as the amount obtained by deducting fixed costs. Smallholder farmers usually have few fixed costs and thus the total gross margin is almost equal to the total profit.

Cash flow is the difference between money received from the sale of farm produce (cash inflows) and money paid out for inputs and materials used (cash outflows). Although a farm may be able to make a profit, there may be times of the year when it runs out of cash and is then unable to purchase inputs and materials.

Efficiency refers to wise (i.e. optimal) use of resources available to the farmer which is an opportunity to maximize the profit.

Farmers must take risks into account such as weather and diseases affecting farm yields or changes in market and input prices.

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3.2 Comparison between organic and conventional farming from an economic point of view

The global expansion of organic farming depends on its financial performance and economic competitiveness compared to conventional farming. Crop yields, labour expenses, organic products' premium prices, income challenges during the conversion period, potential cost reduction from reduced reliance on non-renewable resources and external inputs are major factors influencing the profitability of organic farming.

Conversion costs

Shifting to organic farming often goes along with higher cost and initial investments, such as purchasing organic-certified seeds, fertilisers, and pest control methods, equipment (machinery, buildings etc.) in order to adapt existing to organic ecological standards.
Another component of conversional costs is certification cost. Farmers need to comply with organic certification processes, which appears in fees related to adherence to specific regulatory standards. A significant issue is that during the certification period lasting up to 3 years, the products cannot be sold as organic (i.e. on higher price which also means an income loss for the farmer), despite the shift in practices.

Decreased yields during conversion

Farmers often experience reduced yields during the conversion period, as it takes time for the soil condition and quality to improve and the organic farming systems to be established. Usually, the yield-gap between conventional and organic farming is about 10-20% and varies by crop (e.g. higher for corn, wheat, apple and lower for legumes and vegetables). In general, crops that are sensitive to the presence of nitrogen such as corn, wheat, potatoes, are much more likely to have a lower average yield.
This initial drop in production can result in lower revenue, adding to the financial challenges. After the conversion period, organic farms can achieve more stable and sustainable yields, though they might remain lower than conventional yields in some cases.

Cost structure changes

The input costs of an organic farm are mostly lower than those of a conventional one which is largely due to the use of own, family-members' labour, older (but not obsolete) tools/equipment, own seeds, organic fertiliser (manure), etc. Organic farming typically relies on fewer synthetic chemicals and the elimination of increasingly expensive fertilisers and pesticides from production can reduce the input costs.
However, organic alternatives may still be expensive. Organic farming is often more labour-intensive, requiring manual weeding, crop rotation, and careful management of soil fertility.

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Labour costs may increase due to these demands. Organic farms, especially the mixed and horticultural ones, even without the labour requirements of processing and sales, on average use more labour than conventional farms.
Therefore, some types of costs (e.g. purchased materials) decrease, while others (e.g. mechanical work, wages and public charges) increase significantly in organic farming.

Premium prices
Consumer demand for organic products is constantly increasing, creating profitable market opportunities. Certified organic products usually tend to command higher market prices, due to the sale in relatively small lots, more expensive environmentally friendly packaging and higher market costs e.g. related to certification and inspection. Premium prices can help offset the potential decline in yields and increased labour costs. However, it has to be noted, that since the higher consumer price of organic products does not necessarily result from higher production costs, it is not a structural element of organic agriculture.

Environmental (long-term) benefits
Sustainability gains of organic farming practices such soil health improvement, water conservation and pollution reduction, can lower long-term costs associated with land degradation or regulatory compliance. Improved biodiversity and soil fertility over time lead to more robust crop resilience, potentially lowering pest management and irrigation costs in the future. These environmental benefits (positive externalities) enhance the farm's sustainability and resilience.

Risk and uncertainty
The organic market may be volatile, with prices fluctuating based on consumer demand, certification barriers, and international competition. In addition, the long conversion period and upfront costs mean that financial risk is significant for farmers without access to capital, subsidies, or support programs.

Profitability
As mentioned above, in most cases organic farms reach lower yields, slightly lower costs but higher producer prices than conventional ones, which affects the profitability. The average profitability rates of organic farms vary - 20% to +20%, in comparison to conventional farms' profitability rates. It should be noted that the profitability gap varies by region, crop type, cost structure, market demand and organic farming can even be more profitable in favourable market conditions (due to higher prices and subsidies, despite lower yields).

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Government support/subsidies

Many northern countries (e.g. EU member states and the USA) provide financial help for the conversion to organic agriculture which reduces the overall economic burden in this period (related to falling yields as it takes time for full biological activity of the agro-ecosystem to be restored). A variety of forms including compensation for losses (as during conversion products cannot be sold as organic), integration of extra costs (e.g. certification) or support for infrastructure developments (e.g. for the purchase of machinery or for restructuring rural buildings) can be applied. The financial support may be available not only during the conversion period, but sometimes even beyond. These payments are often made as a specific amount per hectare but may appear as tax reductions or preferential conditions for credit. Indirect financial help can also be given beside the direct one, in the form of investment in research, rural extension and training for farmers, and organic market development (e.g. awareness campaigns). The premium prices paid by the consumer for the organic produce also form an economic incentive for the individual farmer.

Note: *Organic farming requires greater intellectual investment. Results from several research studies indicate that organic farmers are higher educated and younger than conventional ones, while most of them come from an urban environment and have little experience in agricultural matters.*

3.3 Business Plan

Creating a business plan is essential for setting up and operating an organic farm. A well-considered and designed plan outlines the vision, strategy, and financial projections to ensure success and economic sustainability of the farm. A business plan can be developed for several purposes, one of which may be the mapping out of the conversion from conventional to organic farming, among others (e.g. expanding activities, involving new business partners, creating added value through product processing, direct sales or cooperative marketing).

3.3.1 Business plan (including financial plan) development

In the following is presented a guide on how to create an organic farm business plan, along with the key sections it should include (Figure 1.1).

1) **Executive Summary**
    - Business Overview: Describe the nature of the organic farm, including its location, the types of crops or livestock that will be produced, and the mission statement.
    - Goals and Objectives: Outline short-term and long-term business goals, such as production targets, market expansion, and sustainability milestones.

- Business Vision: Highlight the values and vision for the farm, such as promoting environmental sustainability, producing high-quality organic products, or serving a specific niche market.
- Ownership Structure: Define the legal structure (sole proprietorship, partnership, LLC, etc.).
- Summary of Financials: Provide a high-level overview of expected profitability, revenue, and any required funding.

2) **Market Research and Analysis**
    - Target Market: Identify the customer base, such as organic food consumers, grocery stores, restaurants, farmer's markets, and direct-to-consumer sales (CSAs).
    - Market Trends: Discuss the demand for organic products in your area, as well as nationwide or global trends in organic farming. Provide statistics or market research showing the growth in consumer interest in organic products.
    - Competitive Analysis: Analyse competitors in the given region—other organic farms, conventional farms, or local grocery stores—and highlight what differentiates the farm products (quality, pricing, sustainability practices, etc.).
    - Market Positioning: Define how the farmer will position her/his farm in the marketplace—whether as a premium product, locally sourced option, or certified organic producer.
3) **Organic Farm Operations Plan**
    - Farm Location: Describe the size and location of the farm and explain how the land is suited for organic farming.
    - Production Plan: Outline the crops or livestock to be produced, production schedules, crop rotation plans, and organic farming practices (e.g., composting, cover cropping, biological pest control).
    - Organic Certification: Detail the certification process, including timelines, costs, and compliance with organic standards.
    - Equipment and Technology: List the tools, machinery, and technology required to run the farm (e.g., tractors, irrigation systems, greenhouses).
    - Labour Requirements: Estimate the number of workers needed, both seasonal and permanent, and describe their roles, from planting to harvesting to marketing.
4) **Marketing and Sales Strategy** (see Marketing plan below)
5) **Management and Organization**
    - Management Structure: Identify the key individuals involved in running the farm, their qualifications, and their responsibilities.
    - Roles and Responsibilities: Break down the specific tasks, such as farm operations, financial management, marketing, and customer relations, and assign them to team members.

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- Advisors and Consultants: List any experts or advisors you'll work with, such as organic certification consultants, agronomists, or business mentors.
- Legal and Regulatory Compliance: Ensure compliance with local, state, and federal laws related to farming, organic certification, labour regulations, and environmental standards.

6) **Financial Plan**
    - Start-up Costs: Detail the costs associated with starting the organic farm, including land acquisition, equipment, initial labour, seed and input purchases, and organic certification fees.
    - Operating Costs: List ongoing expenses such as seeds, organic fertilisers, labour, utilities, repairs, fuel, and marketing.
    - Revenue Projections: Estimate expected income from sales of crops or livestock, taking into account the seasonal nature of farming and potential variations in yields.
    - Profit and Loss Projections: Develop projected financial statements for the first 3-5 years, including expected profit margins, gross revenue, and net income.
    - Break-Even Analysis: Calculate the point at which the farm will become profitable by comparing total costs to projected revenue.
    - Funding Requirements: If additional capital is needed, outline how much is required and for what purpose (land acquisition, equipment, etc.). Identify potential sources of funding, such as loans, grants, or investor contributions.
7) **Risk Management**
    - Production Risks: Address risks related to crop failure, pests, diseases, and adverse weather, and propose solutions (e.g., crop diversification, organic pest control, crop insurance).
    - Market Risks: Identify market-related risks such as price fluctuations, changes in consumer preferences, or competition, and explain how you'll adapt (e.g., adjusting product mix, expanding marketing efforts).
    - Financial Risks: Discuss the financial risks associated with debt, cash flow management, or unexpected costs and how you'll manage them (e.g., maintaining a cash reserve, contingency planning).
8) **Sustainability and Environmental Stewardship**
    - Sustainable Practices: Detail the environmentally friendly practices you'll employ, such as no-till farming, water conservation techniques, renewable energy usage, and habitat protection for wildlife.
    - Soil and Water Conservation: Highlight efforts to preserve soil health and water resources through organic methods like cover crops, composting, and integrated pest management (IPM).

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- Community Engagement: Describe how your farm will engage with the local community through educational programs, workshops, or collaborations with other local organic producers.

9) Appendices

- Supporting Documents: Include any necessary documents such as lease agreements, organic certification documentation, market research data, and detailed financial statements.

Figure 3.1. *Steps of business plan for organic farming conversion. Source: Authors own compilation*

The Organic Conversion Business Plan is a strategic tool used to manage, fund, and communicate the process of converting to organic farming. Once completed, it serves as a practical guide by outlining the key steps, timelines, and resources required for implementation, helping to manage the conversion efficiently. The plan also demonstrates

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compliance with organic certification standards and is often submitted to certifying bodies. Additionally, it supports applications for financial assistance, such as loans, grants, or subsidies, by clearly presenting the farm's goals and strategies. After certification, it serves as a foundation for marketing and branding efforts.

3.3.2 Specifics of business plans during conversion

During the conversion to organic farming, the business plan must be tailored to reflect the challenges of the conversion period. This phase often brings a significant drop in both revenue and operational efficiency – sometimes by several tens of percent. These declines are typically due to a variety of factors, including adjustments in production practices, reduced yields, and increased costs.

As such, the business plan should account for these more difficult operating conditions and the potentially deteriorated economic situation of the farm. One specific challenge during this period is the inability to label products as fully organic. While national laws may allow a designation like "product from the conversion period to organic farming," this label is rarely supported by a recognizable logo or strong consumer awareness.

To address this, the business plan must include strong communication strategies aimed at informing consumers about the farm's organic conversion. At the same time, it should incorporate financial reserves or buffers to help the business cope with the economic strain of the conversion period.

Ideally, the business plan should be divided into three phases, each reflecting the stage of conversion the farm is in:

- Pre-Conversion Phase: This phase focuses on preparation, including building financial reserves and gradually implementing changes in agricultural practices. The goal is to reduce the shock of the full conversion once it begins.
- Conversion Period: This second phase begins once the farm enters the official conversion period. It involves adapting management systems and continuing to refine production methods to align with organic standards.
- Post-Conversion Phase: This final phase begins after the successful completion of the conversion. At this point, the farm is officially operating under organic farming standards and can market its products accordingly.

Marketing efforts should align with each of these phases, clearly communicating progress and milestones to customers. This helps create a sense of involvement and support, encouraging consumers to stand by their local farmers during the conversion and beyond.

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3.4 Marketing

3.4.1 Basics of marketing (including sales and distribution)

Marketing strategies are an important tool for increasing awareness of your farm, boosting customer trust, and building your brand in the long term. The aim is to reach your target market, set prices effectively, choose appropriate distribution channels and ensure logistics that support the quality and freshness of your organic products.

Target market identification

The target market represents the group of customers that your marketing activities and sales strategies will be most focused on. An important part of this step is the analysis of customer needs, preferences and purchasing behaviour. This analysis will help you better understand what type of products; presentation method and price level will be most suitable for each segment.
Key segments for organic products include:

- Households: Consumers who prefer healthy, fresh and organic products will especially appreciate the wide range and easy accessibility. These customers are often looking for products with a clear origin and want to be sure that they are buying from a trusted source.
- Restaurants and catering establishments: Owners and chefs are looking for quality, fresh ingredients with guaranteed organic origin in order to offer their guests a more valuable gastronomic experience. A stable and reliable supply of quality organic products is crucial for them.
- Specialty stores and farmers' markets: These points of sale attract consumers actively seeking organic certification, who are often willing to pay extra for quality, provenance, and sustainability. Here you can highlight the story of your farm as well as direct contact with the buyer.
- Institutions (schools, hospitals): These organizations may prefer organic products for their positive health effects and the opportunity to offer students and patients quality foods that promote healthier lifestyles.

Building brand and trust

Building a brand is a long-term process that involves consistently creating and presenting your farm so that customers associate positive values, environmental responsibility and high quality. To gain customer trust, it is necessary to:

- Transparency: Openly share information about the origin of raw materials, processing methods, environmental certifications and ethical standards. Open communication builds trust and strengthens customer loyalty.

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- Visualisation: Packaging and labelling should emphasise the environmental friendliness of your products, e.g. by using natural and recyclable materials. Thoughtful design helps customers remember your brand better.
- Story: Tell the story of the creation of your farm, its values and its contribution to society and the environment. Emotionally charged content helps inspire customers and motivate them to buy from a trustworthy and meaningful source.

Pricing strategy

Pricing is key to success in the organic market. The price should reflect the added value of your products, but at the same time remain attractive to consumers.

- Competitive price analysis: Find out what prices similar farms or stores offer to better set competitive and reasonable prices.
- Setting premium prices: If your organic products provide higher quality, freshness or organic value, you can afford to slightly increase the price level. This will emphasize that the customer is getting something unique.
- Community Models (Community-Supported Agriculture – CSA): Offer subscriptions to fresh produce that benefit from stable income for the farm and the ability to provide customers with discounts for long-term collaborations. Such a model strengthens community ties and creates a sense of belonging.

Sales and distribution

Distribution channels

Effective distribution is essential to ensure that your products reach your end customers in perfect quality and on time. The right mix of distribution channels can help you reach a diverse audience and maximise sales.

1) Farmers' markets: Direct contact with the end consumer allows for personal communication, building trust and presenting your farm's values. Here you can respond to feedback directly from customers.
2) Community Supported Agriculture): With this model, customers subscribe to regular deliveries of fresh produce, which creates a stable income and strengthens the relationship with consumers who feel part of your farm.
3) Online sales: Use online stores, social media, and e-commerce platforms to reach customers regardless of their geographic location. Modern technologies make it easier to establish contact with new groups of customers.
4) Retail partners: Work with organic stores and select supermarkets for a wide reach. This will spread your brand awareness and reach more people with your products.

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Logistics

Logistics are essential to maintain the quality and freshness of organic products. Efficient logistics solutions reduce costs and improve customer satisfaction.

- Cold Chain: Ensure the right conditions to maintain optimal temperature and freshness of products throughout transportation and storage.
- Delivery optimization: Plan routes and schedules to minimize your environmental footprint, shorten delivery times, and save costs.
- Collaboration: Create shared distribution models with other farmers to reduce transportation costs, increase efficiency, and facilitate access to wider market segments.

Marketing strategies are a comprehensive set of procedures that help farmers target their customers, build a strong and trustworthy brand, set optimal prices and choose effective distribution channels. Understanding the needs of each segment, strengthening customer trust through transparency and storytelling, and ensuring a smooth flow of goods with an emphasis on logistics and sustainability are key. In this way, farmers will achieve long-term success, increase the resilience of their business to market fluctuations and contribute to positive change in society. Successful marketing strategies for organic products are built on the correct identification of the target market, thoughtful brand building, optimal pricing, efficient distribution and carefully managed logistics. Together, these factors create a solid foundation for the growth, stability and reputation of the farm, which will be perceived as a reliable and sustainable source of quality organic products in the long term.

3.4.2 Specificities of organic market

Organic products usually cannot compete with conventional production with the most common tool - i.e. price, so the marketing of organic production and the market with organic products as such have certain specifics. The fact that our product will not only compete with equivalent products from the eco-farmers' circle, but also with similar conventional production (overwhelmingly cheaper) must be taken into account by the farmer from the very beginning when analysing and compiling a marketing plan.

The market for organic products, including products from the conversion period to organic farming, also has other specifics. A customer considering the purchase of organic products usually considers other added values in addition to the product itself, its composition and price, and the following interconnected areas enter into his decision-making:

- Ethical demands – In the marketing of organic production, we should not resort to practices that are ethically on the edge. The customer has a higher sensitivity to the verifiability and veracity of the information provided, misleading information should not be used, and the information should not be manipulated to improve the image of the product.

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- Sustainability – Bioproduction plays a big role in marketing, so it is optimal to pay attention to sustainable practices beyond the product itself (e.g. packaging method, packaging materials, distribution methods, recycling...)
- Comprehensive approach – Marketing of organic production can increasingly rely on a holistic approach; it can be assumed that customers will be able to perceive the context and evaluate its impacts and impacts related to its sale in addition to the product itself. These include, for example, interconnected social criteria, regional production, etc.
- Added values of a non-material nature – As part of the marketing of organic production, we communicate not only the product itself and its parameters, but also the positive externalities arising from the purchase of this product. Within a comprehensive approach, a customer who prefers organic products perceives as an added value not only the quality of the product itself, but also the intangible values that the origin of the product in organic farming brings and which should be emphasized in marketing.

New customers who have not yet purchased organic products are usually acquired from the ranks of consumers of the conventional product. In the first phase, it is therefore necessary to motivate the customer to switch from cheaper conventional production to organic products, but at the same time to attract them to their organic product brand. The sub-strategies differ for individual products, but in the first phase it is necessary to sufficiently emphasize the added value of organic products and to provide the customer with a sufficient amount of clearly formulated information that should motivate him to prefer an organic product to a conventional product. Here it is possible to take advantage of the good interconnection of organic production with other trends, such as healthy nutrition, vegetarianism or veganism, preference for regional production, fair trade, etc.

This also applies to the phase of conversion to organic farming, when we do not yet have organic certification, but in many countries, it is possible to obtain the label "product from the conversion period to organic farming" and the production and practices themselves already comply with the standards of certified organic farming.

The specificity of organic production is therefore taken into account throughout the entire marketing process, starting with the selection of the target group and the targeting of advertising and the modification of the appearance of the final product. In addition to focusing on the added value of organic production, it is possible to focus on linking the actual sale of the product with other services that the organic farmer develops within the framework of non-production activities. The use and acquisition of some of these services should also lead the customer to buy an organic product. In general, a large part of success in this respect lies in being well informed about the customer, so it is possible to link some services with customer education, who then gains additional motivation to buy an organic product thanks to the newly acquired information. An example is the provision of information on animal welfare or ecological principles of crop cultivation, which the customer receives as part of agritourism. A strong motivating factor that can be used in the marketing of organic production is also the principle of regionality, which is strengthened in combination with organic production.

Within the marketing of organic production, it is necessary to operate more with customer education, often in directions that only marginally affect the product itself. It is true that a customer who has decided to buy organic products on the basis of a comprehensive set of information is more loyal than a consumer who has come to organic production once and without a sufficient knowledge base, and customer loyalty to our product should be one of the main marketing goals.

3.4.3 Options of marketing during the conversion (including marketing plan structure)

The conversion to organic farming brings a number of challenges, but also opportunities to develop a strong marketing strategy that will help gain customer trust and ensure stable income. Marketing during conversion is a specific phase when products are not yet fully certified as organic, but the farmer is already investing in sustainable practices.

The goal of marketing during this period is to communicate the farm's values and commitment to sustainability to customers, even though formal certification is still underway. To do this, you can use:

- Transparent communication about the ongoing conversion and the benefits of green practices for health and the environment.
- Brand building focused on sustainable values and a direct link between producer and consumer.
- Market segmentation to reach customers who value certification processes.

Marketing plan structure

A marketing strategy is a crucial document that describes how a company plans to sell and market its goods and services in order to meet established goals. This strategy becomes more crucial when switching to organic farming because it impacts not just output but also profitability, market positioning, and perceptions among customers. Building a strong brand identity and customer while navigating the conversion's obstacles is made easier for organic farmers with a well-thought-out marketing strategy. The format of a thorough marketing plan during this significant conversion is explained in the parts that follow.

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1) Summary

This section should provide a concise overview of the farm's history, its vision for the future, and the specific goals driving the conversion to organic farming. It should briefly explain the farm's mission, the reasons for pursuing organic farming and outline key objectives like gaining organic certification, entering new markets, or increasing consumer trust. This summary sets the tone and context for the entire plan.

2) Market analysis

In this section, the farm identifies its target market—typically health-conscious consumers, environmentally aware individuals, or buyers seeking organic-certified goods. It should also assess market trends and consumer preferences related to organic products. A competitive analysis helps determine how other farms or brands position their organic products, pricing strategies, and promotional methods. Understanding this landscape enables the farm to identify gaps, opportunities, and threats in the organic market, and to tailor its approach accordingly.

3) Marketing strategy

The marketing strategy outlines how the farm will reach its audience and communicate its value proposition. Goals may include increasing brand recognition, educating customers about the conversion process, and building consumer loyalty. The strategy should specify the communication channels to be used—such as social media, farmers' markets, newsletters, community events, or partnerships with local stores. Messaging must be transparent and authentic, emphasizing the farm's organic journey, the health and environmental benefits, and what sets the farm apart.

4) Operation and distribution

This component details how the farm will deliver its products to consumers. It includes plans for distributing produce through local markets, CSA (Community Supported Agriculture) programs, online platforms, or retail partners. Operationally, it outlines the logistics of harvesting, packaging, and transporting goods in compliance with organic standards. It may also discuss labelling and how to handle the "conversion" period labelling, when products cannot yet be marketed as fully organic.

5) Financial plan

The financial plan estimates the cost of implementing marketing activities during the conversion and projects potential returns. It should include a breakdown of expenses related to branding, certification, promotional campaigns, packaging redesign, distribution, and consumer education efforts. At the same time, it forecasts expected revenue from organic produce, considering both short-term (during conversion) and long-term gains once full certification is achieved. This section helps ensure the plan is financially viable and sustainable.

6) Evaluation and measurement of results

To ensure the plan remains effective, this section defines how progress will be monitored and assessed. It identifies Key Performance Indicators (KPIs) such as website traffic, social media engagement, sales volume, customer retention, and feedback. The plan should include timelines for reviewing results and mechanisms for making data-driven adjustments. This ensures continuous improvement and alignment with market needs as the farm completes its conversion to organic certification.

The following diagram shows the structure of a typical marketing plan:

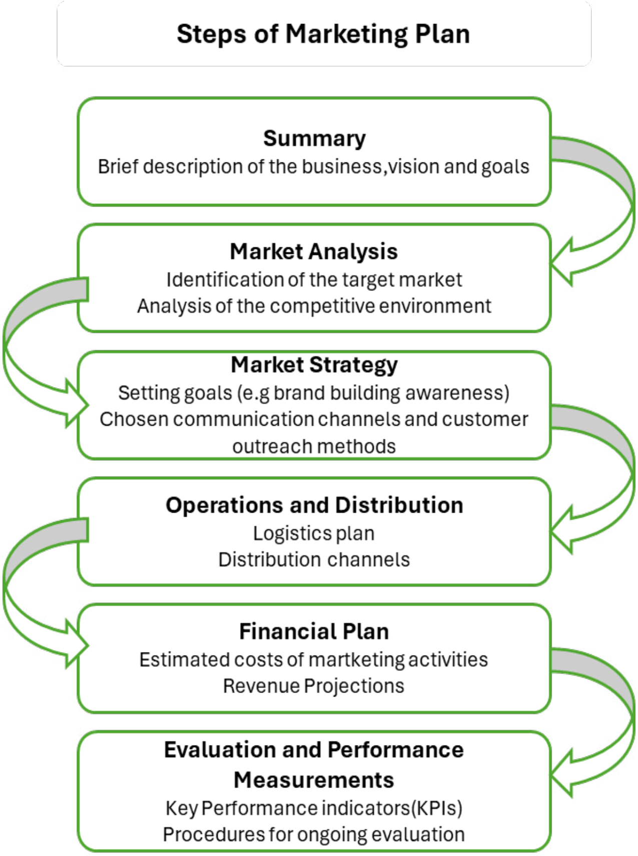

Figure 3.2. *Steps of marketing plan. Source: Authors own compilation*

3.5 Diversification

3.5.1 Need of diversification

Diversification is a key strategy in agriculture that helps farmers reduce risks, improve income stability, and maximize resource utilization. Dependence on one type of crop or farm can be risky, especially in times of climate change, fluctuations in market prices or changes in consumer demand. Diversification thus offers a solution for a more sustainable and flexible farm operation in the long term.

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Reasons for diversification

1) **Risk reduction**

Nature and markets are unpredictable. Farmers who rely on a single crop or customer segment face a higher risk of losses in the event of adverse conditions such as extreme weather, pests, crop diseases or price fluctuations. Diversifying production can spread these risks and secure income even in difficult times.

2) **Increasing economic stability**

A diversified farm has the opportunity to earn income from a variety of sources, which can offset seasonal or market fluctuations. For example, a combination of vegetable growing, livestock farming, and agritourism can provide a farm with a more stable income throughout the year.

3) **Optimize resource use**

Diversification allows for a more efficient use of resources such as land, water, labour, and capital. Diverse production can improve a farm's biodiversity, promote soil health, and reduce the need for external inputs such as chemical fertilisers or pesticides.

4) **Responding to changes in demand**

Consumer preferences are changing rapidly, and farms that diversify their production are more flexible and able to respond to new trends, such as the demand for organic products, local food or specialties.

3.5.2 Diversification options

Diversification plays an important role both in the management itself and in sales and marketing. The right level of diversification increases stability and sustainability, but at the same time does not entail unnecessary costs and organisational and labour burdens. We can talk about diversification on two levels, which are interconnected:

- Diversification of production – Usually at the level of the farm/enterprise, it is the choice of crops grown, animals bred, focus of processing capacities, etc.
- Product diversification – At the level of a commodity or a specific product, these are steps aimed at expanding the product portfolio without the need for further diversification of production.

Diversification of production is usually influenced by hindering forces in the form of the need for additional inputs and costs, both material and non-material. Although it is true that stability increases with increasing diversification, it is necessary to realize that additional costs for mechanization, logistics capacities (storage, transport), processing, and even in the form of additional labor costs may arise in parallel At the same time, as diversification increases, the organizational demands are increasing and it is important to set an optimal level of diversity where processes are as manageable as possible:

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- Time (including coordination of activities)
- No additional costs (new machines, technologies, buildings...)
- Economically efficient (the benefit of further diversification exceeds the sum of all costs incurred)
- Knowledge (diversification will not bring excessive effort to acquire new procedures and knowledge)

To a large extent, this also applies to product diversification, which also has its own specifics. Product diversification allows us to create a wider portfolio of products on one cornerstone, both by differentiating the basic product itself and by offering accessories or services related to it.

As part of product diversification, it is possible to start with the basic raw material for its production itself and consider what other products can be made from it using the currently available technological possibilities. Here it is also advisable to work with zero waste philosophy, where we process all parts/components of the basic raw material if possible. For example, in addition to cheese, we can also make yoghurts, cream, sourdough, etc., or sell it directly. However, a more advanced product can also be diversified. For example, in the case of the already mentioned cheeses, we can let them mature for different periods of time and thus create several variants with different properties.

A classic method of product diversification is to choose the size of the package, which will again allow you to create a whole range of packages, from a small sample to a family package weighing several kilograms. In addition to the size (volume) of the package, it is also possible to work with the form of packaging. This includes not only the treatment of the packaging itself, its printing, etc., but also the use of various packaging materials, while it is not only about the presentation of sustainability by using recyclable and natural materials, but also about the possibility of communicating and diversifying through the form of packaging.

If we want to present the product as more luxurious, it is also necessary to choose an appropriate packaging method, such as using glass instead of plastic packaging, or adding additional and aesthetically higher quality packaging (e.g. putting the bottle in a wooden box, etc.). For more common products, on the other hand, we choose packaging that only minimally increases the price of the end product (e.g. degradable plastics, paper, etc.) and at the same time does not visually present the product as premium.

Another way to diversify a product is to modify it with the help of additives (e.g. herbs, salts, sweeteners, spices, etc.), which can be used to change, for example, the colour or smell of the product, while various colour modifications in particular can be well used when targeting different target groups of customers.

A very useful marketing option for product diversification is also the possibility of changing the shape. Here we can modify the product to better serve a specific purpose (e.g. cooking) or modify the shape to increase the attractiveness of the product (e.g. forming into figures).

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Figure 3.3. *Organic product diversification examples. Source: Apolka Ujj.*

In this way, additional added value can be created for the product and at the same time differentiated from competing products.
Even in product diversification, it is necessary to evaluate the optimal scale ratio, both in terms of the number of newly created products and in terms of economic efficiency.

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Further resources

Books:

DiGiacomo, G., King, R., Nordquist, D. (2003). Building a Sustainable Business: A Guide to Developing a Business Plan for Farms and Rural Businesses. Sustainable Agriculture Research and Education (SARE) College Park, MD, pp. 276, https://misa.umn.edu/publications/building-sustainable-business
The guide helps farmers to develop their holistic business plan rooted in personal, community, economic and environmental values. With a business plan in hand, today's farmers and rural entrepreneurs will be able to take that first step toward the creation of a successful and sustainable business.

Kahan, D. (2008). Economics for farm management extension. Food and Agriculture Organization of the United Nations, Rome. https://www.fao.org/uploads/media/2-EconomicsInternLores.pdf
The book introduces farmers to some of the concepts and principles of economics that are relevant to smallholder farming – particularly market-oriented farming. They also learn about the application of these economic concepts to the day-to-day farming activities and can look at some of the critical areas of decision-making.

Videos:

Planning Your Organic Farm for Profit Webinar:
https://www.youtube.com/watch?v=8muBj6QhmxE
A farmer from East Montpelier, Vermont provides a step-by-step guide to achieve a healthy bottom line, assessing markets and developing a production plan, a roadmap of how to grow what you plan to sell. He also shares techniques for discovering your profit centers.

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4. Communication in change processes and advocating for organic farming

Useful communicative skills for organic farmers

Opening

"Leadership is first and foremost a communicative task." – Thomas Lauer

"The single biggest problem in communication is the illusion that it has taken place."
– George Bernard Shaw

"Problem talk causes problems; solution talk produces solutions." – Steve de Shazer

This material aims to equip learners with useful knowledge and skills that enable them to solve difficult interpersonal challenges that might occur during a conversion process. In the first part, it delves into the field of change management to explore what can be applied to communication in a conversion process. The second part deep dives into the technique of storytelling which can be a useful asset in advocating for organic farming.

Key words

[CHANGE MANAGEMENT] [CHANGE COMMUNICATION] [DEALING WITH RESISTANCE] [TARGET GROUP ANALYSES] [STORYTELLING] [PROS AND CONS] [STRONG ARGUMENTS]

4.1 Communication in change processes

Despite the benefits, going organic is a pretty substantial change process for a business. It is not just the farming itself that will change. Different products and suppliers are needed, a new marketing strategy must be developed, and new customers must be found. Then there is the issue of regulation, administration and controls. New contacts, new schedules, new structures, coupled with inevitable moments of uncertainty and imperfection…

A conversion to organic can be challenging for the person managing this process – but also for everyone else involved. Employees in particular may not react with enthusiasm, but so may establish business relationships, family members and regular customers. Change can be difficult.

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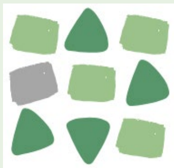
4.1.1 Change processes and change management

Change management means "achieving an optimal design of the path from start to goal". In the past, management theory focused mainly on strategy development. But practice has shown: The real challenge usually lies in implementing the strategy. This is because implementing change is not a mechanical process. There is one crucial factor that is difficult to predict: people. People, who have needs, ideas, experiences, emotions, personalities and complex – often invisible – social structures (Lauer, 2021).

Table 4.1 gives an overview on the phases of a change process according to Lewins Three-Step Model (Lewin, 1947), using the example of a conversion to organic farming.

Table 4. 1. *Adapted version of Kurt Lewins Three-Step Model of Change. (Lewin, 1947) The accustomed structures of an organisation first must "unfreeze" before the change can happen. Then new-built structures must "refreeze" for the change to be sustainable. Source: Lea Doobe.*

		
1. Unfreeze	**2. Change**	**3. Refreeze**
Create a sense of urgency by showing why a conversion is necessary and what benefits it will bring. Develop a motivating vision for the future organic farm. Create a conversion plan and make the necessary steps transparent.	This phase involves implementing the conversion plan. Empowerment of employees is essential, as is listening to their concerns and resistance. Many new experiences are made. Celebrate initial successes.	Organic practices become the new normal. Employees are well equipped to deal with their responsibilities. Encourage openness to continuous learning and curiosity to improve organic practices. Celebrate success.

4.1.2 The human factor: Resistance to change

Looking at organisational change processes around the world, it seems that about 75 % of them fail for the same reason which is employee resistance (Lauer, 2021). But on closer inspection, the resistance itself may not be the issue. In fact, resistance to change is very normal and human: it serves as a protective mechanism for the individual, while also being a useful indicator of blind spots for initiators and managers (Lauer, 2021).

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In her TED Talk, Dr. Taylor Harrel shines a different light of the factor of resistance by saying: "*People don't resist change. They resist loss.*" (Harrell, 2022)

Organisational change can mean the loss of crucial factors for stakeholders, such as

- **Loss of security:** Due to the loss of predictability, stability and routines that are important for psychological safety, perhaps even loss of job security.
- **Loss of freedom:** Especially if the change feels forced, there may be a perceived loss of choice and autonomy.
- **Loss of status:** Loss of power and influence, e.g. as the value of previous work experience diminishes
- **Loss of belonging:** Change can create distance from previously important relationships or groups
- **Loss of fairness:** Change can upset the social structure and responsibilities within an organisation, which may be perceived as unfair.

In conclusion, resistance to change (and to the losses that come with it) is a normal and very human reaction. The more relevant issue is the way it is handled (Lauer, 2021). Resistance – as well as the mere toleration of the change process – needs to be noticed, cared for and, ideally, transformed into support (Endrejat, 2021).

4.1.3 The handling: What change communication needs

Leadership is about communication. When leading a change process, understanding what, how, when and to whom you communicate is very useful. The goals of sound change communication are transparency and orientation for all stakeholders involved, as well as the resolution of conflicts and resistance (Lauer, 2021).

Some overall beneficial factors for an effective change communication are:

- **Target group orientation** (in content and style)
- **Personal conversation** (enables questions and explanation)
- **Timely and simultaneous communication** (to avoid rumours and to show appreciation towards all)
- **The offering of participation options**
- **Transparency and honesty.**

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If we look at the phases of a change process there are different communication needs depending on whether you are in the early stages of change or already implementing it (Lauer, 2021). In the initial phase of conversion (unfreeze) the overall goal is to *create readiness for change.*

Phase: Unfreeze
Aim: Create readiness for change
Topics:

1) **Background & urgency**
   Why is a conversion necessary/important? What are the wins? What are the dangers of not converting?
   → *Explain the reasons.*

2) **Vision, goals & strategy**
   What is the vision? Why is conversion to organic farming the right strategy?
   → *Convey a sense of purpose, communicate target group specific & use pictorial analogies.*

3) **Realistic outlook**
   What transformations and difficulties are to be expected? Who will face which problems?
   → *Acknowledge the challenge the conversion might impose.*

4) **Existing capabilities & resources**
   What existing competences and resources will help the process?
   → *Show trust, give options for participation and support, mention what stays the same.*

5) **Identification & mitigation of resistance**
   Who is not enthusiastic about the conversion? Why? What losses do they resist to?
   → *Listen and find out what is needed to transform resistance into support.*

Once the change process (in this case the conversion process) is running, change communication needs to switch to different aspects. The main goals now are *to maintain motivation and anchor the new approaches*.

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Phase: Change & Refreeze
Aim: Maintain motivation, anchor new approaches
Topics:

1) **Progress**
   Where are we? What struggles did we encounter? What solutions were found? What is still to be solved?
   → *Keep everybody concerned in the loop of what is going on.*

2) **Positive developments**
   What struggles were recognised and overcome? Which new practices are already established?
   → *Highlight proven and newly acquired skills and routines.*

3) **Successes & wins**
   What is going really well? Where and how is participation happening?
   → *Celebrate success.*

4) **Appreciation**
   What are you grateful for?
   → *Show acknowledgement and gratitude for support and also for overcoming resistance and obstacles.*

And again, Harrell (2022) offers some extended advice on what change communication needs:

- Consider the wisdom in resistance (In case of conversion: Are there risks you have not yet considered?)
- Name the losses (Where will you and others face hard times during the conversion process?)
- Shine a light on what stays the same (What will not change in the way the farm works?)
- Turn towards possibility. (What is your vision for the farm?)

4.1.4 Dealing with resistance

Resistance can be demonstrated openly, e.g. through complaints, opposition or openly upset behaviour, or it can be more subtle and hidden, e.g. through rumours, lack of commitment and even plain silence. Once it is understood that resistance to change (or the losses associated with it) is a very human and self-protective reaction, this empathy makes it easier to deal with resistance in an analytical and constructive way. In any case, when dealing with resistance, communication is key.

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For this, Lauer (2021) suggests three sets of questions:

First set: Needs

- What is particularly important for those affected?
- What interests, needs or concerns do they have?

Second set: Fears

- What could happen if you proceed as planned?
- What, in the view of those affected, should be prevented if possible?

Third set: Adjustments

- What alternatives do those affected see for themselves?
- What do they think should be done to solve the problem to the satisfaction of all concerned?

Endrejat (2021) offers a method called *Motivational Interviewing (MI)* which works by finding and reinforcing the other person's own motives for change as described in **table 4.2**.

Table 4.2. *Communication methods for working through resistance with employees. Source: Adapted from Endrejat.*

Motivational interviewing methods	General tips for difficult conversations
• Find and reinforce the other person's own motives for change • Use open questions that focus on finding solutions • Honour the willingness to collaborate • Reflect together on what has been said • Summarise before moving to the next steps • Avoid the "correction reflex" (overriding the other person with demonstration of power or threats)	• Listen more, talk less • Acknowledge, give approval and ask for the other persons input • Signal attention by using "micro-encouragements" (hm, yes, uh-huh) • Put yourself in their shoes • Talk about the 'we' instead of 'you' and 'I'

4.1.5 Individually tailored: Target group specific communication

The most effective communication is a targeted communication: carefully tailored to each stakeholder, e.g. employees, family members, customers, or suppliers. To do this, there are two key strategies: first, addressing the target group's interests and second, adopting the respective language style and communication channel (Lauer, 2021). Change – as well as not changing – involves pros and cons for every party and knowing these can serve as a starting

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point for a targeted communication. As an example, **table 4.3** shows a collection of possible pros and cons of a conversion for the target group "employees".

Table 4.3. *Possible pros and cons of conversion to organic farming for employees. Source: Lea Doobe.*

Employees	Pros	Cons
Change	+ Active contribution to environmental and climate protection, animal welfare and human health + A clear conscience, integrity with values + Increased sense of purpose at work + Learning opportunities, new knowledge and experience, better qualification + Increased sense of togetherness, social integration after a joint change process + Opportunity for a future-proof workplace + Appreciation from management and customers + A reason to be proud of yourself + New momentum and energy from a positive challenge + Possibly: prospect of better pay after the successful changeover	- Loss of cherished routines, loss of identity as conventional farmer, loss of tradition - Devaluation of previous work - Loss of previous business relationships - The challenge to learn a lot and to handle new tasks - Moments of frustration, insecurities and overload - Risks of temporary economic concern, the experience of anxiety - Possibly: Being confronted with own scepticism or rejection of organic farming -The challenge of explaining the change to family and friends that might be sceptical or rejective towards organic
No change	+ Comfortable + Own identity and expertise remain untouched + Cherished Routines and business relationships are kept + The safety of the known + No resources need to be mobilised for a challenging change process + Protection from overwhelming situations, anxiety etc.	- Missing out on an opportunity for new experiences, better qualifications, new knowledge and a revitalising team dynamic - Economic uncertainty of conventional farming operations - Possibly: Missing out of better economic chances - Having to endure the cognitive dissonance that one's own work is less beneficial to environmental and climate protection, animal welfare and human health - Possibly: Boredom

Usually, it will not be possible to address every item on the list. It is therefore useful to prioritise when considering which issues to address. What are the likely sticking points? And how can they be addressed from the outset? Once the most important factors for an audience have been identified and considered, they can be included in communicating the reasons and objectives, developing the vision and planning the process – and thus, help the change communication to run smoothly.

4.2 Advocating for organic farming

When discussing conversion, most people will have an opinion about such a venture. Being able to advocate for organic farming thus is useful for every professional in the field.

4.2.1 By conviction: Organic farming has benefits

Going organic is not without challenge so there must be good reasons to do it. And as long as the technical part seems feasible – the reasons for farmers to convert usually are either economic or value-based (Latruffe et al., 2013). The ETICOF project conducted a farmer's survey to analyse drivers and obstacles for conversion in Europe. This survey underlined an impression which many professionals in this area share: Being convinced of organic farming is a key factor for conversion interest. Or like one farmer from our survey put it: *„You really have to want it, otherwise you wouldn't dare it."*

It is not so difficult to research on pro and contra arguments for organic farming. An incomplete list might look as follows:

Table 4.4. *An incomplete list of arguments for and against organic farming. Source: own.*

Pro	Contra
+ **Environmental Sustainability**: Organic farming practices promote soil health, biodiversity, and water conservation, reducing the overall environmental footprint compared to conventional methods.	**- Higher Production Costs**: Organic farming typically incurs higher costs due to more labour-intensive practices and slightly lower yields. These costs mean higher prices for consumers, which can limit market accessibility especially during economic downturns.
+ **Increased Resilience**: Organic farming practices enhance resilience to climate change by promoting biodiversity and soil health. Techniques such as crop rotation, cover cropping, and reduced chemical inputs improve soil structure and fertility, making farms better equipped to withstand extreme weather events, droughts, and pests.	- **Lower Yields**: Crop yields in organic farming can be lower than in conventional farming, sometimes by as much as 20%.
+ **Healthier Produce**: Organic foods are often discussed as healthier due to lower pesticide residues and potentially higher nutrient content.	- **Labor Intensity**: Organic farming requires more manual labour for tasks such as weeding and pest control, increasing operational complexity and costs. Farmers may need to hire more workers or invest more time in managing their farms.
+ **Market Demand and Profitability**: The demand for high quality products often allows organic farmers to charge higher prices. This can lead to increased profitability for those who successfully manage organic operations, despite higher production costs.	- **Certification Challenges**: Obtaining organic certification can be a lengthy and costly process, deterring some farmers from pursuing organic methods. During the conversion period, farmers may face financial shortfalls without already being allowed to sell their products as organic.
+ **Reduced Chemical Use**: Organic farming does without the use of synthetic pesticides and fertilisers, which can have harmful effects on human health and the environment.	- **Crop Vulnerability**: Organic farms may be more susceptible to crop failures from pests or diseases due to the avoidance of synthetic chemicals. This unpredictability can lead to unprofitable years if crops fail, or yields are insufficient.
+ **Improved Animal Welfare:** Organic farming enhances animal welfare by allowing animals to engage in natural behaviours, while also limiting antibiotic use to only necessary treatments. This approach promotes both the physical and emotional well-being of animals, contributing to a healthier and more humane farming system.	- **Increased Land Use Requirements**: Converting to organic farming on a large scale may require more land to produce the same amount of food as conventional farming. This increased need in land use could competes with other important societal needs, like infrastructure, housing and nature conservation.

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The thing is, simply hearing a factual argument – as convincing or true it might be – usually is not enough to make or break a conviction. So, how are we to be convinced then?

4.2.2 The power of Storytelling

The authors' story: Why I think that storytelling is a suitable method for advocating for organic farming

In 2018, I had the privilege to be part of a trainee-program of the organic food sector in Germany. In our training, we had a lesson on how to advocate for organic farming. And this lesson was quite an exciting event, because the lecturer was the head of one of the most relevant organic associations in Germany – and for us young trainees it was a big honour to be taught by such an "important" person.

So, the day came, our lecturer arrived from a big, important international meeting he attended before and chatted cheerily with our trainers. We sat in a circle of chairs, shyly waiting for a lecture to start and a list of bullet points to appear on our flip chart.

But instead, our lecturer told us: "Ok, so let's play a game. You guys will challenge me with critical questions and counterarguments on organic farming, and I will answer to them." And we played. First argument, second, then a third. And little by little, we came to notice, that he rarely ever used hard facts and data to out-argument us. Quite the difference. Rather, he would start talking about an old farmer he talked to once, a young boy he knew, story after story. But the thing was: By doing so, he basically swapped us off our feet. We left this lesson liking him a lot, being even more convinced that organic farming is great and the only reasonable way to do agriculture than we were before and simply in a good mood.

It was some years later, when I started to do public relations for an NGO that I learned about a communication technique named "storytelling" …

At their core, humans are emotional and social creatures who do not make decisions based on rationality (Adamczyk, 2018). The human brain has evolved in a certain way. If we travel back in time to the origins of human existence, we will find a technique that has always been used to share knowledge and that our brains are programmed to respond to in a positive way: The telling of stories (Cortes Arevalo et al., 2023). And this programming can be used to educate and advocate for organic farming.

Storytelling as a communication strategy means using stories in a targeted, conscious and skilful way to make content easier to understand, to support the audience's learning, to spread ideas, and to encourage intellectual participation (Frenzel et al., 2014). The Ted Talk The magical science of storytelling by David JP Phillips (TED, 2017) educates about the neurobiology of storytelling: In situations like e.g. an argument or a debate, stress hormones like cortisol and adrenalin are elevated, which results in more intolerant, irritable, uncreative and critical reactions. At the same time, engaging or being engaged in a story induces a different kind of hormone release (like dopamine, oxytocin and serotonin), which results in elevated focus, memory, motivation, empathy and creativity.

This means, having information and agency transported in the vehicle of a story will most likely help the audience focus, understand, memorize and engage more openly with the subject. Or, as Cortes Arevalo et al. put it: "*Stories help overcome the perceived abstract, often distant nature of knowledge, allowing people with different backgrounds to relate to each other's identity and understanding of the world*." (Cortes Arevalo et al., 2023).

4.2.3 Good stories for advocacy

There is a difference between a collection of facts told from an impersonal perspective and a story. "*A story typically refers to a collection of events with a beginning, a middle, and an end, where something happens and changes the protagonist.*" (Cortes Arevalo et al., 2023). Often, in classes on storytelling, complex strategies for building stories are taught, like e.g. the twelve step "*heroes' journey*" which was often base to extremely popular stories like e.g. *Lord of the Rings* or *Star Wars*.

But if the goal is to advocate for a specific topic or agenda, there is often only an about two-minute slot to present an idea or answer a question. This is why storytelling expert Philipp Humm (The Storytelling Structure That I Use For 99% Of My Stories) offers a simplified story structure that serves for exactly those kind of purposes: the "*CART*"-Method (Humm, 2024).

- **Context** | Who? When? Where? What? Give the necessary but keep it short.
- **Adversity** | What is the challenge or struggle? How does the character feel?
- **Resolution** | How does the character respond? What actions do they take? What happens next? How does it touch or change the character?
- **Takeaway** | What did you learn from this experience? What is the point of the story?

Next to those aspects, to make the story more captivating, there are numerous techniques to add suspense, emotional involvement or humour. Rather simple to adept are:

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- Giving the audience some **time to raise questions** in their head to create suspense
- Quoting the **characters' thoughts**, raw and unfiltered to create connection
- Share the **dialogue in direct speech.**

Finally, to avoid exhausting your audience's patience, stick to the points that are relevant to your story.

4.2.4 In practice: How to use storytelling for advocating for organic farming

Using storytelling intentionally might feel unfamiliar a first, but authors on this issue stress that it is not something we have to learn. It is more something we have to rediscover, to dig out (Fuchs, 2018). To find suitable stories, it is recommended to search for experiences from life that have parallels to the current topic (Adamczyk, 2018).

How to use storytelling for advocating for organic farming:

1) Pick a strong, factual argument that ideally matters to the person you are talking to.
2) Find a personal story from your own biography, which can transport and accompany this argument, explain contexts and create meaning, e.g.
   a. When and why did you learn about this and why did it matter to you?
   b. Do you know any person that has shared experiences with you which undermine this argument?
   c. What triggers you about this topic and why?
3) Taylor the story in length and wording, so that it suits the situation and audience.

Example argument: Organic farming is free of synthetic pesticides and therefore healthier for biodiversity and human health.

The authors' story: *For me, it was always an important argument that organic farming works without synthetic plant protection. When I was a child – and this was in the nineties – my dad had a one-man, organic vegetable production. This was still at the beginning of the organic movement, so he had to justify his practice a lot. People he was selling his produce to did not understand, that his cabbage was 20 pennies more than at the neighbours' market stall. Because it was not easy to earn a living like this, my parents used to discuss a lot at home, sometimes even questioning if growing food organically really was the way to go.*

So little 8-year-old me got curious: "What is this organic, you are talking about? What does it mean?" I asked them. And my dad explained to me one issue which was an important and challenging factor for him: "I don't want to use pesticides." He spoke. I asked him: "What are pesticides?" and he explained to me that in "normal" agriculture, it is very common to use poison to kill weeds, bugs and fungi and that he does not want to do this. "But isn't this dangerous?" I remember me saying. "Using poison on a field? I mean, there are so many animals, and there is the farmer, and maybe sometimes children playing...?"

Using toxins to kill bugs felt really wrong to me, just not like a very kind thing to do – and to be honest – it still does. So, I was glad my dad wouldn't do it and more importantly, I was relieved that everybody was save in our vegetable garden.

Finally, it is important to be prepared that not every story will have the intended impact and that is OK. It takes time and practice to learn which stories can support an agency meaningfully. The goal of this method is not to manipulate someone into a particular opinion, instead the power is its ability to build bridges across different viewpoints, demographics and disciplines, ideally supporting constructive dialogue and unity among people (Cortes Arevalo et al., 2023).

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Further resources

Articles

How to Communicate Organizational Change: 4 Steps (hbs.edu)
4 Essential Steps to Mastering Change Communication | Staffbase
What Is Active Listening and How Can You Improve This Key Skill? | Coursera
The power of storytelling in advocacy: using real stories to drive change and influence public policy - Laura Mellado 2024
The Storytelling Structure That I Use For 99% Of My Stories

Videos

What leaders need to know about change | Taylor Harrell | TEDxSDSU - YouTube
The Change Curve - YouTube
Overcoming Resistance to Change - Isn't It Obvious? - YouTube
How to Deal with Resistance to Change | Heather Stagl | TEDxGeorgiaStateU - YouTube
Lifting the Burden in Motivational Interviewing - YouTube
How To Tell Better Stories Than 99% Of People (5 Steps) - YouTube
The magical science of storytelling by David JP Phillips

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5. Adaptation to climate change and alternative farming approaches

Teaching material for module 5 “Achieving Sustainability despite Climate Change”

Opening

Climate change in Europe has increased enormously in the last decades and seriously affects the agricultural sector. Winters are shorter, cold spells are rarer, and summers are significantly warmer and drier. Temperatures in Europe rose by around 0.5 °C per decade between 1991 and 2020, more than twice as much as the global average. This makes Europe the continent that has warmed the most (approx. 0.4 °C/decade). The main cause of warming is the increasing greenhouse effect due to increased emissions (Klimaänderungen in Europa – Klimawandel, n.d.).

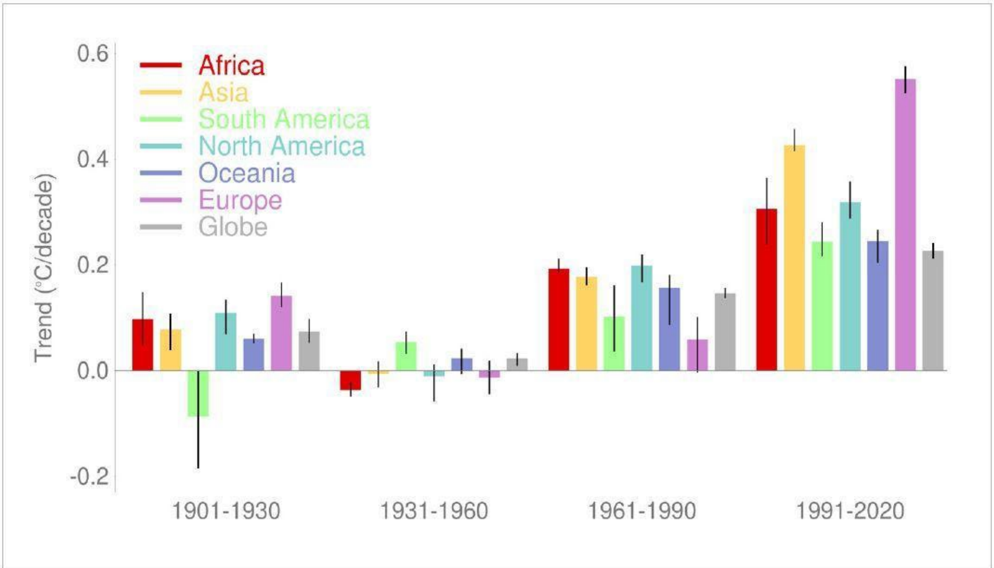

Figure 5.1. *Global climate change from 1901-2020. Source: WMO.*

On the other hand, there is much more heavy rainfall in summer, which does not replenish water supplies. Dried-out soils can hardly absorb any water, valuable topsoil is washed away. The ongoing drought leads to a decline in groundwater and soil water content.
In this way, agriculture is one of the most vulnerable sectors to Climate Change.

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When it comes to climate change, the agricultural sector is both a polluter and a victim.

On the one hand, agriculture is a relevant emitter of greenhouse gases, e.g. through various processes in animal husbandry and crop production. Worldwide, around 20 percent of total emissions are attributed to animal husbandry (Landwirtschaft Trägt Zum Klimawandel Bei, n.d.).

Methane is a much stronger greenhouse gas than CO^2 in terms of its 'warming potential'. Over a 100-year timescale, and without considering climate feedback, one tonne of methane would generate 28 times the amount of warming as one tonne of CO2 (Ritchie et al., 2020). Agriculture, fossil fuel production, and the management of waste are the primary sources of methane emissions.

On the other hand, the increase in extreme weather situations and changes in seasonal weather patterns lead to challenges and lower yields in crop cultivation, but also to losses in livestock farming. There is now a shift in awareness in politics and agricultural practice towards sustainable and more climate-friendly farming and it is recognized that sustainable agriculture should contribute to stable climate conditions and is dependent on them (Bildung, 2021b).

"We believe that limiting global warming to 1.5°C (2.7°F) is still achievable through deep fossil fuel emission cuts and the transformation of our food system based on organic principles and agroecology. Given its potential for reducing carbon emissions, enhancing soil fertility and improving climate resilience, organic agriculture should form the basis of comprehensive policy tools for addressing the future of global nutrition and addressing climate change."

IFOAM (https://www.ifoam.bio/our-work/what/climate-change)

How is organic farming engaging in climate change adaptation? What effects and challenges do we have to consider? How can organic farmers contribute to the mitigation of climate change and achieve sustainability? And how can organic farming go hand in hand with other alternative farming approaches to combat climate change? These are the questions we want to focus on in this chapter.

Key words

[EFFECTS OF CLIMATE CHANGE ON AGRICULTURE, MEASURES TO MITIGATE CLIMATE CHANGE IN ORGANIC FARMING, ALTERNATIVE FARMING APPROACHES]

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5.1 Effects of climate change on agriculture and challenges for organic farming

Extreme weather and climate events affect the agriculture sector directly by lowering the yield and reducing the quality of the products. Socio-economic consequences of Climate Change in the agriculture sector spread across the whole economy, influencing food prices, farm incomes, and ultimately food security at local, regional, and global scales.

Increased temperatures, heat waves, late frosts, drought, heavy rain, hail and storms have a direct impact on agricultural production. Due to this high dependence on weather and climate, it is particularly important for agriculture as well as fruit cultivation, viticulture and horticulture to be aware of the impacts of climate change and to prepare for them in time.

5.1.1 Effects of climate change on agriculture

Global warming and the associated change in weather patterns have mainly negative effects on agriculture. The extent and severity of the impact depends on the geographical location, specific external changes in e.g. temperature, precipitation and CO2 concentration, as well as possible changes in agroecosystems, the crops grown and the ability of agriculture to adapt to the changing circumstances. The effects can be divided into direct and indirect effects on agriculture and livestock farming:

- **Direct effects:** changes in precipitation and water availability, an increase in the average temperature and CO2 concentration as well as an increase in extreme weather events (heat, heavy rain, hail, permafrost)
- **Indirect effects:** include the spread of pests and diseases, soil erosion, declining yields and an increased risk of crop failures (EEA, 2024).

Direct and indirect effects in turn have an impact on productivity, yields and ultimately prices. All of this leads to greater vulnerability of production, growing uncertainties and increased income and livelihood risks within the sector (Bildung, 2021b).

The European Environmental Agency emphasizes in its latest European Climate Risk Assessment that climate change is threatening food security in Europe:

“Key climate risks to European food production are reductions in crop and livestock production from changing growing conditions and extreme weather events, particularly in southern Europe.

Food production is at risk from reduced water availability and quality as well as the deteriorated status of terrestrial and marine ecosystems. Impacts on fisheries and aquaculture arise through changing habitats, diseases and water stress.

Uncertainties in the mid-and long term are related to pollinator decline, pests and diseases in crops, livestock and aquatic environments, the climate resilience of new crop production systems […]” (EEA, 2024).

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Climate change has an impact on agriculture via:

- Sea warming, marine heatwaves and acidification
- Warming
- Heatwaves
- Droughts
- Other extreme weather events (heavy rain, hail, storm).

The interviews conducted within the international project ETICOF do confirm the Climate Risk Assessment of the EEA. As part of this project, 80 farmers (40 conventional and 40 organic farmers) from Slovakia, Hungary, Germany and the Czech Republic were asked about their observations about the impact climate change has on their farms.

The interview analysis concludes that climate change is already a big challenge for farming. Most of the farmers interviewed are reporting negative consequences due to changing weather conditions. Especially the German farmers reported a huge impact that climate change has on farming. All interviewed German farmers who have converted to organic farming reported immense problems with the impact of climate change.

The changing weather conditions mentioned by the interviewed farmers from Germany, Slovakia, the Czech Republic and Hungary include:

- Extreme rainfalls, more floods, thunderstorms
- Late frost
- Snowless and light wet winters
- High temperatures
- Long dry periods (especially in Slovakia and Germany a lack of rain is a challenging condition).

These weather phenomena lead to new challenges, especially:

- A higher demand for irrigation (uncertain natural water supply)
- Changing dates of sowing and harvesting
- New pests and weeds
- Declining and unstable yields (e.g. shorter vegetation time of some crops, higher death rate of calves, product quality deterioration e.g. for fodder and shortage of feed, unexpected damages)
- Unstable prices and rising costs (extreme unpredictability, as well as requiring extra efforts and extra work to achieve the same yield, extra expenses, e.g. for frost protection, cooling the chicken coops during summer heat, irrigation, difficulties of planning the investment and yield level to the unstable weather)
- Rising mental and physical load for the farmers.

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5.1.2. Mitigation of climate change

Agriculture is responsible for around 20 to 30 percent of global greenhouse gas emissions through direct and indirect emissions. At the same time, the effects of climate change are endangering agricultural production and thus food security in many places. Agriculture therefore faces a double challenge: On the one hand, it must take suitable measures to mitigate climate change; on the other hand, it must develop production systems that remain as stable as possible in the face of the effects of climate change.

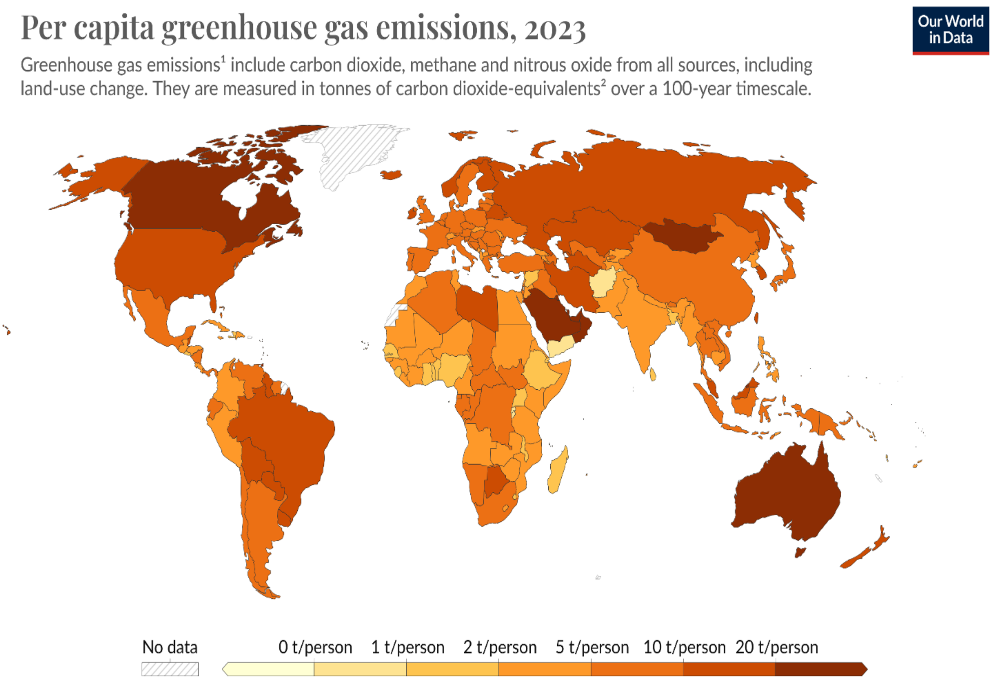

Figure 5.2. *Per capita greenhouse gas emissions. Source: Jones et al. CC (https://ourworldindata.org/greenhouse-gas-emissions)*

Humus build-up reduces climate change

Agricultural practices that promote humus formation have the greatest mitigation potential. This stores carbon from the air in agricultural soils. Organic fertilization and diverse crop rotations with catch crops, for example, promote the build-up of humus. Climate change can also be mitigated by not using mineral fertilisers and not burning crop residues in an uncontrolled manner. Organic farming consistently favours these practices and therefore has significant potential to mitigate climate change.

Stable agroecosystems resist better to the consequences of climate change
Organic farming practices also lead to more stable ecosystems that are better able to adapt to the effects of climate change. A higher humus content improves the water retention capacity of soils and increases soil fertility. Such soils are less susceptible to drought, extreme precipitation, flooding and waterlogging. A lower level of fertilisation, avoidance of chemical pesticides and varied crop rotations increase diversity and thus the stability of agroecosystems. At the same time, these measures reduce input costs. This reduces the production risks associated with extreme weather events (FiBL, n.d.-b).

Thus, the potential of organic agriculture is high. As humus build up and biodiversity are integral parts of organic farming, while the negative impacts of industrial farming on soil and biodiversity are significantly higher (Aertsens et al., 2009).

The International Federation of Organic Agriculture Movements (IFOAM) summarizes the **benefits of organic agriculture** as follows (IFOAM, 2022):

Reduced emissions by non-use of mineral fertilisers
- 20% of global agricultural GHG emissions could be reduced using no mineral fertilisers
- 40% less N2O emissions/ha
- Less dependency from fossil fuel intensive external inputs.

Improved manure management
- 70% lower methane emissions
- 50% lower nitrous oxide emissions.

Reduced GHG emissions and increased carbon sequestration
- Additional 3.5 tonnes C/ha soil organic carbon stocks
- Additional 450 kg C/ha/yr carbon sequestration
- 15% less energy consumed per kg of product
- More resilient to changing weather conditions
- 1082 kg CO2 eq/ha/yr avg climate protection performance.

Soil and plant health benefits
- Improved soil quality and fertility
- Better structure
- Higher humus content

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- Better soil aggregate stability
- 22% less soil loss
- 26% lower soil surface water flow
- Increased water infiltration rate by 137%.

Biodiversity and healthy soil

- Increased biodiversity supports natural pest control
- Stabler yields during drought periods
- Increased adaptability to future environmental conditions
- Biodiversity benefits
- 30% more species
- 50% more individuals
- 20-95% more plant species
- 150% higher abundance of plant species
- 23% more insect species
- 30% more pollinators.

Water benefits

- 28-39% less nitrate leaching
- Water bodies are protected from contaminants.

5.2 Adaptation measures to climate change in organic farming

Climate change adaptation is defined by the IPCC (2001) as 'adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects or impacts (pg. 818). Many farmers are adapting to climate change, both experienced and projected (Moser and Ekstrom, 2010).

The adaptation to climate change widely depends on the location of the farms. It needs to be answered differently for Northern, Central and Southern Europe. In Northern Europe e.g. climate change will increase the range of suitable crops, at the same the time the North will also be challenged by extreme weather events like heat waves, cold spells, floods and storms (IFOAM, 2012). Especially Southern Europe is already facing higher temperatures, a poorer soil quality caused by erosion and less precipitation (IFOAM, 2012).

Studies have proven that farms applying intensive farming methods with high inputs and monocultures are more vulnerable to climate change than diverse farms with fewer input (Reidsma et al., 2010).

The meaning of healthy soil and diversity are the main reasons why organic farming adapts more easily to climate change than conventional farming. A high level of diversity and a high-quality

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soil contribute to greater resilience in the face of climatic changes and more extreme weather conditions (El-Hage Scialabba/Müller-Lindenlauf 2010). Simultaneously, organic farming is less dependent on fossil fuels as mineral fertilisers are not used.
Nevertheless, organic farming is also facing challenges caused by changing climatic conditions. Adaptation techniques to climate change in organic farming are a combination of:

- **Adapted water management**, e.g. water harvesting (keeping, storing and utilizing rainwater on the site, e.g. through canals or reservoirs, drainage during periods of intensive rainfall)
- **Soil and nutrient management** (e.g. through mulching, building up humus through the use of compost, use of Effective microorganisms[1], use of cover crops for nitrogen fixation, etc.)
- **Direct sowing, mulch sowing and reduced tillage**, which preserve the soil structure and soil life. Less water evaporates through the covered soil, humus formation is promoted and the soil can therefore retain moisture better, adjusted sowing and harvesting schedules
- **Crop diversification** to minimize risk and increase biodiversity (drought-tolerant varieties, mixed crops, catch crops, new species, etc.)
- **Utilisation of agroforestry systems and planting of shrubs** as carbon storage (shade, water storage, humus enrichment) and to increase biodiversity and reduce soil and wind erosion
- **Climate-adapted animal husbandry:** flexible barn structures for opening and closing, good ventilation, misting and showers used in stables, straw bales as insulation for heat protection, a combination of agroforestry and extensive grassland, pasture management to avoid overgrazing and erosion damage, reduction in livestock numbers
- **Measures against heat stress** in grazing cows: include bringing them back into the barn, providing drinking troughs and shade, grazing in the cooler hours of the day, timely observation and use of heat warning apps and insect protection
- **Adapted farm management practices (e.g. acquisition of new management skills** (IFOAM, 2012).

[1] Effective microorganisms (EM) can help to improve and maintain the soil chemical and physical properties. EM improves the structure of the soil, increases its fertility and radically improve biological diversity, suppresses soil-borne pathogens, fixes the nitrogen in soil and enhances nutrient uptake, accelerates the decomposition of organic waste, residues and composting, increases beneficial minerals in organic compound and boosts the strength of plants and yield of crops. (Himangini Joshi, 2019: Role of Effective Microorganisms (EM) in Sustainable Agriculture, https://doi.org/10.20546/ijcmas.2019.803.024)

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Climate adaptation and climate protection can also go hand in hand (climate smart agriculture). Technical solutions in adaptation to climate change in organic farming are precision technologies, such as drones, drip irrigation (vegetables), etc.
It is also useful to utilize measures and tools to reduce the carbon footprint, e.g. by using a farm carbon calculator (https://calculator.farmcarbontoolkit.org.uk/).

5.3 Alternative and innovative farming approaches

More farmers have been interested in alternative farming approaches in the past years. This is mainly caused by the urgent challenges climate change caused in farming. The alternative approaches that are summarized on the following pages have two things in common: They contribute to healthy soil and biodiversity – the key answers when it comes to adapting to climate change. While Regenerative Agriculture already plays a more significant role in farming in the EU, Agroforestry and Mob Grazing are still in a niche. Nevertheless, they are explained briefly in the following chapter to give an overview of alternative organic farming approaches based on practical experience.

5.3.1 Regenerative agriculture

Regenerative agriculture integrates ideas from conventional agriculture, organic farming, permaculture, agroecology and agroforestry. The Food and Agriculture Organisation of the United Nations (FAO) recommends this form of agriculture, which can sustainably feed humanity while preserving the irreplaceable resource of soil for the future.

Regenerative agriculture is a farming approach, focused on improving soil health, biodiversity, water cycles, and ecosystem resilience. It goes beyond sustainability by aiming to restore degraded land and sequester carbon in the soil, addressing climate change while maintaining productivity.
Core Principles of Regenerative Agriculture:

- **Minimizing soil disturbance:**
  Reducing or eliminating tillage to protect soil structure and microbial life
- **Maximizing soil cover:**
  Using cover crops or crop residues to protect soil from erosion, retain moisture, and suppress weeds.
- **Diverse crop rotation:**
  Planting a variety of crops to promote biodiversity, improve nutrient cycling, and disrupt pest and disease cycles.
- **Integrating livestock:**
  Employing managed grazing to recycle nutrients, enhance soil organic matter, and boost ecosystem resilience.

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- **Maintaining living roots:**
  Keeping live plants in the soil year-round to support soil microbial activity and structure.
- **Promoting biodiversity:**
  Encouraging a wide range of plant and animal species to improve ecological balance and system stability.
- **Building organic matter:**
  Enhancing soil carbon content to improve fertility, water retention, and resilience against extreme weather.

The Five C Principles

The **Five C** principles are foundational practices in regenerative agriculture and sustainable soil management. They focus on improving soil quality, ecosystem health, and biodiversity. The Five C principles can be explained as follows:

Cover crops:

- Cover crops protect the soil from erosion, help retain moisture, and improve biological activity in the soil.
- They enhance nutrient cycling, such as legumes enriching the soil with nitrogen.

Crop diversity:

- Growing a variety of crops promotes biodiversity, improves resistance to pests and diseases, and optimizes soil resource use.
- It also supports diverse root exudates that nourish soil microorganisms.

Continuous living roots:

- Keeping living plant roots in the soil year-round supports microbial activity, stabilizes soil, and improves its structure.
- It helps with carbon sequestration in the soil.

Conservation tillage:

- Minimizing or eliminating tillage preserves soil structure and reduces erosion.
- It also limits carbon loss and fosters biological activity.

Compost and organic matter:

- Increasing organic matter in the soil through compost, crop residues, or other natural materials.
- Organic matter improves water retention, supplies nutrients, and supports soil life.

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These five principles focus on building and maintaining healthy soils, which are the foundation of long-term sustainable agriculture. Soils with high organic matter and biological activity:

- Retain water more effectively.
- Are more resilient to extreme weather conditions.
- Provide stable yields without over-reliance on synthetic inputs.

The principles underpin the regenerative approach to farming. Implementing them leads to reducing agriculture's carbon footprint and conserving natural resources for future generations.

More information about regenerative agriculture:
European Alliance for Regenerative Agriculture (EARA): Links practitioners and policymakers across Europe, including Germany.
Soil and More Impacts (German-based): Offers consulting services for regenerative practices.
Demeter International: A biodynamic certification body rooted in Germany that overlaps with regenerative principles.

5.3.2 Agroforestry and Keyline design

The term agroforestry is used to describe land use systems in which woody plants (trees or shrubs) are combined with arable crops and/or livestock farming in an area in such a way that ecological and economic benefits are created between the various components (Nair, 1985b). Typical for all types of agroforestry are consciously utilized interactions between woody and arable crops.

In agroforestry systems, a distinction is usually made between the combination of

- Trees with arable crops (silvoarable systems),
- Trees with livestock (silvopastoral systems) and
- Trees with arable crops and livestock (agrosilvopastoral systems) (Nair 1985).

As the age, distribution and arrangement of woody plants can vary, there are many different forms.
Landowners can benefit from agroforestry systems by:

- Reduction of soil erosion caused by wind and water
- Reduction in the discharge of substances from agricultural land into ground and surface waters
- Increased soil fertility through more closed nutrient cycles and humus enrichment.
- There are many reasons for the management of agroforestry systems for farmers.
- Provision of high-demand woody bioenergy sources on agricultural land
- Expansion of the agricultural product range (product diversification)

- Improved area-related energy balance and improved nutrient utilization efficiency
- Improved protection of arable crops against adverse weather conditions
- Reduction in area-related fertiliser and pesticide consumption
- Better seasonal distribution of labor peaks (cultivation of woody plants mainly in winter)
- Improvement of the income function (especially in low-yield locations)
- Positive yield effects and higher yield stability for annual crops due to an improved microclimate (e.g. through the wind protection effect of tree strips).

(Deutscher Fachverband für Agroforstwirtschaft (DeFAF) e.V., 2024b)

Figure 5.3. *Agroforest with Hazelnut cultivation in Thuringia. Source: Thüringer Ökoherz e.V.*

Nevertheless, there are limitations of agroforestry:

- Higher establishment costs of agroforestry systems compared to annual crops
- Greater effort and higher costs for management
- Long-term capital and land commitment due to the comparatively slow-growing woody plants
- In special cases: Woody roots can penetrate existing arable drainage systems and destroy them
- Competition between woody plants and arable crops for light, nutrients, water and growing space with negative effects on plant growth

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However, careful planning before the establishment of the area and the professional establishment and management of agroforestry systems can generally prevent the majority of the negative effects mentioned or at least reduce them to a tolerable level.
(Deutscher Fachverband für Agroforstwirtschaft (Deutscher Fachverband für Agroforstwirtschaft (DeFAF) e.V., 2024b).

Another relative practice to adapt to climate change is the system of **Keyline design**, which is a landscaping technique to optimize water resources. It is based on simple traditional systems that involve creating a system of collection ditches with a precisely defined gradient. In this way, it might play an important role in times of climate change by distributing and storing effectively water on a farm. It can be applied either on a whole farm or just on certain fields. Important for Keyline design is a profound planning process to establish an individual system for each farm. This includes a geomorphologic analysis of the farm to understand how the water is moving and dividing on the fields. On this data base, the farm manager can plan the arable land use and combine agroforest systems or orchards in combination with the keylines. The keylines are designed with dredgers, plough or other machines. Combined with woody structures, such as agroforestry, keylines can also contrisbute significantly to the water storage capacity of the land.

Figure 5.4. *Keyline Design on the organic farm Katzhof in Switzerland. Source: FiBL/Thomas Alföldi.*

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One person who knows all about keyline design is Dr. Philipp Gerhardt. The forestry scientist is one of the few keyline design consultants in Germany and has been advising farms on keyline design for around 10 years.
"Our experience over the last 10 years shows that the effort - usually in combination with agroforestry measures - is generally always worthwhile for the farm.

"Take, for example, an area with 500 to 600 millimetres of rainfall and pronounced spring or summer drought: if you have a retention ditch with a tree strip every 30 metres, this minimises heat and water stress immensely and the grain yield is at least more stable, if not higher. The tree strip provides the farm with additional income in the form of fruit and wood, for example. In addition, heavy rainfall no longer leads to erosion and the loss of fertile soil."

(Keyline Design: Landwirtschaft Optimieren Mit Intelligenter Wasserführung, n.d.-b)

5.3.3 Mob grazing

Grazing systems are increasingly threatened by frequently dry and hot summers combined with heavy rainfall.
Mob grazing is characterized by a short stocking time and a long rest period. In contrast to traditional grazing, the animals eat the plants a little deeper. Mob grazing is intended to increase the humus content in the soil, which in turn improves the water storage capacity. Other advantages cited by farmers include good herd control and benefits for calf health. However, there are also challenges such as shading the animals, providing drinking troughs and mice infestation on permanent pastures.
Mob grazing is particularly suitable for farms in summer-dry areas. However, it requires a certain willingness on the part of farmers to take risks and experiment.

As early as 1985, Gildersleeve et al. defined mob grazing as a pasture management system that simulates intensive rotational grazing characterized by a high animal density on a defined, limited area for a short period of time. Mob grazing is part of a sustainable grazing strategy specifically for dryland and plant populations adapted to them.

Four points are essential:

- High stocking densities (herd effect)
- High growth with long roots
- Long resting time of the growth
- Large trampled-down willow residues of more than half of the vegetation to form a mulch layer

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Depending on the respective site conditions, mob grazing can be useful all year round. However, it can also be part of a strategically sensible grazing plan alternating with other forms of grazing. With mob grazing, there is a strong focus on the temporal component of grazing. In order to prevent overgrazing, the grazing period for mob grazing varies depending on the site conditions, i.e. the dryness and height of the vegetation, among other things. Overgrazing means that the animals put more strain on the pasture than it can recover from (Netzwerk Mob Grazing, n.d.).

Figure 5.5. *Mob grazing in Northeast Germany. (Network Mob Grazing)*

5.3.4 Alternative approaches in comparison to organic farming

In principle, agroforestry systems and Regenerative Farming are quite similar to organic farming. And on some farms, e.g. on the Werragut in Thuringia/Germany, the different approaches go hand in hand. Nevertheless, there are some differences, e.g. digging and plowing are not practiced in Regenerative Farming, as heavy clay soils become loose and airy even with the addition of humus.

The concepts of agroforestry and Keyline Design offer solutions against drought and heavy rainfall events. Modern agroforestry systems can improve soil fertility, water quality, biodiversity and the microclimate. They also make an effective contribution to climate protection. Soil fertility is increased through more closed nutrient cycles between arable crops and woody plants. Leaf fall, dead fine roots and root excretions help to enrich humus and thus improve soil quality in the long term. The trees also act as a water and nutrient pump with their deep roots. The root system also absorbs excess nitrate from the soil and thus contributes to groundwater protection. Furthermore, agroforestry systems contribute to increasing biodiversity, as they provide a habitat for many different creatures. This diversity contributes to a stable, healthy agroecosystem. (Welche Vorteile Bieten Agroforstsysteme?, n.d.)

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What is Regenerative Agriculture?
Keyline Design & Agroforst
High-grass pasture or mob pasture: adapting pasture management to the consequences of climate change

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Selected topics to facilitate conversion

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