Inspiring4Biodiversity

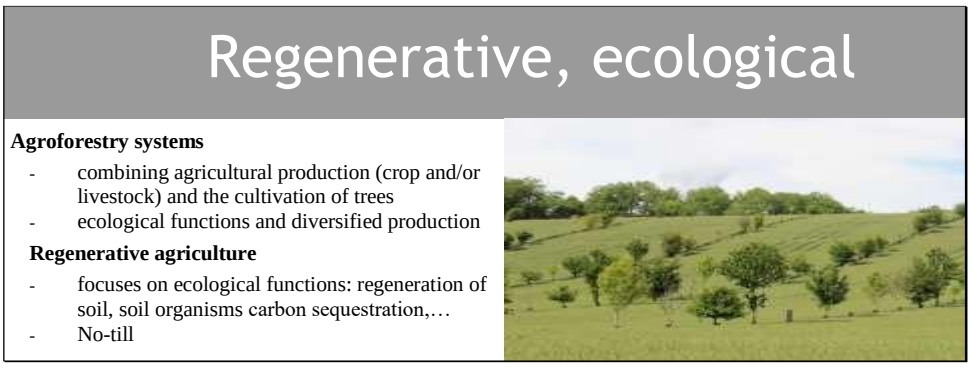
Regenerative agriculture, agroforestry and old varieties of fruit trees

Introduction to the subject

Annotated handout for the preparation of a presentation or lecture

Erasmus+

Opening screen - a photograph taken near the village of Moravské Lieskové, Slovakia, an orchard of old varieties of fruit trees. Sheep help with the maintenance of the grassy areas. This is also one of the examples and types of agroforestry systems in Slovakia - a combination of tree growing and animal husbandry.



The concept of organic farming is well known and probably everyone has come across it. In the case of regenerative agriculture and agroforestry, or agroforestry systems, these are relatively new and unfamiliar concepts not only among lay people but often also among the professional public.

What are the differences between these systems? How do they overlap and how do they differ from each other? This brief overview of definitions and explanatory terms provides an answer:

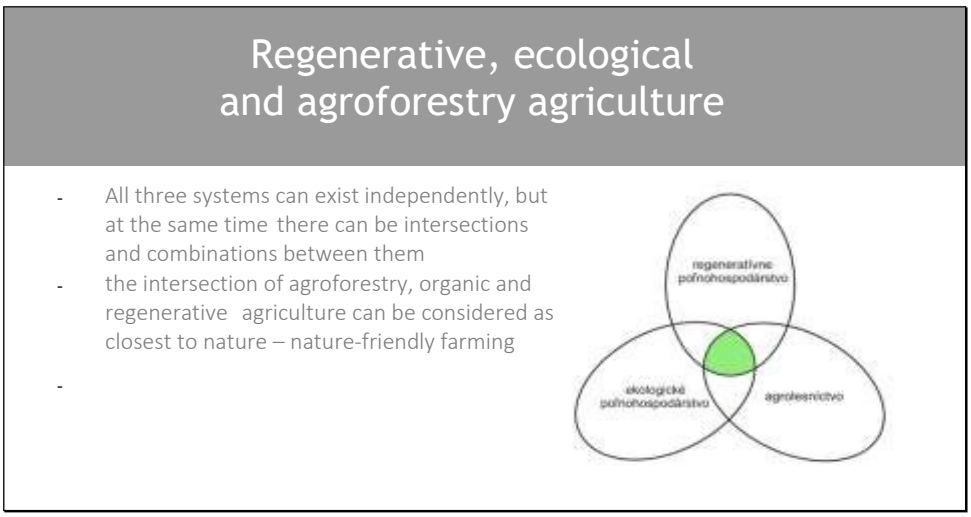
Agroforestry systems combine agricultural production (crop and/or livestock) and the cultivation of trees (forest and/or fruit and/or shrubs). The aim is to provide ecological functions alongside production and to increase biodiversity.

No agrochemicals are used in ecological (organic) farming, only authorised products and controls, production and soil analyses are carried out by the inspection bodies. The organic certificate does not require the fulfilment or monitoring of ecological functions such as increasing biodiversity, improving soil quality, protection against erosion, drought, etc. The soil may be ploughed.

Regenerative agriculture focuses on ecological functions: regeneration of soil, soil organisms and the ecosystem, biodiversity, carbon sequestration, mitigation of soil water and wind erosion, water retention in the landscape and mitigation of the negative impacts of climate change. The soil is not ploughed, no-till technologies are used. Instead, direct sowing into the residues of the pre-crop or intercrop is

performed. Also strip-till (only a narrow strip of soil is tilled into which the seed is sown, the soil between the rows is untilled) is possible.

On the picture we see existing agroforestry systems in Western Europe, where agroforestry has been practiced longer and is much further along in its exploration and implementation.

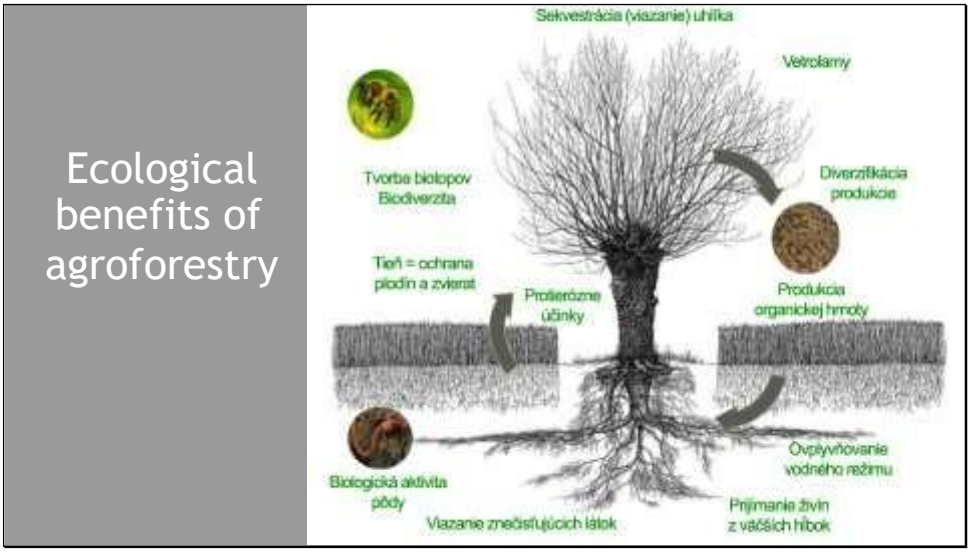


All three systems can exist independently, but at the same time there can be overlaps and combinations between them.

Agroforestry is considered by some to be part of regenerative agriculture

The intersection of agroforestry, organic and regenerative farming can be seen as the closest to nature - farming close to nature.

Conventional farming can only have full penetration with agroforestry - penetration with organic farming is ruled out by the use of agrochemicals, penetration with regenerative farming is ruled out by intensive tillage and soil degradation.



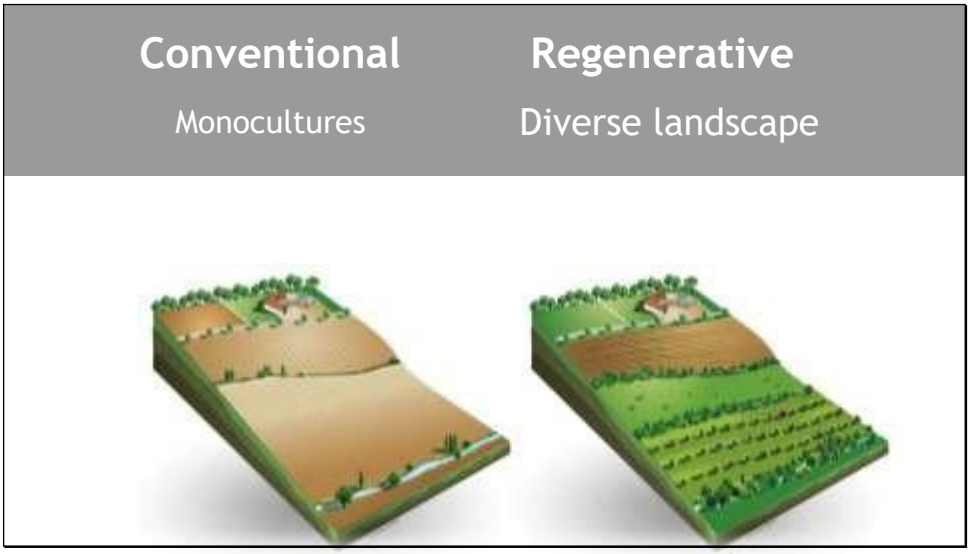
Although the diversification and increase or maintenance of production is a significant benefit of agroforestry systems, the greatest benefit of agroforestry can be considered to be its environmental benefit.

As can be seen in the figure, the combination of tree and field crops contributes significantly to the biological activity of the soil and, to the anti-erosion effect (windbreaks, prevention of water erosion. Moreover it contributes to the creation of a good quality environment for animals - 'wellfare farming' (protection against adverse weather conditions), to the creation of habitat creation, biodiversity enhancement, carbon sequestration (fixation), production of organic matter (fallen leaves remain in the soil), direct influence on the water regime (water retention in the soil), uptake of nutrients from greater depths and fixation of pollutants.

This is probably what the Slovak landscape looks like in the most intensively farmed areas of Slovakia. Slovakia is one of the countries in Europe where monocultures cover the largest areas. It is common to see single-crop fields of 150 hectares or more

In the media we have often encountered criticism of the large yellow rapeseed fields in Slovakia in the past period. However, the problem is not the rapeseed itself, which is a valuable crop, but the way of its cultivation. However, this is true of any crop that is grown as a monoculture on too large an area, as we can observe in current agricultural practice.

The modified image shows today's rapeseed fields, but also an alternative to how rapeseed can be grown more organically within agroforestry systems



Food production and farming methods should also be considered holistically in terms of the environment and other elements of the landscape. The picture on the left shows a typical picture of today's agriculture, which prioritises only production.

On the right are farming systems that not only produce food, but make the landscape more stable, resilient, healthy and diverse. This can be achieved by applying the principles of regenerative agriculture and agroforestry.

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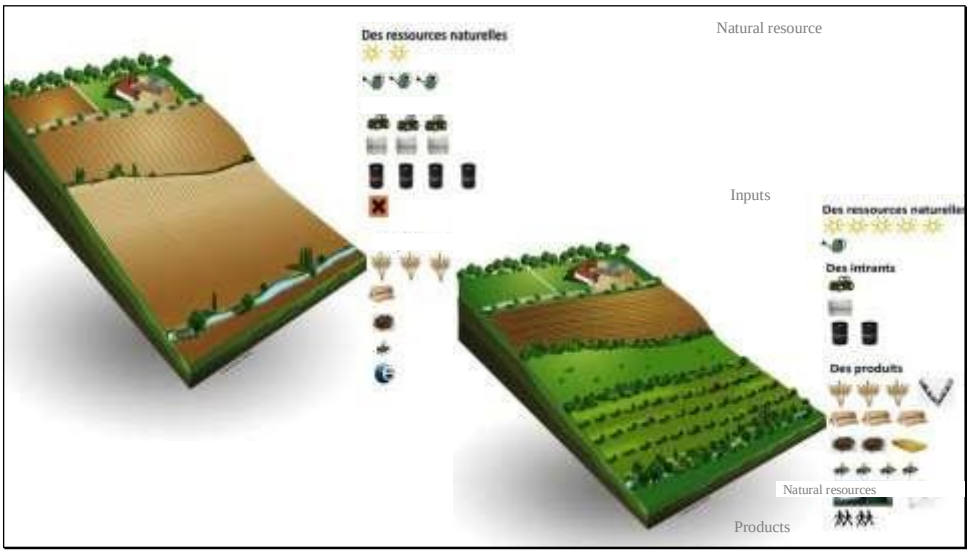
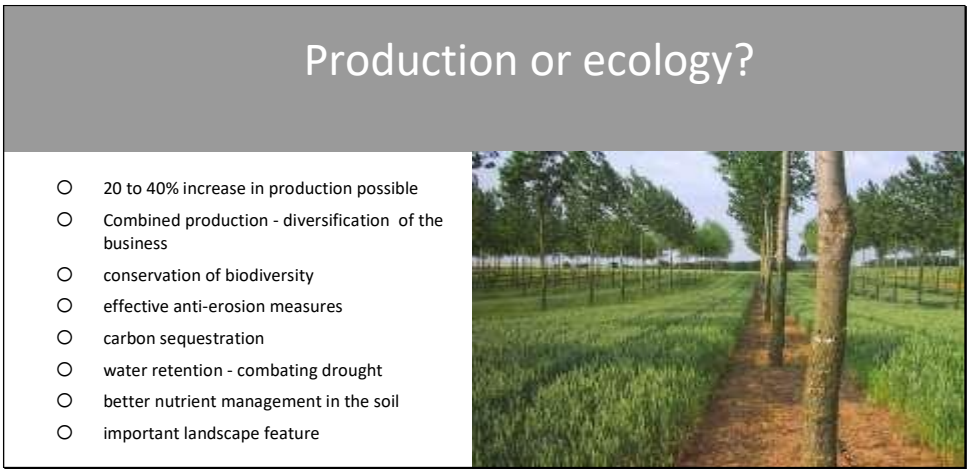


A closer look at the differences in the two approaches to agricultural production. When focusing on the necessary inputs and outputs (products) from both types of farming, the obvious differences between them become apparent. The pictograms mean that the second method (regenerative) makes better use of natural resources such as solar energy and water. It also results in lower fuel requirements, less intensive input of machinery in the field, lower (or no) application of fertilisers and pesticides.

In addition, this type of farming brings diversified production, greater overall production and additional benefits in terms of the fulfilment of ecological and social functions (rural employment, tourism, recreational environment, etc.).



The ecological benefits of agroforestry systems are evident and are summarised in this slide.

A frequent argument of current farmers and fertiliser company representatives and pesticide users who reject alternatives to conventional agriculture is that greener systems cannot produce enough food to feed everyone on the planet.

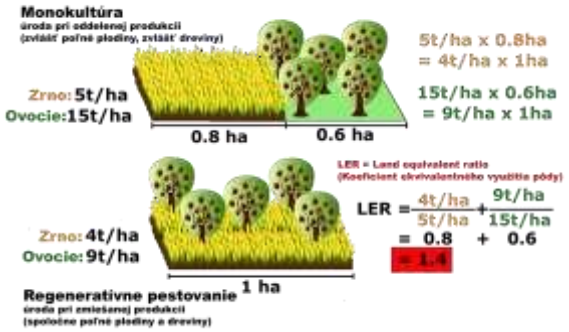
In the case of agroforestry, for example, they argue that tree crops take up farmland that would otherwise be sown with field crops, and agroforestry systems thus produce lower yields of field crops per hectare. This ignores the fact that a farmer can also monetise production from the tree part of agroforestry systems, whether in the form of biomass - timber or fruits.

According to foreign studies, where long-term agroforestry trials have been established, unlike in Slovakia, this type of farming can be even more efficient by 20 % and, according to some sources, even 40 % compared with conventional farming

Production or ecology?
Production and ecology!

Calculating the Land Equivalent Ratio:

- not only farm land but also trees are productive land



We can therefore take a closer look at production in agroforestry systems

The schematic picture above visually shows the conventional - current farming method. This means that tree species are grown separately in, for example, orchards or fast-growing plantations. Field crops are also grown separately in fields in large monocultures.

In this case, field crops occupy 0,8 ha and tree crops 0,6 ha. This area produces a crop of 4 t of cereals, which translates into a yield of 5 t/ha. The tree crops in this conventional system produce 9 t of fruit on this area, giving a yield of 15 t/ha.

The figure below shows the combined cultivation of tree and field crops on a single area with a total area of 1 ha. In this system, although the yields per ha are lower - 4 t/ha for cereals and 9 t/ha for fruit - the total area used is only 1 ha compared to the previous system where we used a total area of up to 1.4 ha.

This comparison gives a Land Equivalent Ratio of LER=1.4. This shows that agroforestry systems can be up to 1.4 times more efficient than conventional farming with monocultures. Of course, this is a theoretical calculation; in practice, this equivalent is also influenced by other factors (type of crop, tree species, variety, environmental conditions, etc.).

Definition of regenerative agriculture

"Regenerative agriculture is the renewal of production and farming systems. It aims to regenerate soils, increase biodiversity, and improve the cycling of minerals, carbon and water, while improving profitability throughout the supply chain." (Gabe Brown)

The term regenerative agriculture was defined by Robert Rodale in the early 1980s. However, it did not come to wider public attention until after 2010. It is the opposite of agriculture, which degrades the soil and the environment as a whole. Although specific agronomic practices vary by climate region, what is important is the content and themes that regenerative agriculture addresses. In most countries, even in different climates, they coincide.

Leading expert and farmer Gabe Brown defines regenerative agriculture as follows: "It is the renewal of production and farming systems. It aims to regenerate the soil, increase

biodiversity, improving the cycling of minerals, carbon and water, while improving profitability throughout the supply chain."

In the photo you can see the rape sown directly into the unploughed stubble of the previous crop. In regenerative agriculture, it is often said that after the combine harvester, the drill heads out into the field immediately after to establish a new crop (new crop or intercrop) so that the **soil is not left without the vegetative cover.**

Basic principles of regenerative agriculture

- **minimum soil disturbance, no-till farming, strip-till**
- **diversified main crops, improved crop rotation**

greater demands on crop rotation planning

- **involvement of intercrops and cover crops**

better soil structure, lower incidence of pests and weeds, higher biological activity, nitrogen absorbtion

- **managed animal grazing**

intensive short-term grazing

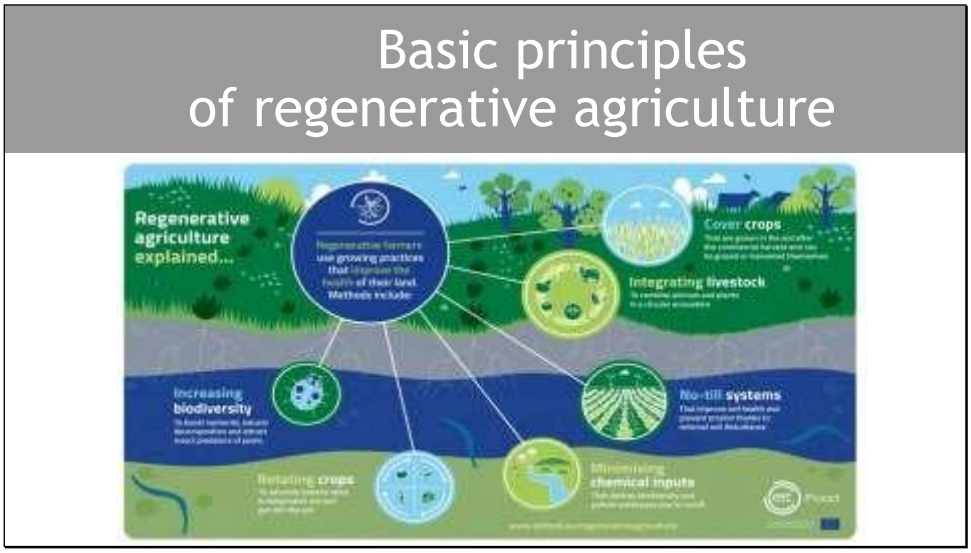
- **building soil organic matter**

carbon sequestration (from 1.8% to 3-5% organic matter)

- **fostering biodiversity**

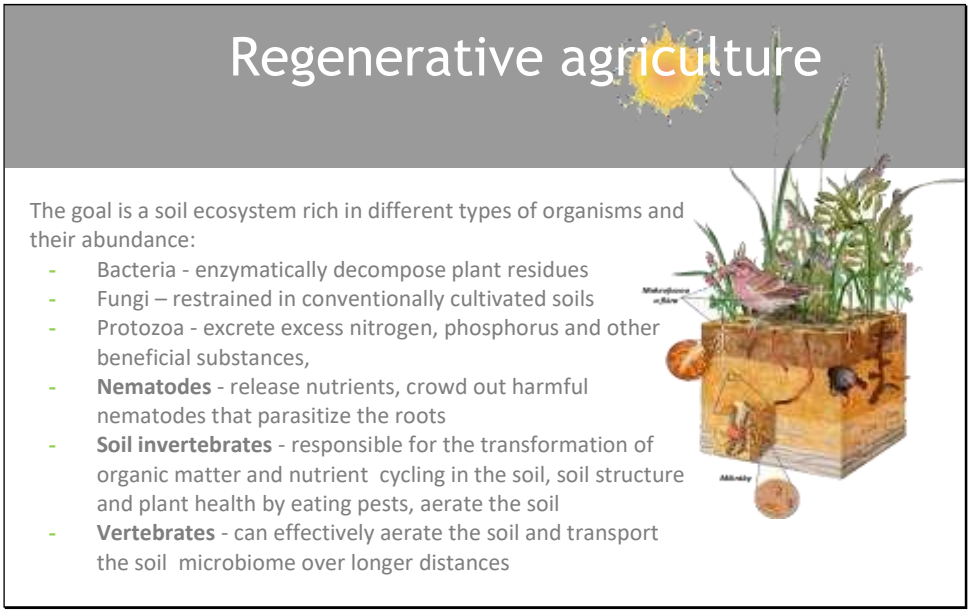
The basic pillars of regenerative agriculture according to Gabe Brown are:

- minimum tillage, no-till or strip-till
- diversified main crops, improved crop rotations, which also entail higher demands on crop rotation planning
- the inclusion of intercrops and cover crops, which improve soil structure, reduce the incidence of pests, diseases and weeds, increase the biological activity of the soil and capture nutrients more efficiently
- managed animal grazing means intensive but short-term grazing
- building soil organic matter - regenerative agriculture is expected to sequester carbon and increase the proportion of organic matter (currently averaging 1.8 %) to the desired level of 3 to 5 %.
- improving biodiversity.



A summary of the basic principles of regenerative agriculture in illustration.

Robert Rodale of the Rodale Institute about regenerative agriculture: "Regenerative agriculture goes beyond the term sustainable because it seeks to improve soil quality and health. Soil health affects everything from plant health, human health and well-being to the future of our planet. Regeneration prioritizes soil health while embracing high standards of animal welfare and worker equity. The goal is to create farming systems that work in harmony with nature and improve the quality of life for every creature."



A healthy soil is an ecosystem rich in different types of organisms and their abundance. There are more organisms in one handful of soil than there are people on the planet, namely:

Bacteria form the basic structure of soil, called micro-aggregates, which allow soil to breathe and retain the ater. They enzymatically break down plant debris, living in symbiosis with plants and making nutrients available to them. Some bacteria fix atmospheric nitrogen, others can break down mineral particles in the soil. Exceptionally, under unsuitable conditions, pathogenic bacteria can occur (anaerobic in compacted soils).

Fungi are often absent in agricultural soils today, making plants more susceptible to fungi and various diseases. Beneficial fungi form long filaments - hyphae - underground and connect invisible parts of the soil into visible macroaggregates. The soil then breathes better and retains more water. The fungi produce enzymes that break down both wood and minerals.

Protozoa are small single-celled organisms, typically 10 to 100 times larger than bacteria. Well-known are amoebae, flagellates, and, in less aerated soil, funnel webs. Protozoa eat bacteria, up to 10,000 a day. They excrete excess nitrogen, phosphorus and other beneficial substances into the soil. With sufficient protozoa, plants have a constant supply of nutrients and the soil is fertilised naturally.

The presence of **nematodes** indicates a lot about the health of the soil. Beneficial nematodes feed on bacteria, fungi, protozoa and other nematodes. After digesting them, they release nutrients. They also crowd out harmful nematodes that suck the sap out of the roots, such as the potato cyst nematode.

Small soil invertebrates play an important role in the complex web of soil life, although many of these organisms are still unknown. They are responsible for the transformation of organic matter and nutrient cycling in the soil. Many are fed on fungi, physically and chemically breaking down available organic matter. They spread

bacteria and fungal spores on their bodies through the soil, thus accelerating soil processes. They improve soil structure and plant health by eating pests. **Large soil invertebrates** carry the microbiome on their bodies and inoculate their surroundings with it. They improve plant health by devouring pests. They are also called soil engineers. Ants move large amounts of soil and organic matter. Earthworms create tunnels in the soil to aerate it and are vital for infiltrating more rainfall. Centipedes and beetles act as predators - sanitizers of the soil ecosystem. **Vertebrates** are often perceived as soil pests (moles, rodents), but they can effectively aerate the soil and transport the soil microbiome over greater distances.

Plants are the primary food source for the soil ecosystem. Roots, in the form of exudates, move an average of 40% of their photosynthetic energy to bacteria and fungi. On exchange they obtain nutrients and other substances they need from microbes, e.g. protective substances, hormones, enzymes, etc. The dead plant matter becomes food for the soil microbiome

According so-called ecoschemes in the new Common Agricultural Policy (CAP), each Member State is entitled to allocate up to 25% of the CAP to ecoschemes.

This is a completely new instrument that farmers will have to learn to work with.

Ecoschemes also include principles that coincide with those of agroforestry and regenerative agriculture.

Opportunities in the Eco-schemes 2023-2027 according to the European Commission:

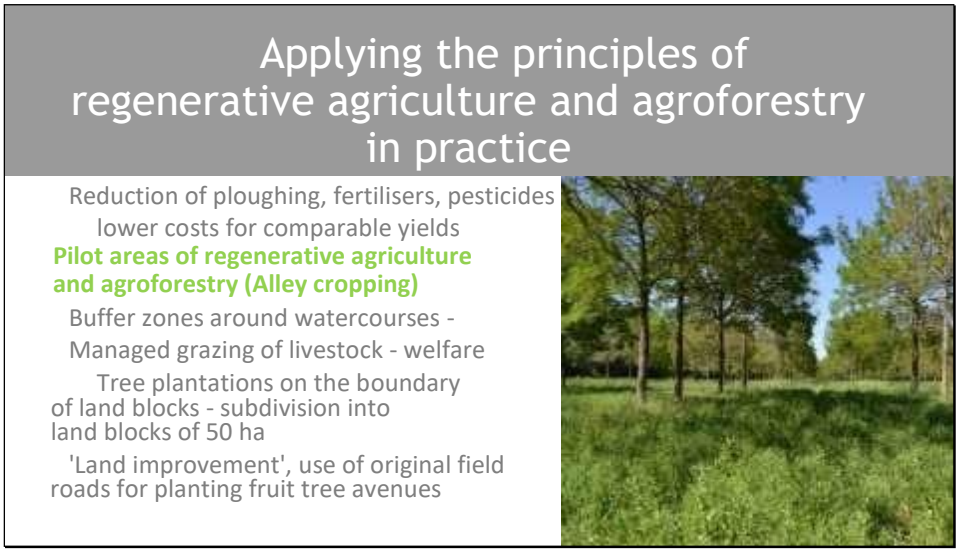
- Agroecological practices - e.g. use of nitrogen-fixing crops, multi-cropping, intercropping...
- Livestock and animal welfare plans - e.g. feed quality, paddocks...
- Agroforestry practices
- High nature value farming practices - e.g. biodiversity support, fertiliser reduction...
- Carbon farming - carbon capture

- Precision farming - e.g. reduction of inputs
- Improved nutrient management - e.g. reduction and prevention of water, soil and air pollution
- - Protection of water resources and other soil conservation practices

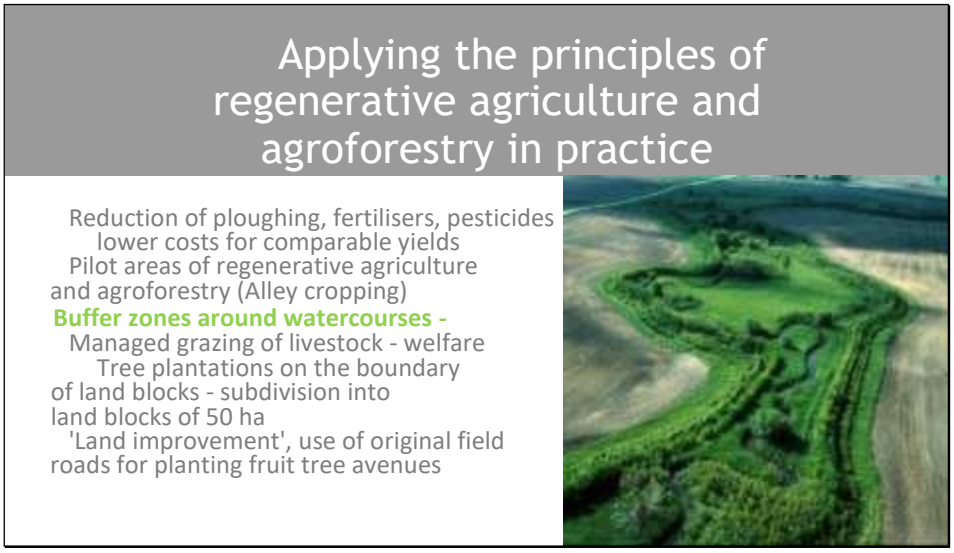
From the above information, concrete recommendations for farmers and the agro-sector have emerged, which can start to be implemented immediately.

These are:

- Reduce tillage, fertilisers, pesticides, thus achieving lower costs at comparable yields

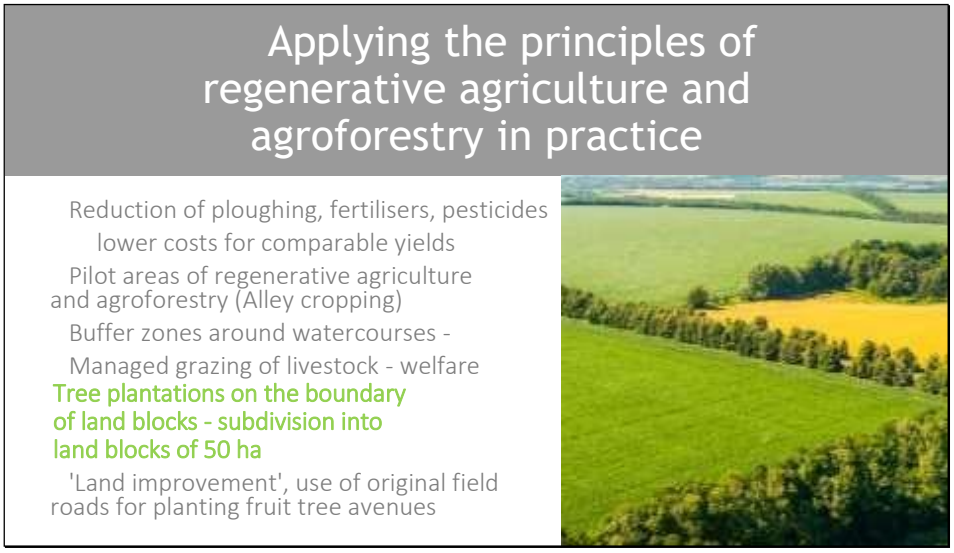


- Establish the first pilot areas of regenerative agriculture and agroforestry (Alley cropping). There are still very few of them in Slovakia. Pilot areas would contribute to the education and training of farmers.



- The vicinity of watercourses needs to be protected from erosion from fields and the release of unused fertiliser into surface and groundwater. This would create buffer zones separating agricultural areas from watercourses.

- Managed grazing of livestock brings, among other things, the necessary well-being to the animals (wellfare), which also results in higher quality milk and meat production.



- The plantations of trees can be started first on the edges of soil blocks. This would divide the fields into smaller blocks of no more than 50 hectares.

Note: this section is specific to context in Slovakia

- Actual land adjustments are in sight. This hinders not only their efficient use
- and the exercise of property rights, but also the planting of trees in the landscape. According to the legislation, it is not possible to plant trees on land that we lease but do not own, or that we do not have the owner's consent for such activities.
- For the purpose of 'land improvements' for the purpose of establishing avenue plantings, we can use the original dirt roads that are owned by the Slovak Republic.
- It would be ideal to implement at least a Pilot Project aimed at the use of land owned by the Slovak Republic, possibly by municipalities or under the administration of the Slovak Land Fund.

Pilot project

A pilot project should be set up in a selected cadastral area with the implementation of linear planting of trees in agricultural landscapes in combination with field crops and monitoring of their positive environmental benefits - increasing soil quality, soil water retention, elimination of erosion, increasing biodiversity, carbon sequestration and other positive functions. Suitable linear parcels, such as former dirt roads and parcels managed by the Slovak Land Fund,

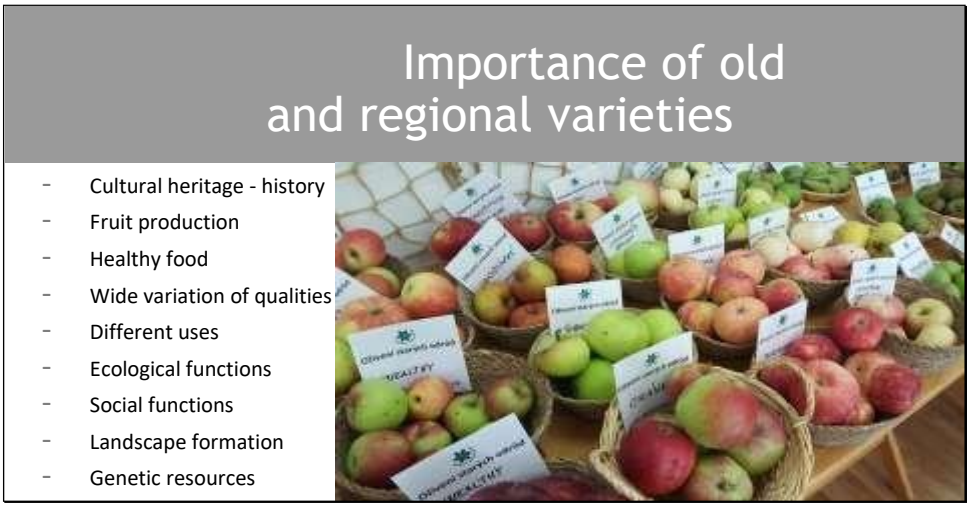
Water Management Company, Slovak Railways or owned by municipalities will be used for the purpose of preserving genetic resources of fruit trees for planting old varieties of fruit trees in the form of avenues or silvo-ornamental systems of alley cropping or regenerative systems without roots. The former dirt roads represent suitable plots not only in terms of their ownership but also because of their predominantly contour orientation on sloping terrain, where they have in the past provided an important anti-erosion function and naturally divided the soil blocks into smaller soil units of maximum 50 ha. After its implementation, the pilot project can serve as a „Living Lab" for further research and as an example of good practice for further application in other regions of Slovakia.

The diversity of characteristics of the old varieties also allows their **varied use in the landscape**, where they fulfil important ecological functions. The old and region specific varieties are suitable for extensive and organic farming methods. Growing them on seed and vigorously growing rootstocks in the form of a semi-stem or tall stem gives them longevity, and resistance to adverse factors. Wider staples and grassing allow multifunctional use of extensive orchards also for livestock production. Low level of agrotechnology requires fewer inputs in the form of artificial fertilisers, pesticides and lower cutting intensity. Of course, the grower must also consider the negatives that growing old varieties in such systems entails. These include later onset

of fruiting, lower yields, variable fruiting and lower fruit quality compared with production in intensive orchards.

Different varieties have different crown types. Narrow crowns are suitable for roads ('Bernese Rose', 'Matkino'). Trees with broad and spreading crowns as solitaires in the landscape (Boskoopskie, Gravstynskie).

Long-standing old massive trees have a favourable influence on the microclimate, water regime, reduce the negative effects of climate change, fulfil soil-protective, aesthetic, architectural, social, recreational and psychological functions.



As the essence of agroforestry systems is the combined cultivation of tree species and conventional farming activities, an important aspect is the selection of the right tree species for use in these systems. Each grower may prefer different criteria. They can choose to produce timber for further processing or to produce fruit. In the latter case, there is the possibility of considering planting old varieties of fruit trees that are grown as high trunks. This would provide the farmer with an income from fruit production, but would also make a significant contribution to saving

endangered gene pool. However, in addition to fruit production, such trees also fulfil a number of ecological functions. For example, they contribute to soil conservation, influence the water regime, improve

microclimate of the environment, are an attractive habitat for other organisms, thereby increasing biodiversity and help to improve the environment in a number of ways. The gene pool of old and landraces deserves appropriate protection not only because of the importance of preserving its natural uniqueness but also because of its undeniable cultural value.

The following illustrations show various examples of existing agroforestry systems that are already implemented successfully:

Corn in alley cropping

A closer look at the same system with corn

Wheat in young tree planting – alley cropping

An aerial view of the alley cropping system

A similar shot from above

Grassland for grazing or fodder production

Tree species grown for timber production, the riparian zone is kept weed free, which is not necessary. It is more environmentally friendly to keep it vegetated and maintained by mowing or mulching

The following three images are from Montpellier, France, where the first experimental plots of agroforestry systems were established more than 20 years ago. France is thus one of the leading countries in

research and implementation of agroforestry systems in practice. It combines the cultivation of field crops peas and cereals with black walnut to produce valuable timber. These timber crops are now at a stage where they can be harvested and the biomass production can be financially valued.

Another shot of the experimental areas in Montpellier (Restinclieres)

Many scientists, farmers and those interested in learning about agroforestry systems in practice come to Montpellier (Restinclieres)

Agroforestry areas in China, focused on timber production

Silvopastoral agroforestry system – pigs

Silvopastoral agroforestry system - poultry

Young tree planting in combination with vegetable production

Hazelnut grown in a double row in combination with potatoes

Also aromatic and medicinal herbs can be grown together with woody plants

On extremely windy sites or sites with increased erosion, tree allleys are an excellent solution

Imprint

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Jakubec et al: The White Carpathian fruit treasure - Rescue of old and regional varieties of fruit trees in the White Carpathian region, Uherková, Jakubec: Old varieties are IN, Vašš, Veselý: Growing viable fruit trees and shrubs, Briggs: Agroforestry
Internet: www.idnes.cz, https://www.youtube.com/watch?v=QvhIPw76AcM
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