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Education material packages: collection of topics on agriculture solutions

Material prepared under the project *Farm to Fork Academy: V4 for Sustainable Agriculture in Albania,* supported by the **International Visegrad Fund** and implemented by **Albanian Network for Rural Development, in partnership with** Rural Parliament in Slovakia, Hungarian National Rural Network, Local Action Group „Vistula – Terra Culmensis" and Czech-Moravian Association of Agricultural Entrepreneurs.

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SUSTAINABLE AGRICULTURE

The basic assumption of sustainable agriculture is to satisfy the human food and fiber needs while making the most efficient use of available resources and reducing or eliminating threads to the natural environment. Sustainable agriculture is a key element of building a sustainable society and responding to environmental threads.

This concept aims to link economic development with the protection of natural resources and the global balance of ecosystems. Sustainable agriculture shall integrate three main objectives: a healthy environment, social and economic equity and economic profitability.

Although the transition to more sustainable systems has been a goal of the EU for several years now, food production still contributes to environmental pollution, loss of biodiversity and climate change. Therefore, as an attempt to find an ambitious and holistic response to environmental-related challenges, the **European Green Deal** has been created. It is an inclusive growth strategy that aims to transform the EU into a sustainable, resource-efficient modern economy and effectively make Europe the first climate-neutral continent by 2050. Above-mentioned goals have the purpose of improving the health and quality of life of EU citizens.

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Farmers, agri-food businesses, foresters, and rural communities have an essential role to play in several of the Green Deal's key policy areas, including:

- building a sustainable food system through the Farm to Fork strategy;
- adding to the new biodiversity strategy by protecting and enhancing the variety of plants and animals in the rural ecosystem;
- contributing to the climate action of the Green Deal to achieve the goal of net-zero emissions in the EU by 2050;
- supporting the updated forestry strategy, to be announced in 2020, by maintaining healthy forests;
- contributing to a zero pollution action plan, to be set out in 2021, by safeguarding natural resources such as water, air and soil.[1]

[1] *Sustainable agriculture in the CAP,* https://ec.europa.eu/info/food-farming-fisheries/sustainability/sustainable-cap_en

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COMMON AGRICULTURAL POLICY

The EU's common agricultural policy (CAP) is a partnership between agriculture and society, and between Europe and its farmers. It aims to:

- support farmers and improve agricultural productivity, ensuring a stable supply of affordable food;
- safeguard European Union farmers to make a reasonable living;
- help tackle climate change and the sustainable management of natural resources;
- maintain rural areas and landscapes across the EU;
- keep the rural economy alive by promoting jobs in farming, agri-foods industries and associated sectors.[2]

All V4 farmers, as well as other EU members, are obliged to comply with the provisions of the Common Agricultural Policy, which, inter alia, regulates the issues relating to the protection of the agricultural environment used in the agricultural production process. CAP combines social, economic, and

[2] *Aims of the common agricultural policy,* https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-glance_en

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environmental approaches that shall lead the EU to achieving a sustainable system of agriculture.

Previous CAP was in the period 2014-2020. Legislative proposals on the new CAP for the period 2021-27 were presented by the European Commission in June 2018. They ensure that the CAP still aims to provide support for European farming, enabling prosperous rural areas and the production of high-quality food.

In particular, the Commission's proposals focus on:

- securing a fair deal and a stable economic future for farmers;
- setting higher ambitions for environmental and climate action;
- safeguarding agriculture's position at the heart of Europe's society.[3]

The new common agricultural policy is meant to be built around nine key objectives, that will serve as the basis upon which EU countries will design their CAP strategic plans.

[3] *Future of the common agricultural policy*, https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/future-cap_en

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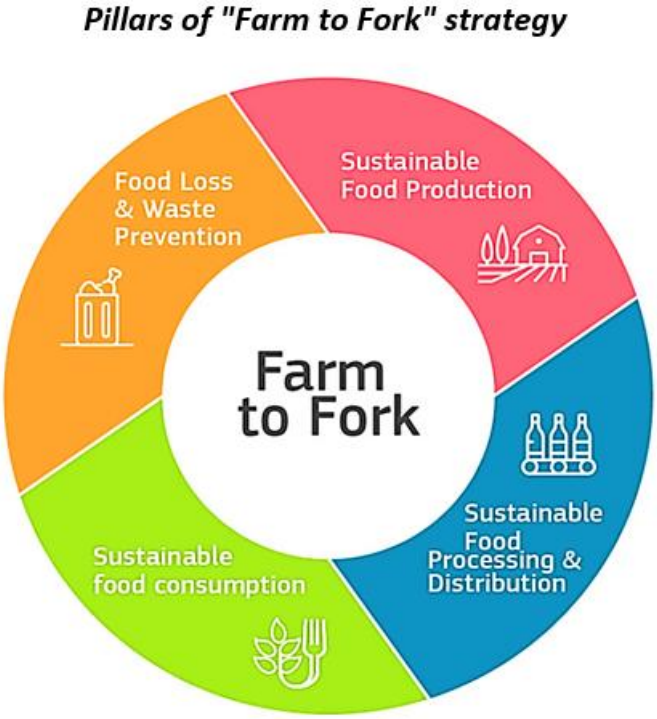
"FARM TO FORK" STRATEGY

The "Farm to Fork" strategy for sustainable food is a key component of the European Green Deal. The main aim of the strategy is to make food systems fair, healthy and environmentally friendly.[4]

The strategy aims to facilitate the transition into a sustainable food system, based on circular economy, neutral environmental impact of the food processing and retail sectors, and technological innovations. Through some specific measures, it will also encourage the farmers to shorten the supply chain for their products – and therefore minimize their dependence on food brokers.



Source: European Commission

[4] *Farm to Fork Strategy*, https://ec.europa.eu/food/farm2fork_en

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This strategy has 27 concrete actions to transform the EU's food system by 2030, inter alia:

- a reduction by 50% of the use and risk of pesticides
- a reduction by at least 20% of the use of fertilizers – including animal manure
- a reduction by 50% in sales of antimicrobials used for farmed animals and aquaculture
- reaching 25% of agricultural land under organic farming, of which the current level is 8%.[5]

BIODIVERSITY

According to the FAO definition, agricultural biodiversity includes the components of biological diversity that are essential for feeding human populations and improving the quality of life. It is built on the variety and variability of ecosystems, animals, plants and microorganisms, at the genetic,

[5] *European Union's Farm to Fork Strategy – for a fair, healthy and environmentally-friendly food system,* http://www.fao.org/agroecology/database/detail/en/c/1277002/

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species and ecosystem levels, which are necessary to sustain human life as well as the key functions of the ecosystem.[6]

Biodiversity conservation is an important element of EU agricultural strategies and one of the priorities of the new Green Deal. Therefore, the 2030 Biodiversity strategy was created as an effort to strengthen biodiversity conservation and stop biodiversity loss in European Union.

The key commitments that were included in the strategy to reach by 2030:

1. Legally protect a minimum of 30% of the EU's land area and 30% of the EU's sea area and integrate ecological corridors, as part of a true Trans-European Nature Network.

2. Strictly protect at least a third of the EU's protected areas, including all remaining EU primary and old-growth forests

3. Effectively manage all protected areas, defining clear conservation objectives and measures, and monitoring them appropriately.[7]

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[6] *NSP - What is agricultural biodiversity*, http://www.fao.org/agriculture/crops/thematic-sitemap/theme/compendium/tools-guidelines/what-is-agricultural-biodiversity/en/

[7] *COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS*, https://eur-lex.europa.eu/resource.html?uri=cellar:a3c806a6-9ab3-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF

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At least EUR 20 billion a year will be unlocked to meet the objectives of this strategy, including investments priorities for Natura 2000 and green infrastructure. Moreover, as nature restoration will make a major contribution to climate objectives, a significant proportion of the 25% of the EU budget dedicated to climate action will be invested on biodiversity and nature-based solutions.[8]

Also old varieties of crop plants are becoming more and more popular, as they are highly resistant to diseases and have modest requirements as to the soil. It's worth mentioning that a great amount of old apple varieties is still present on the market and gaining in popularity. Most of these plant varieties can be successfully grown in low-cost technologies and ecological production systems. Its is believed that promotion of old varieties cultivation plays significant role in supporting biodiversity. An appropriate approach to conservation of plants and animal genetic resources is their conservation in the natural environment in regions closely related to their origin. This type of protection helps in preserving a given form at its place of origin, and continues to implement the traditional method of cultivation and selection that led to its creation.

[8] *COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS*, https://eur-lex.europa.eu/resource.html?uri=cellar:a3c806a6-9ab3-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF.

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ORGANIC AGRICULTURE IN EU

Organic products market has enjoyed steady growth within the last decades. This growth is notably visible in Eastern European countries – even though organic products are still less popular there than is the case of Western European countries, especially Germany being the leading market for organic products in the EU. The total organic area in the EU increased by 70% in the last ten years and organic retail sales reached EUR 34 billion in 2017. 13.4 million hectares of land in the EU is dedicated to organic farming.[9]

Organic farming is a type of farming which responds to the growing societal demands for quality food produced with high environmental, biodiversity and animal welfare standards. It is supported by the Common Agricultural Policy (CAP).[10]

On 30 May 2018, the European Parliament and the Council adopted new European Union (EU) regulations on organic production and labelling of organic products.

New organic legislation is expected to enter into force on 1 January 2022. The regulation covers the objectives, such as:

[9] *Organic farming in the EU,* https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/market-brief-organic-farming-in-the-eu_mar2019_en.pdf

[10] *Questions and Answers - European Green Deal: Commission prepares new initiatives to boost the organic farming sector,* https://ec.europa.eu/commission/presscorner/detail/en/QANDA_20_1539

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- Production rules will be simplified through the phasing out of a number of exceptions and opt outs;
- The control system will be strengthened thanks to tighter precautionary measures and robust checks along the entire supply chain;
- Producers in third countries will have to comply with the same set of rules as those producing in the EU;
- Organic rules will cover a wider list of products (e.g. salt, cork, beeswax, vine leaves, palm hearts) and will have additional production rules (e.g. deer, rabbits and poultry);
- Certification will be easier for small farmers thanks to a new system of group certification;
- There will be a more uniform approach to reducing the risk of accidental contamination from pesticides;
- Exemptions for production in demarcated beds in greenhouses will be phased out.[11]

The main distribution channels for organic products are:

- direct purchase from farmers and processors
- supermarkets
- specialty stores

[11] *Questions and Answers - European Green Deal: Commission prepares new initiatives to boost the organic farming sector,* https://ec.europa.eu/info/food-farming-fisheries/farming/organic-farming/future-organics_en

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The holding structure, characteristic for agriculture in Central-Eastern Europe, is an important factor favorable for development of organic farming. Historically, these holdings have been characterized by conducting the agricultural production with a minimal use of plant protection products and synthetic fertilizers. Tendency for consumption of organic food, is constantly growing, moreover, organic methods of cultivation are very well grounded in agriculture. Further growth of environmental awareness among modern farmers has been supported through various European subsidies. Moreover, the EU has been consistently investing in developing research in the field of organic farming, and in further dissemination of scientific knowledge via popular science publications.

CERTIFICATION

Specific requirements have been determined for a farm in order to be officially recognized as an organic food producer. First and foremost, such farms must undergo a conversion period. The length of this conversion period depends on the type of organic product being produced:

- 3 years for orchards of perennial soft, top and vine fruits,
- 12 months for pig and poultry grazing,
- 2 years for land ruminant grazing annual crops.[12]

[12] *Becoming an organic farmer*, https://ec.europa.eu/info/food-farming-fisheries/farming/organic-farming/becoming-organic-farmer_en

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In each member country there is a designated certification body, which provides the farmers with necessary information and takes control during both the conversion period and after its completion. EU countries can decide whether this is a public or a private body but they all check that the European Union's rules on organic production are followed.[13] During the conversion period, the farmer also receives payments for possible difficulties and loss of yield during the conversion period from conventional to organic production. In addition to that, the EU offers other forms of support for organic farmers under the Common Agricultural Policy and greening payments.

IMPORTANT CERTIFICATES

EU organic logo

The EU organic logo gives a coherent visual identity to European Union produced organic products. This makes it easier for the consumers to identify organic products and helps farmers to market them across the entirety of the EU.

The organic logo can only be used on products that have been certified as organic by an authorized control agency or body. This means that they have fulfilled strict conditions on how they must be produced, processed, transported

[13] *Ibidem.*

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and stored.[14] Products that have been granted the certificate must contain at least 95% of organic ingredients and additionally respect further strict conditions for the remaining 5%. Producers are also obliged to provide additional information on the packaging: a code number of the body control and information on the place where the agricultural raw materials composing the product have been farmed.

EU Ecolabel

Established in 1992, the EU Ecolabel is a voluntary environmental performance certificate that is awarded to products and services meeting high environmental standards. This certificate promotes circular economy and controls the whole life-cycle of a product, from raw material extraction to disposal.

The EU Ecolabel criteria provide exigent guidelines for companies looking to lower their environmental impact and guarantee the efficiency of their environmental actions through third party controls. Furthermore, many companies turn to the EU Ecolabel criteria as it is designed to encourage the producers to reduce their overall environmental impact and generate less waste and CO2 during the manufacturing process. The criteria for each product group

[14] *Organics at a glance,* https://ec.europa.eu/info/food-farming-fisheries/farming/organic-farming/organics-glance_en

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are developed by experts in consultation with main stakeholders, and they are tailored to address the unique characteristics of each product type. Every four years on average, the criteria are revised and changed if necessary, in order to reflect technical innovation in the production process, such as evolution of materials or in emission reduction and changes in the market.

Every product or service supplied for distribution, consumption or use in the European Economic Area market (European Union plus Iceland, Liechtenstein and Norway) and included in one of the established non-food and non-medical product groups, is eligible for the EU Ecolabel.[15]

[15] *Environment,* https://ec.europa.eu/environment/ecolabel/how-to-apply-for-eu-ecolabel.html

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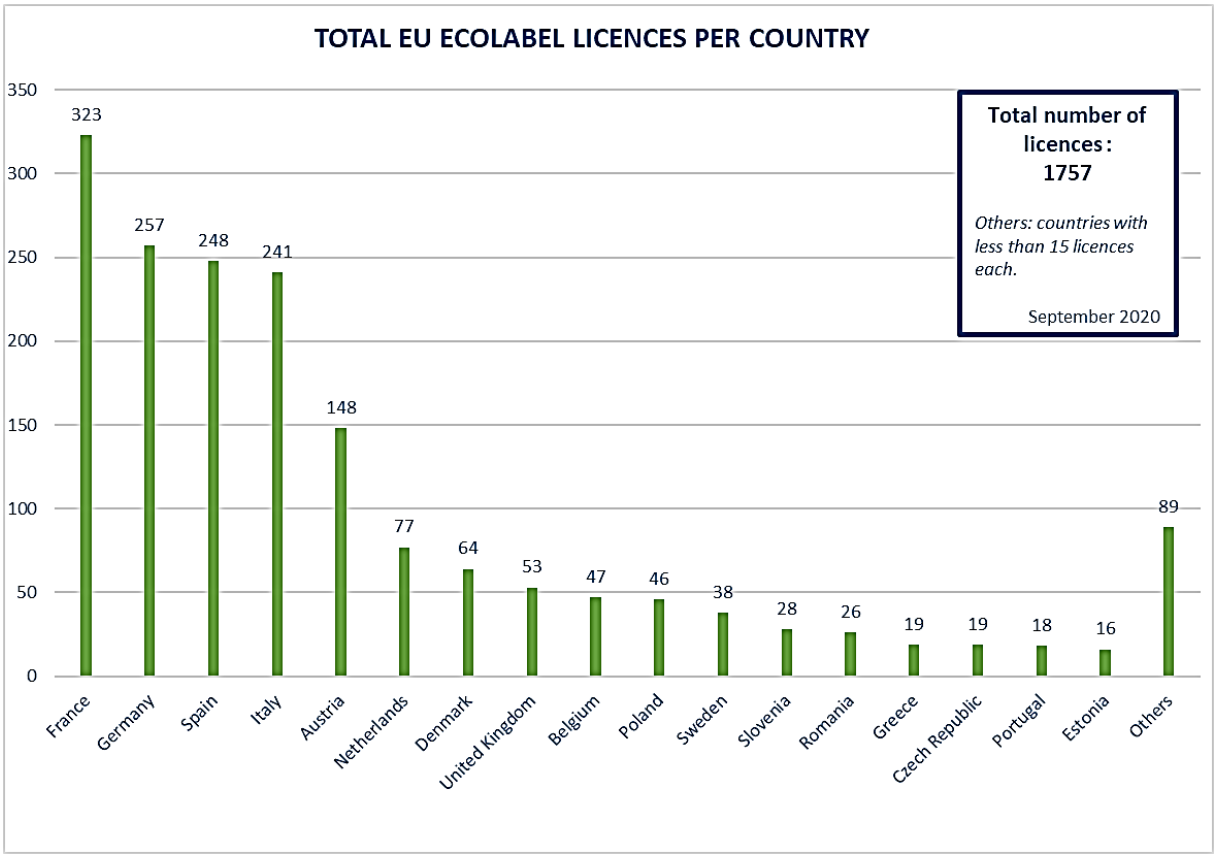

Source: European Commission (2020)

GEOGRAPHICAL INDICATIONS

To distinguish traditional, local products, the European labelling system has been developed. The EU Geographical indications system protects the names

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of products that originate from specific regions and have specific qualities or enjoy a reputation linked to the production territory[16]. It serves both to promote high-quality food among customers, but also to protect producers against unfair competitors and their counterfeit products.

GI schemes play an important role in promoting sustainable rural development, improving farm income and opening new export potential. They also contribute to better protection of local heritage.

There are two categories of products recognized within the European policy of quality and protection of exceptional products:

- regional products of known origin to which the designation Protected Designation of Origin and Protected Geographical Indication applies,
- traditional products to which the label Traditional Specialty Guaranteed applies.

General rules concerning geographical indications do not differ between all European Union member countries.

[16] *Aims of EU quality schemes,* https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/quality-schemes-explained_en

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Available certifications:

Protected designation of origin (PDO)

Product names registered as PDO are those that have the strongest links to the place in which they are made – every part of the production, processing and preparation process must take place in the specific region. This certificate is dedicated to food, agricultural products and wines.[17]

Protected geographical indication (PGI)

PGI emphasizes the relationship between the specific geographic region and the name of the product, where a particular quality, reputation or other characteristic is essentially attributable to its geographical origin. Here at least one of the stages of production, processing or preparation takes place in the region. This certificate is dedicated to food, agricultural products and wines. Another certificate is dedicated specifically to spirit

[17] *Aims of EU quality schemes*, https://ec.europa.eu/info/food-farming-fisheries/food-safety-and-quality/certification/quality-labels/quality-schemes-explained_en

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drinks and aromatized wines - Geographical indication of spirit drinks and aromatized wines (GI)[18]

Traditional Specialty Guaranteed

Traditional specialty guaranteed (TSG) highlights the traditional aspects such as the way the product is made or its composition, without being linked to a specific geographical area. The name of a product being registered as a TSG protects it against falsification and misuse. This certificate can be granted to food and agricultural products.

Unit responsible for the registration process in Poland is the Polish Ministry of Agriculture and Rural Development. The registration is a two-stage procedure – the first phase is conducted at the member state level, the second phase is carried out by European Commission. So far 44 Polish products have been registered as GI – honeydew honey from Beskids region being the once most recently added to this list[19]. Also, in order to strengthen the support for local traditional producers, Polish Ministry of Agriculture and regional authorities

[18] Ibidem.

[19] *Produkty zarejestrowane jako Chronione Nazwy Pochodzenia, Chronione Oznaczenia Geograficzne oraz Gwarantowane Tradycyjne Specjalności,* https://www.gov.pl/web/rolnictwo/produkty-zarejestrowane-jako-chronione-nazwy-pochodzenia-chronione-oznaczenia-geograficzne-oraz-gwarantowane-tradycyjne-specjalnosci

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established a national List of Traditional Products. Currently there are more than 1600 products included on this list.[20]

COMMUNITY SUPPORTED AGRICULTURE

Community Supported Agriculture is a initiative related to agriculture connecting (apart from the official agricultural policy of the state) farmers with consumers in direct, short, based on mutual trust and without intermediaries and without margins food chains.

The movement consists in gathering a group of recipients around a given farm (e.g. associated in a special association), who collectively decides what should be cultivated (affecting demand), so that the farmer meets the consumer's needs precisely. A set of agricultural products developed in this way is delivered by the farmer to recipients during the season at certain intervals, usually once a week. The goods are delivered either directly to group members or to several selected collection points (one can have a range of up to several dozen kilometers, and there can be many recipients). First payment/prepayment is paid by recipients before the season and allocated to the acquisition of means of production and covering labor costs. The second part of the fee is usually paid after the season. All elements of the process are regulated in detail in the contract. The farmer is obliged to cultivate with the maximum limitation of the

[20] *Lista produktów tradycyjnych,* https://www.gov.pl/web/rolnictwo/lista-produktow-tradycyjnych12

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use of artificial fertilizers and pesticides. Consumers and the farmer share the financial responsibility and risk of low yields caused by natural factors.

Apart from providing consumers with fresh and healthy vegetables and supporting small and medium-sized farms, socially supported agriculture aims to create social bonds that strengthen all parties to the contract in the competitive struggle with corporate agribusiness.

SMALL FARMS

Supporting micro and mid-size farms remains at the heart of CAP under 2014-20 perspective. While small farms have a relatively insignificant role in agricultural production and can be considered a limitation for implementing technological innovation in the agricultural production process, they also have an excellent potential for further development of the market for traditional and local food products, as well as for preserving the environmental qualities of the local landscape. Farms shall be seen not only as production units, but also as the elements of a bigger chain – they perform ecological, social, educational, recreational and cultural functions. This perception of the farms is an essential part of the concept of sustainable development of rural areas, which has been promoted in the EU through implementation of several frameworks and strategies.

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SMART VILLAGES

"Smart Villages" is a new project proposed by the European Commission in order to provide a higher standard of life and public services for citizens. It is a part of the broader thematic work of the European Network for Rural Development (ENRD) – theme "Smart and competitive Rural Areas". This sub-theme programme was implemented in the period 2017-2020.

Smart Villages have been defined as these communities in rural areas that use innovative solutions to improve their resilience, building on local strengths and opportunities.[21] The aim of this programme was to support the development of areas in decline by using digital technologies and innovations, in order to develop and implement their strategy to improve their economic, social and/or environmental conditions, in particular by mobilizing solutions offered by digital technologies. Initiatives taken under this programme strongly rely on a participatory approach.[22]

LOCAL ACTION GROUPS

[21] *Smart Village workshop*, https://digitevent-images.s3.amazonaws.com/5c0e6198801d2065233ff996-registrationfiletexteditor-1551115459927-smart-villages-briefing-note.pdf
[22] *Ibidem*.

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LEADER is a local development method which has been used since 1991 to engage local actors in the design and delivery of strategies, decision-making and resource allocation for the development of their rural areas.[23] In 2018 there were around 2800 LAGs in the EU, covering 61% of its rural population. LAGs are funded by the European Agricultural Fund for Development. They receive financial support in the form of grants for small-scale projects, bringing together private, public and civil-society actors within a particular area.

LEADER is a European program aiming support rural development, in which local initiatives are implemented in cooperation with voivodship governments, thanks to funding from the European Union. The most important subject of the program is the local community, which participates in it through Local Action Groups (LAGs), composed of representatives of residents, local social partners, and public authorities. Local Groups prepare local development strategies (LDS), indicating what the local community is particularly interested in and what needs to be done within the planned budget, to achieve the goal.

Leader is primarily focused at supporting the development of rural areas, stimulating the activity of local communities and their involvement in the creation and implementation of local strategies development of rural areas and improving their competitiveness as a place to live and run a business. The Leader approach encourages rural areas to search new ways to become or

[23] *LEADER/CLLD,* https://enrd.ec.europa.eu/leader-clld_en

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remain competitive, to make the most of your strengths and to overcome potential challenges such as an aging population, poor service provision and no employability. The program takes a holistic approach to solving rural problems. Recognizes, for example, that being competitive in food production, having an attractive natural environment and creating job opportunities for the local population are mutually supportive aspects of rural life, requiring specific skills, appropriate technologies and services to be considered as a coherent package along with the specially adapted policy measures.

Actions under Leader can, for example, activate and mobilize local resources by supporting pre-development projects (such as studies diagnostics and feasibility studies or local capacity building), which increase the ability of these areas to access and use not only Leader funds, but also other sources of development financing (e.g. wider EU programs and national rural development and regional development programs). The Leader approach also helps those sectors and categories of recipients who receive no support or only limited support from other programs implemented in rural areas, such as cultural activities, improvement of the natural environment, restoration of architectural and historic buildings, rural tourism, improving the relationship between producers and consumers etc.

A site-based approach means that as the target area of policy implementation is a small, homogeneous, and socially coherent territory, often with common traditions, local identity, a sense of belonging, and common needs and waiting.

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That facilitates the recognition of local strengths, weaknesses, threats and opportunities, endogenous potential, and to identify the more important bottlenecks for sustainable development. Territory targeting essentially means that it is a local approach. The main concept behind the Leader approach is that, given the diversity of rural areas in Europe, development strategies are more effective and efficient when consulted and implemented locally by local partners with clear and transparent procedures, along with the support of the relevant public administration and the necessary technical assistance for transfer of good practices.

Each feature complements and interacts positively with the others throughout the implementation period, bringing lasting effects under in relation to the dynamics of rural development and their ability to solve own problems. Local Action Groups have been delegated to take over a large proportion of management responsibilities (e.g. project selection, payment, monitoring, control and evaluation) of individual activities. Local authorities, non-governmental organizations, entrepreneurs, people who want to start their own business receive assistance in connection with the proposed rural development projects.

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The LEADER approach or method is based on seven specific features and it is crucial for all of them to be implemented in the programme:

1. Bottom-up approach
2. Area-based approach
3. The local partnership
4. An integrated and multi-sectoral strategy
5. Networking
6. Innovation
7. Cooperation.[24]

Within LAGs groups, the local actors develop concepts for regional development that would match the needs of the local community. Main goals of the programme have been defined as:

1. Diversity of rural areas and landscapes
2. Complex local identity
3. High-quality natural surroundings.[25]

[24] *LEADER/CLLD explained*, https://enrd.ec.europa.eu/leader-clld/leader-toolkit/leaderclld-explained_en#top
[25] *CZYM JEST LEADER?*, https://www.lag-uckermark.de/pl/czym-jest-leader/

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Overview on most important agricultural practices: favoring sustainable agriculture

- Ensuring the financial stability of the farm - only a farm that is sustainable and has development potential can be sustainable. For this to be the case, the farm must be financially stable and managed in accordance with a well-thought-out business plan.

- Building soil fertility by increasing the humus content - sustainability in field production is based on the soil's own fertility, only supported by fertilizers. Fertility can be built by increasing the content of humus in the soil, which is also a water store. As a result, the farm produces more and cheaper, being less sensitive to unfavorable weather phenomena.

- Changing crops to enhance soil biodiversity - the task of each farmer is to plan crops in such a way that in the following years other plant species will be cultivated in the field in a way that enriches the soil, increases its fertility and biodiversity potential. This has a positive effect on the profitability of production and allows for the development of the farm.

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- Optimal selection of crops and proper sowing - the differentiation of climatic and soil conditions requires a well-thought-out selection of species and varieties of cultivated plants, detailed knowledge of cultivation and protection conditions, in order to optimize the production effect.

- Fertilization of plants based on the fertilizer balance - fertilization of crops should only supplement the nutrients present in the soil, according to the needs of the plants. The nutrients supplied in fertilizers must balance the surplus collected with the crops of plants, bearing in mind also the losses resulting

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from natural processes taking place in the soil.

The basis of the fertilizer balance is the necessary knowledge about the actual fertility of soils, the needs of plants and the fertilizers used.

- Compliance with the principles of integrated pest management - the best protection effects at the lowest costs are achieved by integrating various methods of protection: mechanical, physical, biological, breeding and chemical to be used in the event of ineffectiveness of the previous ones. Using the knowledge about harmful organisms and about crops, it is possible to take various actions in a timely manner to combat them or reduce their harmfulness. The increasing number of digital solutions available to farmers, strongly supporting integrated pest management, can also help here. By implementing these principles, the use of chemical plant protection products and the financial effect of plant protection are optimized.

- Effective use of water resources - the aim of the activities should be the optimal use of available water resources, both soil and irrigation. Its rational use will ensure the stability and sustainability of agricultural production, especially in the context of climate change. A farmer should

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use water sparingly, possibly increase the water retention of soils and monitor its needs and consumption on an ongoing basis.

- Keeping the soil under plant cover for as long as possible - soil erosion is a very harmful phenomenon caused by the action of water and wind, but it can also be the result of inappropriate human activities. Growing plants with a rich root system that covers the soil well - as well as leaving the soil covered with post-harvest debris - prevents erosion. Tillage without plowing, as well as anti-erosion crop rotation, can be effective in reducing soil erosion.

- Supporting biodiversity on the farm and its surroundings - biodiversity contributes to lowering inputs and increasing the production effect. In the fields, we partially limit it in order to obtain a crop, so it needs additional support, outside of their area.

- Ensuring animal welfare - the production and financial effect of a farm with animals depends on their health condition and living conditions. Only healthy animals kept in a proper way will produce a large production of good quality.

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- Using the no-tillage system - no-plowing tillage is an alternative to traditional tillage, eliminating excessive displacement and oxygenation of the soil. The treatments are usually limited to loosening the soil and mixing its surface, without turning it over. The rest of the work is done by earthworms and other soil organisms that build corridors in the soil, thereby improving its fertility, supporting its airing, and also processing post-harvest residues.

No-Tillage agrotechnique method of preparation of sowing field via the use of herbicides on stubble and execution with a special drill (seed Drill). This method can be used to grow maize, legumes, rape, winter cereals and sugar beet.

No-tillage/Zero tillage eliminates many of the disadvantages of plow tillage, such as:

- Destruction of the natural protective layer of the soil (vegetation and organic debris), the lack of which leads to wind and water erosion,
- Violation of the natural soil system, which leads to the destruction of its structure and a reduction in the population of geobionts,
- Formation of a plow sole and crust formation ,
- Lifting stones and soil necrosis ,
- Too fast decomposition of organic matter, disturbance of nutrient circulation in the soil,

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- Reduction of soil bearing capacity (formation of deep ruts),
- The need to replace the plowed field,
- The possibility of sowing only after the soil has left its place,
- High energy consumption.

Direct sowing is used under the following conditions:

- Having special seeders
- A suitable forecrop
- Application of herbicides that destroy forecrop debris and weeds
- Sufficient soil moisture
- Selection of the right species and cultivar variety
- The farmer's having the knowledge and experience to simplify farming

Failure to meet these conditions usually leads to a reduction in yields. The use of zero-tillage, which does not disturb the natural soil system, can occasionally be used in agricultural practice. Too frequent repetition of this cultivation technology in the same field increases the risk of an increase in weed infestation (mainly couch grass) and a reduction in yields . For example, in

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Poland, the zero-tillage technology is an economically attractive alternative to traditional cultivation for large farms operating under new rules (change of ownership forms and management methods).

Tendencies favoring the dissemination of no-tillage/zero-cultivation result, among others with:

- Rising energy (fuel) costs,
- More expensive workforce ,
- Increasing the area of farms and fields,
- Limited time for agrotechnical treatments ,
- Deteriorating soil moisture conditions,
- Low efficiency of machines and tools and their high amortization.

- Striving to reduce greenhouse gas emissions - agriculture emits a number of greenhouse gases (e.g. CO2, CH4, NH3, NOX), which should be minimized by the precise use of machinery and equipment, good management of fuels, organic fertilizers, post-harvest residues, optimization of animal husbandry and sowing conditions cover crops, e.g. as catch crops, allowing better absorption of CO2.

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- Compliance with the law - is a basic condition for any sustainable agricultural production, which must be carried out in compliance with applicable law and within its limits.

- Proper waste management - post-production waste generated on the farm should be maximally used for further production, in addition to municipal waste and waste hazardous to people and the environment, the disposal of which is determined by law.

- Caring for employees, their rights and safety on the farm - consistent observance of employees' rights and care for working conditions guarantee the quality of work performed, proper use of equipment and low accident rates - all these elements improve the profitability of production and the financial result of the farm. The knowledge of the dangers and the correct assessment of the risks that may arise while working on a farm lead to increased work safety. Changes in technology and technical equipment require knowledge about new threats. Occupational health and safety training is a necessary element of work in agriculture, no less important than periodic inspections of agricultural equipment.

- Taking actions for the social acceptance of agriculture - sustainable agriculture is also a response to social expectations that agricultural

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production should be more environmentally friendly. Partnership communication with the local community where the farmer lives, but also with the wider society, is becoming more and more urgent. It is important that in conversations with people who are not related to agriculture or, for example, through social media, the farmer's work and, above all, specific activities for environmental protection.

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How to retain water and reduce erosion?

Although the increase in temperature may seem minimal, in reality the increase in energy accelerating water evaporation is huge. The total precipitation has not changed much, but rather decreases, in addition, the nature of precipitation has changed.

Agriculture will have to change in the face of change: accurate technology can help. They enable rational management of water resources, fertilizers and pesticides. This might fundamentally reduce the negative impacts on the environment.

Example: The latter farm farms on more than 10,000 hectares of arable land in the Vyškov region, which is one of the regions most affected by drought, heat and torrential rain. More than two thirds of the cultivated land in Rostěnice is erosively endangered and lies on the slopes.[26]

Belt agriculture

Interesting technologies that the company is implementing in practice are contour management and belt crop rotation. These technologies combine several methods and enable effective water retention and erosion protection, both wind and water. This method allows crop rotation, even those that would normally be considered erosively dangerous on slopes.

[26] *Zemědělci kvůli klimatu mění své postupy*, https://www.novinky.cz/domaci/clanek/zemedelci-kvuli-klimatu-meni-sve-postupy-40315770

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The essence is the alternation of winter and spring crops, or intermediate crops, in strips 20 to 40 meters wide. They are set so that their direction copies the contour as best as possible. Crop rotation in strips ensures even protection of the land against the effects of erosion, throughout the year. Such a method improves water retention on a slope two to four times compared to slope management. This will also prevent soil erosion.

Crop rotation

Simply an annual change in the place of cultivation of individual vegetables in the vegetable garden, planned for the next few years. This type of cultivation allows for optimal use of space, reduces the occurrence of diseases and pests and keeps the soil in good condition.

Basic principle of crop rotation

One of the main principles of crop rotation is to avoid growing plants from the same botanical family in a given position (the break should be at least 4 years), due to the presence of common diseases and pests. Their spore forms (e.g. pest eggs, fungal spores) may live in the soil for up to several years, infecting subsequent crops from year to year. So if we have grown cabbage in one year, we have to plant it and other cruciferous vegetables in a different place the next year.

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The vegetable garden should be divided into quarters (4 or more), allowing the place of cultivation of individual vegetables to be changed each year. For example, in case of having 4 beds, in the first year - to be plant:

- on **one** cruciferous vegetables (e.g. Brussels sprouts, kale, cabbage),
- on **the other** root (e.g. carrots, parsley),
- on the **third** legume (e.g. broad beans, green beans),
- on the **fourth**, nightshade (e.g. pepper, tomato).[27]

In the following year, the place of cultivation of each group of vegetables should be changed, but in accordance with their nutritional requirements. This is important because individual vegetables need different nutrients, so when grown one after another, they sterilize the soil from a specific nutrient.

[27] *Płodozmian w warzywniku. Co to jest płodozmian i go stosować w praktyce,* http://www.e-ogrodek.pl/a/plodozmian-w-warzywniku-co-to-jest-plodozmian-i-go-stosowac-w-praktyce-20811.html

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After shallow-root plants, e.g. peppers, it is best to plant vegetables with a deep root system, e.g. carrots, which take up nutrients from the deeper layers of the substrate.

Source: https://rodaleinstitute.org/why-organic/organic-farming-practices/crop-rotations/

Crop rotation should also always include legumes, which not only have low nutritional requirements, but also enrich the soil with valuable nitrogen, which they bind from the air with nodule bacteria, leaving a good position for vegetables with high nutritional needs.

Crop rotation - example

Example of crop rotation on 4 plots:

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- 1st year of growing the flower bed: I - nightshade vegetables, II - root vegetables, III - brassica or pumpkin plants , IV - bulbs or legumes.
- II year of growing the bed: I - bulbs or legumes, II - nightshade vegetables, III - root plants, IV - brassica vegetables.
- 3rd year of growing the bed: I - brassica or cucurbits, II - bulbs or legumes, III - nightshade vegetables, IV - root vegetables.
- IV year of growing the bed: I - root vegetables, II - brassica or pumpkin vegetables, III - bulbs or legumes, IV - nightshade vegetables.

Similar procedures also regulate the state of the game. The small number is increasing, while black is being reduced. Overheating of the soil surface is also reduced.

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Plants that target dealing with soil pests and scares off whiteflies and rodents

- One of the best known and valued allelopathic plants is, among others, **marigold** (scattered and haughty), in which the roots contain a chemical compound, which has an unfavorable effect on nematodes and shows antifungal activity against some types of fungi. In horticultural crops, harmful nematodes threaten many plants (including strawberries, beets, cabbage and other vegetables), therefore planting marigolds in their immediate vicinity protects them from pests. The volatile substances secreted by the marigold are also deterred by greenhouse whiteflies, which is why the plant should also be sown under covers. The smell of marigold also deters rodents and moles.

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- **Nasturtium** against aphids and snails. It not only attracts aphids, thus protecting other plants that are less attractive to the pest, but also scares off snails and rodents with its smell. For this reason, it is worth sowing nasturtium near crops particularly endangered by aphids and snails (e.g. cabbage, lettuce).

- **Butterfly vegetables** (including broad beans, beans) are also very interesting phytosanitary plants. They will fertilize the soil, as on their roots there are beneficial papillary bacteria that bind nitrogen from the atmosphere and naturally enrich the substrate.

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- When once decided to grow **legumes**, it is needed to keep in mind not to plant vegetables from the same family for the next 3-4 years, because apart from valuable nitrogen, the soil may contain spores of diseases and pests common to legumes. .

Herbs for special purposes

- Important group of plants that have a beneficial effect on horticultural crops are also herbs, many of which emit strong volatile substances that are not tolerated by pests. These include, among others, garden **marjoram**, the aroma of which deters pests of carrots, brassica vegetables and onions.

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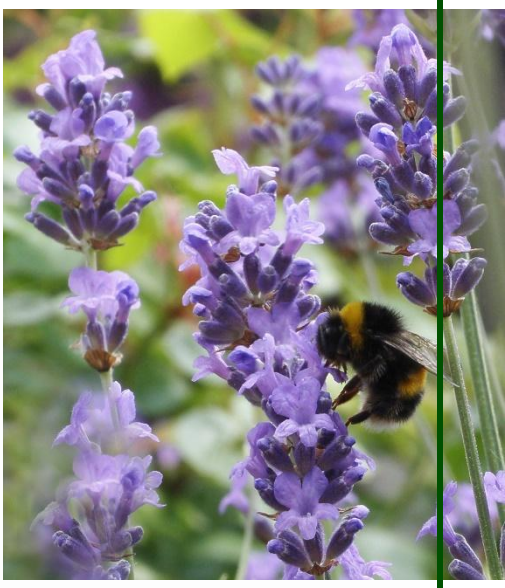
- **Hyssop** destroys pathogenic soil bacteria and scares off agriculture.

- **Sage** also has a deterrent effect on caterpillars, snails, aphids, cabbage beetles and agriculture .



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- In case of a problem with ants, it is also recommended to plant **lavender** and **thyme** near their habitats.

- To reduce the problem with aphids, let's also plant a lot of **peppermint** and **garden savory** near the endangered plants , the smell of which deters pests.

- **Garlic** is also effective allelopathic plant. Sulfur compounds contained in it have a fungicidal effect (they also scare away

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spider mites), especially against powdery mildew, so it is worth planting it near plants particularly exposed to this disease (e.g. paniculate phloxes, roses, vines, strawberries).

Garlic will protect against mildew and purify the air. Also, garlic because it belongs to plants that emit substances that inhibit the development of harmful microorganisms in the air (the so-called phytoncides), thanks to which the surrounding area becomes cleaner and free from pathogens.

Juniper and pine, for example, also have such an effect.

Important considerations for healthy soils

The physical and chemical characteristics of the soils prove to be constant within a given interval, but within this we can make significant changes and improvements. The systems approach is very important. The right choice of varieties, integrated pest management, precision farming only make sense if the whole process takes place within the framework of a concept of soil

conservation and improvement. The focus of this is on the fertility of the soil, because its organic matter stock, humus content and the availability of nutrients determine the success of crop production and then its material efficiency. Active soil life provides the background for the existence of high-quality agro-technics.

In many cases, the reduced crop rotation, intensive tillage without organic manure results in soils with reduced humus content. We all know that soil that has been open for a long time and left uncovered, over-cultivated, compacted and dusted cannot be the key to success. Proper soil structure, pore size and humus are responsible for storing nutrients as well as water.

About 2% of the humus in the soil is mineralized, and this should be replaced regularly, year after year. This is not an impossible mission if we pay attention to ensuring soil life with proper microbiological activity. This is vital, because in the absence of this, neither the straw manure, nor the stubble residues, nor the soil-improving intermediates will be properly utilized or decomposed. If the pH of the soil is adequate, the soil organisms allow the processing of large amounts of organic matter. However, neither bacteria nor fungi can function in acidified soils due to excessive use of fertilizers and pesticides. In this case, even if cellulose-degrading bacteria are released, intensive stem degradation is omitted. However, stubble residues are valuable raw materials, biomass fertilizers that contain bound CO in the form of organic plant residues. Without organic carbon stored in the soil, there is no discussion about soil life.

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Humic acids (humic and fulvic acids) have an ideal effect on soil pH. At the right value, the degrading organisms grow up explosively, whether we use inoculants, bacterial fertilizers, or we are thinking about the expansion of native microorganisms - we need to ensure the right pH for a healthy soil life to function. In a well-pH (6-7), biologically active soil, stem decomposition and subsequent sowing of intermediate crops really make sense. Instead of green manure plants, it is better to talk about catch crops or cover crops. Green manure crops are merely a fast, high-biomass group of intermediate crops. These materials provide only the necessary, but not sufficient, conditions for the resulting carbon cycle.

There is a long way to go from intensive crop production to soil-friendly cultivation systems. In the long run, they are expected to gain significant ground because, in the face of climate change, the tightening of the regulatory environment, and societal expectations, there will be no other way to maintain production levels and profitability; not to mention environmental aspects. Increasingly extreme weather and increasingly unequal rainfall distribution pose challenges to agriculture (as well).

Nutrient replenishment of soils

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The nitrogen supply of the soil can be increased by secondary sowing of butterfly plants (testes, vetch, lupine), thus reducing the amount of fertilizer to be applied to the post-crop.

Nutrient uptake and fertilization efficiency can be improved with strong arable root crops (mustard, oil radish, reclamation radish, buckwheat, fodder rape). It is another question whether we then have the option of differentiated nutrient application based on a field map.

Similarly, in the case of a properly formulated soil cover mixture with an optimal number of plants, we can control the weeds and pests of the components (sand oats, rye, phacelia), which helps to reduce our use of pesticides. The debilitating effect of the phacelia nematode is slowly becoming well known.

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If the cover plant or cover plant mixture cannot be incorporated as an intermediate crop, it is advisable to include one of them as a main crop in the crop rotation, for example by seed cultivation. When choosing a mixture of intermediate plants, it is always necessary to pay attention to what kind of plant is wanted to be grown afterwards. There is a need to think about the right time to sow the catch crops, how to sow and how to apply them later. The mixtures adapted to the crop rotation and the soil conditions and field conditions are determined by the needs of the main crop. It is recommended to choose a mixture that freezes easily in front of the spring main crop and avoid sowing after 15 September, because after that the plants will no longer have time to produce the expected amount of biomass. Only in this way can we increase the humus content of our soils to the appropriate extent. Each plant has a different biomass and nutrient supply capacity. Mixtures that can be destroyed (terminated) in both spring and autumn help to regenerate the soil and maintain its fertility. Their soil structure-improving effect can not only help to eliminate diseases of the cultivating foot (plow base, disc base), but also to create the appropriate pore size. Among the problems to be solved and the goals to be achieved, we often find the importance of protection against wind and water erosion. Root secretions (exudate) produced by plants with high root mass help to establish the chemical balance of the soil. Their soil structure-improving effect can not only help to eliminate diseases of the cultivating foot (ploughshare, disc base), but also to create the appropriate pore size. Among

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the problems to be solved and the goals to be achieved, we often find the importance of protection against wind and water erosion. Root secretions (exudate) produced by plants with high root mass help to establish the chemical balance of the soil. Their soil structure-improving effect can not only help to eliminate diseases of the cultivating foot (ploughshare, disc base), but also to create the appropriate pore size. Among the problems to be solved and the goals to be achieved, we often find the importance of protection against wind and water erosion. Root secretions (exudate) produced by plants with high root mass help to establish the chemical balance of the soil.

On acidified soil, where the conditions for humus formation are not available, we force the “sixty-day” mixtures planned between harvest and autumn sowing for the support system completely unnecessarily. After rotating the high-moisture and low-carbon material, it will rot instead of decomposing, raising a number of phytopathological problems, in addition to causing loss of moisture and nutrients. Rather, restoring the pH of soil with humic acid technology, use stem-breaking bacteria, and reduce the number of operations as well as the depth of cultivation. Between two main plants, we take advantage of the benefits of intermediate plants. In the complex process, the measure of the degree of change will be the humus content. The restarted soil life provides a suitable microbial background for the formation of humus, thereby increasing the fertility of our soil and improving its cultural condition. Cultivation costs will decrease in

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the long run (less fertilizer, pesticides, diesel), especially if there is possibility to take advantage of the opportunities offered by precision farming.[28]

[28] *Talajjavító mezőgazdasági gyakorlat*, https://agraragazat.hu/hir/talajjavito-mezogazdasagi-gyakorlat/

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Precision agriculture (PA), satellite farming or site specific crop management (SSCM): computer- aided farming, based mainly on the collection of data on spatial differentiation of crops within the field . The registration of the yield in the field with precisely defined coordinates is carried out in the combine harvester equipped with a yield meter and based on the satellite-based Differential Global Positioning System (DGPS). These data, after being transferred to a computer equipped with appropriate software, are processed into a color map of the yields whose analysis and interpretation are the most important element of this technology. On the basis of the yield map, fertilization and plant protection treatments are applied selectively , whereby those parts of the field that can yield a greater yield receive appropriately higher fertilization and more intensive plant protection, while those that have a lower yield-generating potential receive correspondingly less . For this purpose machines are used for precise application of agrochemicals . The concept of precision farming ensures higher yields of higher quality, lower production costs and reduction of environmental contamination .

Integrated Farming is new European agriculture organic standard (IF), integrated production or Integrated Farm Management is a whole farm management system which aims to deliver more sustainable agriculture. It is a dynamic approach which can be applied to any farming system around the world. It involves attention to detail and continuous improvement in all areas of

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a farming business through informed management processes. Integrated Farming combines the best of modern tools and technologies with traditional practices according to a given site and situation. In simple words, it means using many ways of cultivation in a small space or land. [29]

Integrated pest management (IPM), is a way to protect plants against harmful organisms, consisting in the use of all available crop protection methods, giving priority to non-chemical methods in a way that minimizes risk to the health of humans, animals and the environment . Thus, integrated plant protection allows the use of chemical plant protection products to be limited to the necessary minimum and thus reduces the pressure on the natural environment and protects the biodiversity of the agricultural environment[30].

[29] *INTEGROWANA PRODUKCJA ROŚLIN,* https://piorin.gov.pl/integrowana-produkcja/

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The term "integrated pest management", adopted in Poland as a translation of the English term "Integrated Pest Management" (IPM), does not very well reflect the meaning of the original, because IPM literally means "integrated pest management", not limited only to the aspect of their control (as suggested by the term "protection")[31].

In integrated pest management, the combined effect of all categories of harmful organisms , i.e. pathogens, insects and weeds present in the environment of a given crop, on its yield is important, therefore pest control is approached holistically, paying particular attention to the interrelationships and interactions that occur. A potentially harmful organism becomes a pest if a host is present, the environment is favorable for both the plant and the harmful organism, and time is favorable for the interaction between the plant and the harmful organism. Moreover, humans and the harmful organism compete with the plant, the degree of plant damage reduces the quantity or quality of the crop .

Integrated pest management uses the full knowledge of organisms harmful to plants (in particular, their biology and harmfulness) to determine the optimal terms for taking action against these organisms, and also uses the natural

[30] *Integrowana ochrona roślin*, https://www.gov.pl/web/rolnictwo/integrowana-ochrona-roslin
[31] *Advisory system in sustainable plant production*, http://www.dss.iung.pulawy.pl/index.html

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occurrence of beneficial organisms, including predators and parasites, organisms harmful to plants, and also uses their introduction[32].

General goals:

- Creating a sustainable agricultural management system that:
    - Takes account of **nature's systems and cycles,** and maintains, improves, and the balance between, soil, water, plants and animals;
    - Contributes to maintaining a high level **of biodiversity** ;
    - Uses **energy and natural resources** such as water, soil, organic matter and air responsibly ;
    - Respects **high animal welfare standards** , and in particular meets the behavioral needs specific to a given species;
- Striving to produce high-quality products;
- Striving to produce a wide range of food and other agricultural products that meet customer demand for goods produced using processes that do not pose a threat to the environment, human health, plant health or animal health and welfare.

[32] *Integrated Pest Management: A Global Overview of History, Programs and Adoption,* https://link.springer.com/chapter/10.1007%2F978-1-4020-8992-3_1?LI=true#

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Organic plant production uses cultivation practices that help **maintain or increase soil organic matter**, increase **soil** stability and biodiversity, and prevent soil compaction and erosion. For this purpose, multi-year crop rotation is applied, the use of biodynamic preparations is allowed, and all the plant production techniques used prevent or minimize environmental pollution.

Prevention of damage caused by pests, diseases and weeds is primarily based on the **protection of natural enemies**, the selection of species and varieties, the use of crop rotation, appropriate cultivation techniques and thermal processes. The collection of wild plants and parts thereof, growing naturally in natural areas, forests and agricultural areas, is considered an organic production method provided that:

- During a period of at least three years before the harvest, those areas have not been treated with products other than those authorized for use in organic production
- The collection does not affect the balance of the natural habitat or the maintenance of the species in the collection area.

The processing of organic food (as well as organic animal feed) should be based on ingredients meeting the same standards, limit the use of additives with mainly technological and sensory functions, and exclude substances and

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methods that may mislead as to the true nature of the product. GMOs and their products are not used in organic production as food, feed or other substances.

Animal Production

Regarding the origin of the animals:

- organically kept animals are born and reared on organic farms (or introduced under specific conditions, after meeting the conversion period requirements).

Regarding to rearing methods and housing conditions:

- Staff keeping animals have the necessary basic knowledge and skills as regards the health and welfare needs of the animals;

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- The rearing method, including densities and indoor conditions, ensure that the developmental, physiological and ethological needs of the animals are met;
- Animals shall have **permanent access to open-air areas**, preferably pasture, whenever weather conditions and the state of the ground allow this, unless restrictions and obligations related to the protection of human and animal health are imposed on the basis of Community legislation;
- **Animal numbers are limited** to minimize overgrazing, soil deterioration, erosion and pollution caused by animals or manure spreading;
- The keeping and isolation of animals shall be prohibited except in cases where such activities are for a limited period of time and carried out in relation to individual animals, and only to the extent justified for reasons of safety, welfare or veterinary reasons;
- The duration of the transport of animals is kept to a minimum;
- **Suffering** of all kinds, including mutilation, is kept to a minimum throughout the life of the animal, including slaughter;
- Apiaries should be located at a sufficient distance from sources that may lead to contamination of bee products or deteriorate the health condition of bee colonies;

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- It is forbidden to destroy bees on combs as a method related to the collection of bee products.

Regarding to breeding:

- The correct breeds are selected. The choice of breeds also contributes to preventing the suffering of the animals and avoiding the need to mutilate them.

Regarding to feed:

- Animal feed is obtained primarily from the farm where the animals are kept or from other organic farms in the same region;
- Growth stimulants and synthetic amino acids are not used;
- Suckling mammals shall be fed with natural milk, preferably mother's milk;
- Disease prevention is based on the selection of breeds and lines, appropriate rearing methods, the provision of high-quality forage, the provision of mobility, appropriate stocking and hygienically adapted premises;
- Diseases are treated immediately to prevent animals from suffering.

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Benefits

Organic production is more varied due to the need to use natural relationships in nature to achieve various purposes (such as providing plants and animals with nutrients, reducing pest populations, managing the water cycle, and so on). The reduction of agricultural mechanization is replaced by the work of humans and animals (in the case of the latter, it is both human-controlled work, e.g. in carts, and natural behavior - e.g. digging in the ground by chickens or pigs). Popularization of organic farming also contributes to increasing the nutritional sovereignty of small farms and the integration of local communities[33] . Eco-farming ensures biological self-regulation, uses methods of soil , water and landscape protection , which results in agricultural products of high biological quality. Limited human interference with the farm ecosystem stops the degradation of the agricultural habitat . Organic farming areas allow many species to survive and are important centers for the expansion of these organisms into the surrounding area. They diversify the landscape, improve the microclimate, and are also a model of correct behavior for less ecologically aware neighbors. Lower nitrogen pollution of soils by 31% per area, and even 49% per product unit.[34]

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[33] *A menu of actions to shape urban food environments for improved nutrition* , https://ruaf.org/assets/2019/11/gain-mufpp-ruaf-a-menu-of-actions-to-shape-urban-food-environments-for-improved-nutrition-2019.pdf

[34] *Does organic farming reduce environmental impacts? - A meta-analysis of European research,* https://www.academia.edu/1907461/Does_organic_farming_reduce_environmental_impacts_A_meta_analysis_of_European_research

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Recently, there is significantly higher increase in the occurrence of voles. They have expanded because they have favorable conditions. As loses in production and income due to voles is getting more common: couple solutions are suggested, such as applying poison-soaked granules to vole burrows in the fields. But it is not possible to secure this with human resources wherever it is needed. The only possible solution is technology. The first such facilities in the Czech Republic are already killing voles in Vlčnov in Slovakia.

Special machines are hitched to a tractor and, to a depth of ten to twenty centimeters, it makes a groove in the soil, into which mechanization places poisoned bait. The artificial burrow is then strengthened by suffocating the cylinder. The device is intended to prevent poisoning and death of predators and other game that hunts voles. The poisonous granules remain in artificial burrows so that neither hares nor feathered game can reach them.[35]

[35] *Zemědělci kvůli klimatu mění své postupy*, https://www.novinky.cz/domaci/clanek/zemedelci-kvuli-klimatu-meni-sve-postupy-40315770

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Other popular agriculture practices

Agro-forestry is an integrated approach that uses the benefits of combining trees and shrubs with crops and livestock. It combines forestry and agricultural technologies to create more diverse, productive, profitable, healthier and sustainable land use systems In agroforestry systems, trees and shrubs are intentionally placed inside agricultural systems, and in forest systems, non-woody plants are introduced.

It is also an agricultural system in which there is an integration of woody (perennial) plants with arable crops or with permanent land and animal production. Agro-forestry has deep roots in Europe. Currently, these systems are tested for adaptation to modern production techniques and are introduced in a new form to practice. [36].

[36] *Agroleśnictwo - najważniejszą innowacją w rolnictwie*, https://modr.pl/technologie-upraw/strona/agrolesnictwo-najwazniejsza-innowacja-w-rolnictwie

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The first example of an extended definition of agroforestry is the so-called avenue cultivation. It is a forest-arable system in which perennial crops are grown together with annual crops. It should be noted here that agroforestry is not a suitable solution in every place and for every farmer. It can make progress if it is adapted to local conditions, but returning to avenue crops, their characteristic feature is that perennial plants such as trees or shrubs and crops are planted alternately in rows. The appearance of cultivation in a forest-arable system, i.e. the width of the strips with annual plants and the spacing of trees and their density, depend on what we want to achieve and what machines used on farms. The question immediately arises: will plants not compete with each other, for example for water, light or nutrients?

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Source: https://www.kpodr.pl/wp-content/uploads/2020/11/Agrole%C5%9Bnictwo-spos%C3%B3b-na-zr%C3%B3wnowa%C5%BCony-ekosystem-rolniczy.pdf

The fact is that in nature there is the phenomenon of allelopathy, that is, the interaction (positive or negative) of a biochemical nature between plants. In the case of agroforestry, the positive influence of plants on each other is used. Thanks to the appropriate selection of species, it is possible to, inter alia, reduce the occurrence of pests. In avenue cultivation, plants with different root system depths are used, which take up nutrients from different layers of the soil. Therefore, not only is the competition for nutrients negligible, but also the use of fertilizers by plants is more effective. However, in the case of competition for water resources, this concern is justified. On the other hand, research confirms that cultivation in a forest-arable system increases the yield of a crop compared to monoculture.

The cultivation of herbs or plants from which valuable herbal raw materials are obtained, fits well with the idea of cultivating alleyways. The usable parts of these plants are flowers, fruits and leaves. This cultivation brings economic benefits, increasing the profitability of a farm per hectare, and ecological

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benefits, enriching biodiversity due to the introduction of cloudberries into the environment, a plant that is extinct in the wild. Additionally, this plantation is very honey-bearing.

Yet another example is forest-pasture system. As the name suggests, this system grazes animals under trees, e.g. in traditional orchards or on wooded pastures. This is a valid idea, because if the goal is to speed up the return on investment in tree cultivation (while trees, for example, have not reached the felling age), it can be achieved through controlled grazing of animals.

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Source: https://www.kpodr.pl/wp-content/uploads/2020/11/Agrole%C5%9Bnictwo-spos%C3%B3b-na-zr%C3%B3wnowa%C5%BCony-ekosystem-rolniczy.pdf

Examples of Polish animal breeds that can be bred in extensive conditions are, for example, Polish ponies, Hucul horses and sheeps from Olkusz (polish city in South Poland). Trees protect animals from unfavorable weather conditions, increasing their welfare. An example of a forest pasture is Highland and Limousine beef cattle, which can be kept on pasture even in winter.

The presence of trees (natural or planted) protects animals against the wind in winter and helps to maintain the heat balance, and against heat in summer. The main advantages of the system are the restoration of unused land for agricultural production, low labor input compared to dairy production, high quality beef sold as an organic and local product, and finally profit from the sale of wood.

Agro-forestry is a very diverse form of plant and animal production, in which the overriding idea is to meet the needs of the society without disturbing the balance of the natural environment. Additional benefits of agroforestry systems include preserving biodiversity, diversifying agriculture, improving water quality, preserving soil fertility and carbon sequestration.

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Agro-forestry is also part of the activities protecting rural landscapes and promoting ecological farms and agritourism. There are many problems with cultivation in the agroforestry system, starting with the appropriate selection of plants and ending with the labor-intensive multiple harvesting. However, practice and research show that these systems work in many countries and in various conditions of cl

A form of agroforestry, which is forest gardening , is especially popular among permaculture supporters.

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Natural construction combines different building systems and materials, with an emphasis on balance, durability, the use of only minimally recycled materials, the use of renewable resources and those that, as a result of recycling or reuse, will create a healthy living environment and maintain healthy air in the building. Natural building is largely based on human labor rather than technology.

The need for natural construction comes from the desire to reduce the environmental impact of buildings and their supporting systems, without sacrificing comfort, health or aesthetics . In order to maintain a balance, natural construction uses surplus, renewable, recycled or reused materials. The architectural design of the building, its orientation in relation to the directions of the world, adaptation to the local climate, focus on natural ventilation already at the design stage, and reduction of building maintenance costs also help to maintain the balance. It aims to be compact and to minimize ecological footprints , as well as local energy generation, water abstraction, alternative sewage systems and water reuse.

The materials used are clay, wood, straw, earth, hemp, stone, turf; however, in practice, they are sometimes used alongside factory materials, such as concrete, polyurethane foam, and mineral wool[37] .

[37] T. Woolley, *Natural Building. A Guide to Materials and Techniques*. Crowood, 2006

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Harvesting Rainwater

Rainwater harvesting is the collection and storage of rainwater before it enters the aquifer[38]. Used for drinking water, livestock watering, irrigation and other typical applications. Rainwater obtained from the roofs of houses and institutions can make a significant difference in the availability of drinking water. It can support subcutaneous waters and increase the amount of urban greenery.

[38] Projekt Paradies. *Das Permakultur* Dorf, 2012, http://aramo.de/rain.html

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Gray water as domestic wastewater such as wash, dishwashing and bath water that can be recycled on site and watering the lawn or creating an artificial wetland. Gray water does not contain urine or feces. Gray water is not toilet water, it is suitable for flushing down the toilet.

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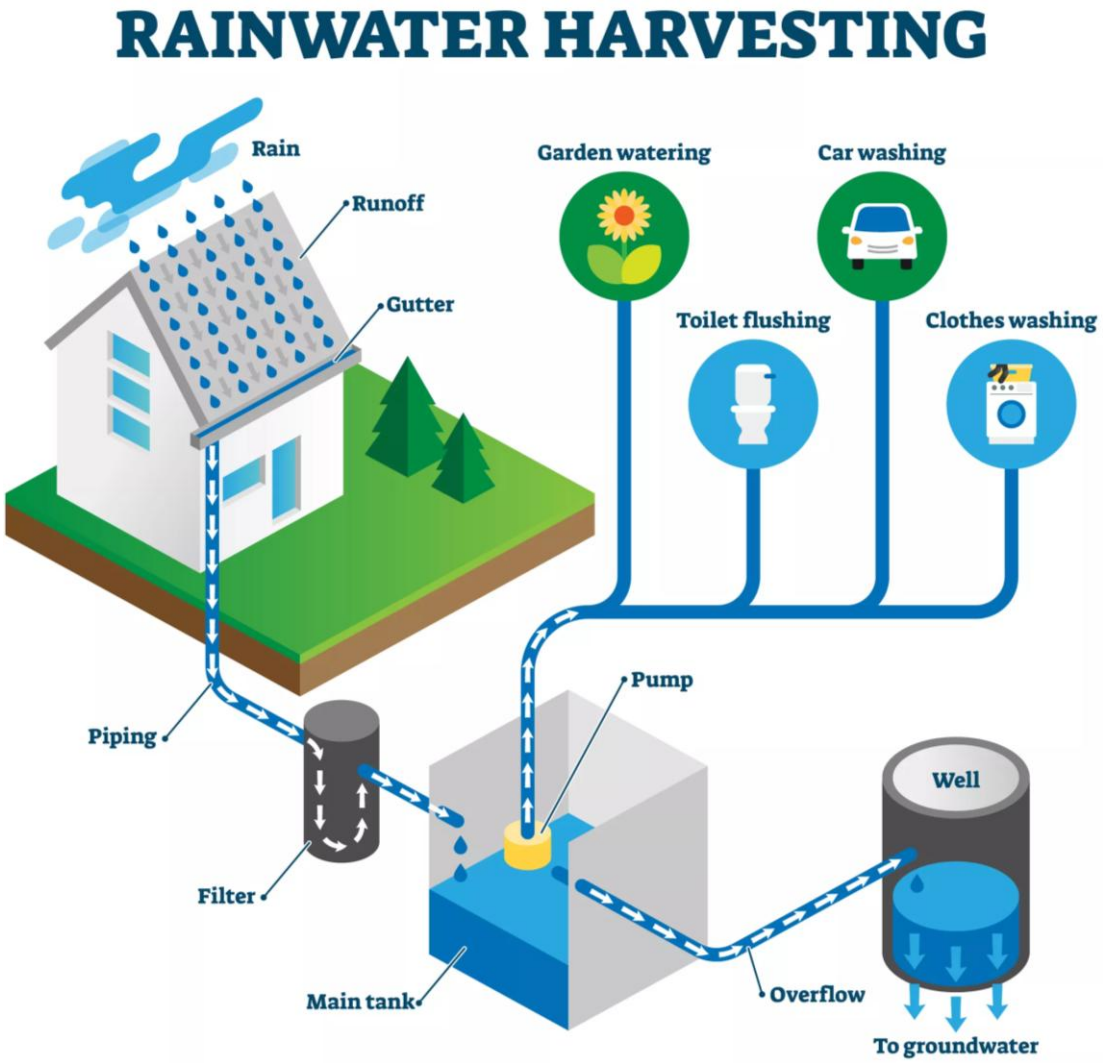

Source: https://www.treehugger.com/beginners-guide-to-rainwater-harvesting-5089884

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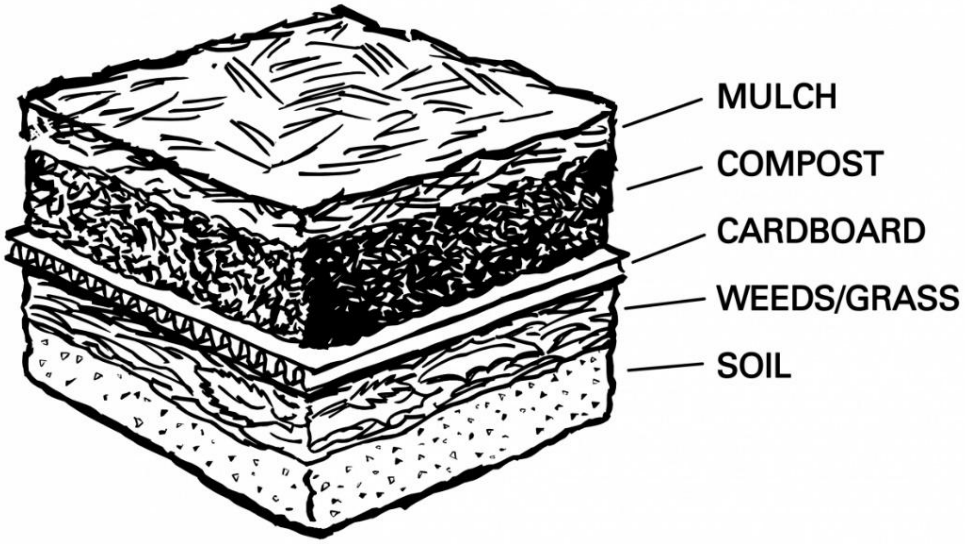
Layered mulching / sheet mulching

In agriculture and horticulture, mulch is a protective layer on the soil. The litter can be any material, e.g. stones, leaves, plastic, cardboard, etc., but permaculture most often uses organic litter because they fulfill the greatest number of functions. These functions include: retaining rainwater, reducing evaporation, supplying nutrients, increasing the amount of organic matter in the soil, nourishing and creating an environment for soil organisms, suppressing weed growth and seed germination, balancing daily temperature fluctuations, protectin
g against frost and reducing erosion soil.



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Source: http://lawntogarden.org/how-to-sheet-mulch/step-four-layer-compost-and-mulch

Layer mulching is an agricultural technique used in horticulture without digging, which is to imitate the natural processes taking place in the forest, imitating a layer of fallen leaves on the forest floor[39].

The mulch layer is the "food bank" that stores the nutrients contained in organic matter and gradually releases these

[39] J. Mason, *SUSTAINABLE AGRICULTURE,* https://www.academia.edu/40766942/SUSTAINABLE_AGRICULTURE_Second_Edition

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nutrients for plant uptake.

Source: https://www.ogrodowisko.pl/artykuly/379-sciolkowanie-w-ogrodzie

It also improves soil quality by attracting and nourishing earthworms and producing humus. Earthworms "cultivate" the land, and their droppings are one of the best fertilizers . Layered mulching can be used to eradicate unwanted plants by depriving them of light, and can be more beneficial in the long run than the use of herbicides.

Raised beds is a form of gardening, where the ground is enclosed in boxes 1.0–1.2 m wide, of any length or shape. The soil is above the soil level around the flower beds (approx. 20 cm - 1 m high), sometimes in a wooden, stone frame, made of concrete blocks; can be enriched with compost.

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Vegetable plants can be geometrically arranged, closer to each other than in traditional horticulture. The distances can be selected so that the adult plants touch each other, which allows to create an appropriate microclimate, prevent the development of weeds and maintain adequate humidity.[40] Raised beds generate multiple benefits: they extend the agricultural season, properly designed plantings

[40] N. Raymond, *Raised-Bed Vegetable Garde*

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reduce the amount of weeds and make the gardener independent from the need to use sterile soil. Since the gardener does not walk in the bed, the soil is not compacted and the roots can develop freely. The close plant distribution and the use of compost generally result in a higher yield compared to traditional row crops.

The beds raised to waist height allow the elderly and disabled people to grow vegetables without the need to bend down.

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Permaculture combines ecological design, ecological engineering and environmental design, creating sustainable architecture of human settlements and self-regulating agricultural systems similar to natural ecosystems.[41]

Permaculture draws from many areas such as organic farming, agroforestry, integrated agriculture, sustainable development and applied ecology.

The primary goal of the movement is to support people to be more self-sufficient by designing and developing fertile and sustainable gardens and farms. The design principles underlying permaculture's conceptual basis are

[41] T. Hemenway, *Gaia's Garden: A Guide to Home-Scale Permaculture,* 2009.

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derived from systems ecology and the study of pre-industrial examples of sustainable land use.

Permaculture design emphasizes landscape patterns, functions, and relationships between species. He asks the question, "Where is the place of this element? How can it be positioned with the greatest benefit to the system? " To answer this question, the main concept of permaculture is to maximize the beneficial connections between the components and the synergy of the final design. Permaculture does not focus on individual elements, but on the relationships created between the components by the way they are composed; the whole becomes more important than the individual components. The design of permaculture systems aims to reduce waste, human labor and energy input, by constructing systems with the maximized benefits of the interconnection of components to achieve a high level of synergy. Permaculture design changes over time due to the relationships of individual elements, becoming a complex system, producing food and materials in a small space, with a minimal input of work.[42]

[42] *Permaculture Design: Linking Local Knowledge in Land Use Planning for House Compound*, https://www.researchgate.net/publication/325714159_Permaculture_Design_Linking_Local_Knowledge_in_Land_Use_Planning_for_House_Compound

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Source: https://permaculture.org/2020/01/14/a-life-in-permaculture-design/

Permaculture is purely a design system and as such can be used wherever design is required. Permaculture is most often used in the design of houses and landscaping, combining agroforestry, natural construction and rainwater harvesting techniques.

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Utility animals are often integrated into the design . Natural activities of animals, such as burrowing in the ground by chickens or burrowing in the ground by pigs), are used to dig soil for cultivation. Chickens or pigs are confined to a small area for a few days, where they eat weeds, parasites and insect larvae that would otherwise harm the crop. In the pasture where horses or cows grazed, goats and sheep will eat plants left by their predecessors .

Ducks in gardens are used to eat snails. Pigs can also be trained to eat snails by adding snails to their food. Soon the pigs will start searching for snails on the ground themselves

A well-known example of animal and plant cooperation, illustrating the principles of permaculture, is a chicken coop adjacent to a greenhouse. Chickens are supposed to release carbon dioxide, which in turn is used by plants, releasing oxygen for the hens to breathe. During the day, the southern wall of the greenhouse will heat the room, and at night, the chickens will heat the hen house with their bodies, thanks to which the temperature in the greenhouse will also increase.

Principles of permaculture design

- ***Observe and interact:*** by spending time collaborating with nature, we can design solutions that meet our needs.
- ***Catch and store energy:*** by creating systems that accumulate resources during prosperity, we can save them for worse times.

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- ***Be efficient*** (Obtain a yield): Get yourself some really useful fruit for your work.
- ***Apply self-regulation and accept feedback***: there is need to limit inappropriate behavior in order for systems to function smoothly.
- ***Use and value renewable resources and services:*** take full advantage of nature's abundance to reduce consumption behavior and dependence on non-renewable resources.
- ***Produce no waste***: When we appreciate and use all available resources, nothing is wasted.
- ***Design from patterns to details:*** looking at a distance, we can observe patterns in nature and society. They can be the backbone of our projects, to which we will then add details.
- ***Integrate rather than segregate***: When we put the right things in the right place, relationships are formed, and the things work together to support each other.
- ***Use small and slow solutions:*** small and slow systems are easier to maintain than large ones, make better use of local resources and produce more sustainable results.
- ***Use and value diversity:*** it reduces the sensitivity to threats and uses the unique properties of the environment in which it is located.

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- ***Use edges and value the marginal***: the most interesting scenes take place at border locations. These are often the most valuable, diverse and productive components of a system.
- ***Creatively use and respond to change***: through careful observation, we can positively influence irreversible changes by intervening at the right time.

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Hügelkultur

The practice of hügelkultur consists in burying wood inside a hill in the shape of a hill or mound. Over time, wood decomposes providing nutrients, and gradually releases water, so

from the second year of its existence such a bed does not need watering. Timber cut into logs and smaller branches are stacked in oblong piles and then covered with earth, creating oblong mounds.

Source: Open Hand Foundation; http://jeffcogardener.blogspot.com/2015/02/hugelkultur-who-knew-composting-process.html

Compost, leaves and fertilizer can be added. Due to the decomposition processes taking place inside, the interior of the mound will be warm. In the first year, plants that do not have long roots and do not need a lot of nitrogen can be planted, but in the following years the soil is more fertile. Wood buried in a flower bed will provide the nutrients for approximately 15 to 20 years[43]The bed should be approx. 180–210 cm high (it will decrease by approx. 30 cm in the first month) and 1.5 m thick. A 60 cm high bed will hold water for only about two months.

Hügelkultur is practiced by burying large amounts of wood in oblong mounds to retain water in the soil. When wood decomposes in the soil, its porous structure acts like a sponge. During the rainy season, a large amount of buried wood can retain enough water for crops during the dry season[44]. The wood in the mound will decompose releasing nutrients for about 20 years. Crops can be grown on the slopes of the mound, which is a kind of raised bed. The mound

[43] *Harnessing hügelkultur*; https://www.groworganic.com/blogs/articles/harnessing-hugelkultur
[44] *Hugelkultur: the ultimate raised garden bed,* shttps://richsoil.com/hugelkultur/

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does not need to be additionally fertilized or watered[45]. A bed of this type helps to retain water on the plot, increases soil fertility, and can bury wood that is no longer suitable for any other use[46]. Not all wood is suitable for burying as fertilizer: black locust does not rot because of too hard wood, black walnut is toxic to most plants, and cherry to animals. Good species are: apple tree, willow, poplar, alder.

[45] A. Fowler, *The joys of hugelkultur (or rotting wood to you and me),* https://www.theguardian.com/lifeandstyle/2012/sep/07/hugelkultur-permaculture-gardening-alys-fowler

[46] *The Art and Science of Making a Hugelkultur Bed – Transforming Woody Debris into a Garden Resource*, https://www.permaculturenews.org/2010/08/03/the-art-and-science-of-making-a-hugelkultur-bed-transforming-woody-debris-into-a-garden-resource/

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Fig. 1, 2, 3, 4. Raised garden bed hügelkultur after: one month (1), one year (2), 2 years (3), 20 years (4). *Source: https://richsoil.com/hugelkultur/*

Fig. 1

Fig. 2

Fig. 3

Fig. 4

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Hugelkultur should be applied in the places where the soil is shallow. The easiest/fastest way is to find excess soil from somewhere else on the property and piling it on some logs.

For those times that the soil is deep and soil is moved by hand. Recommended is to dig up the sod and dig down for 30-50 cm. Then pile in the wood, further: to put sod on top of the wood, upside-down. Then pile the topsoil on top of that. Even better is to figure out where the paths will be, and dig down there too. Add two layers of sod onto the logs and then the double topsoil.

When Hugelkultur raised garden beds are built to be tall enough, there is not need to irrigate, no hoses and no drip system (after the second year). Anything shorter won't require as much irrigation - so there is still some benefit. Imagine going on vacation in the summer without having to hire somebody to water the garden.

Hugelkultur raised garden beds can be built just two feet tall and will hold moisture for about three weeks. Sometimes, its followers start out with hugelkultur raised garden beds that are around 75cm tall and plant only annuals. And each year they will build the size of the bed a foot. So that after a few years, they will have the bigger beds and the neighbors never really noticed. And if they've tasted what comes from it - they might be all for it without caring about the big mounds.

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MAGYAR NEMZETI VIDÉKI HÁLÓZAT

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