The preparation and preservation of the soil vitality

Host: Many people talk about the vitality and fertility of soil and how to preserve it. This is what we will talk about in our episode today with famous Dr Esraa. Doctor, there is a lot of talk about the fertility and vitality of soil. What is the meaning of this term?

Presenter: First of all, I want to thank our engineer for this podcast, as many of those who are interested in agriculture, such as engineers and farmers, are currently listening to us.

Soil fertility is arguably one of the most important elements in the acquisition of healthy plants. The soils supply all the elements, and nutrients plants and crops need to grow, propagate and produce, such as nitrogen, potassium and phosphorus. Other necessary elements such as calcium and copper, which are needed by crops but in smaller quantities, are found in soil. They also contain some organic substances that are important to the structure, strength, coherence and retention of the moisture and nutrients within the soil. These can be added to soil with agricultural fertilisers if not present.

Host: Are there factors that affect soil fertility? For example, you have mentioned soil's acidity?

Of course, there are many factors affecting soil fertility:

Soil depth: As the depth of the soil increases, so does the area that roots are spread across increases. This also increases the amount of nutrients absorbed by plants. In surface soil, plants are more likely to lack water and nutrients than those in deep soil. Larger plants, such as trees, may not find enough space to stabilise roots.

Soil structure: The term "soil structure" refers to the arrangement of soil particles and the rest of their constituent elements (organic matter, water, air). Soil structure plays an essential role in permeability; properly constructed soils facilitate the mineral and aquatic nutrition of plants. If the soil is rich in mineral nutrients and is poorly built and compact, with little or no water and air penetration, it is ill-suited to crop growth and does not yield a good return.

Ventilation: Ventilation is essential to the life of roots and natural organisms (insects and microorganisms). One of the factors that limit good ventilation is soil monitoring and water discharge. A thick layer forms on the soil surface in the spring (due to exposure to wind and heat), and a deep ploughing process leads to a rapid loss of organic materials and water.

Sewage capacity: The discharge process is closely related to ventilation. Fertile soil with a good granular structure allows water on the surface to run out quickly and drain any surplus well enough to be available in root layers.

Water conservation capacity: A fertile soil rich in organic matter can hold back water like a sponge. The soil will give the plant water little by little over a long period. A plant needs water as a nutrient and to replace the water it loses through its leaves (erosion). The roots must provide the plant's need for water regularly; otherwise, they will be compressed and grow less.

Temperature: Temperature affects the activity of living organisms that produce the humus. The lower the temperature, the slower the decomposition process. A higher temperature means faster decomposition, as the living organisms are more active. It increases the conversion of organic substances into humus, which mixes with soil elements, and improves the physical and chemical

properties of the soil. As a result, it improves the water and mineral nutritional conditions of the plants.

Nutrient availability: We call them metallic elements, the most important of which are: nitrogen, phosphorus, and potassium, plus another 15 elements that the plant needs small amounts of. These nutrients can be retained in the soil and can be dissolved in soil water, becoming available to plants.

Soil acidity or alkalinity: Soil is measured in PH. Most plants live in a neutral medium, i.e. a PH equal to seven. A PH lower than 7 is more acidic, whilst a PH higher than 7 is more alkaline. The PH ratio varies from plant species to plant. Most plants live in a PH of 5,5 to 7. When the PH is unsuitable, this can cause a shorter life expectancy.

Host: Much is being said about organic fertilisers and their use as an alternative to chemical fertilisers, so it gives us a brief idea of what organic fertilisers are meant for?

Organic fertilisers have become well-known by farmers and were covered in an earlier episode on the Agricultural Voices podcast. You can listen to it again for more details. But I can briefly sum them up here.

Fertilisers: Organic and inorganic materials used to feed plants and improve the soil's biological, physical, and chemical properties.

The use of fertilisers can affect plants' quantitative and qualitative productivity (in nurseries, fields and gardens), stimulate their growth, strengthen their resistance, and improve their health. The potency of fertilisers is determined by their type, characteristics, susceptibility of the plant species, the nutrients needed, and the content of absorbable soil materials. Depending on their composition, they are divided into two types:

Organic fertilisers: includes animal and plant fertilisers, compost, green fertilisers, etc. They contain all the essential nutrients plants need, such as nitrogen, phosphorus, potassium and calcium.

Chemical fertilisers: Mineral fertilisers, often a combination of 2-3 nutrients (nitrogen, phosphorus, and potassium), or a simple one containing one, like urea.

Organic fertilisers:

Fertilisers that are wholly or partly composed of soil nutrients from plant or animal origin. Organic matter is the main ingredient to be provided in the soil.

Effectiveness:

Compost in soil contains humus that performs the following tasks:

Improving the physical characteristics of the soil: Humus is the main factor in stabilising soil construction and improving soil water-retaining capacity. Humus-rich soils are more resistant to drought.

Improvement of soil chemical characteristics:

- Humus increases soil capacity to retain nutrient elements.
- Humus is a source of nutrients for plants.
- Phosphorus is preserved in a good state, allowing easy absorption by plants, despite lime and free iron.

- It reduces potash fixation in the soil.
- Facilitates plant uptake of nutrients.
- Humus increases the impact of mineral fertilisers added.
- Increase of biological activity in soil: Humus contains an extensive group of microorganisms that make the soil a living medium, so it is considered the basis for the microbial activity of the soil.
- Raising soil production capacity: Improved physical and chemical characteristics of the soil, increased microbial activity, more effective added fertilisers and improved plant mineral nutrition all increase soil productive capacity and thus ensure abundant production.

Host: Do you think there are new systems that help maintain soil fertility?

Presenter: Traditional agricultural systems have led to the depletion of soils and the departure of some of them from agricultural production. This is why some Arab countries, such as Egypt, Tunisia, Morocco, and Algeria, currently depend on conservation agriculture. You're going to ask me what conservation agriculture is, aren't you?

An estimated 125 million hectares of land have been applied by conservation agriculture worldwide. Using a conservation agriculture system (no-tillage) instead of an annual traditional deep-farm system helps reduce dredging, improve soil quality, and sequestrate carbon in the soil, and accordingly reduce global warming (Lalt al., 2003).

Disadvantages of cultivating land and depriving it of the remains of the crop:

1- Increased sensitivity to wind and water drift.
2- A decrease in water drainage into the soil, an increase in surface runoff losses, and a reduction in soil water content.
3- A decline of organic matter in the soil and soil quality and fertility.
4- Global warming is increasing, as organic matter is oxidising and CO2 is released into the atmosphere.
5- Soil characteristics - physical, chemical, and biological - often deteriorate in the long run.
6- Decrease in the productivity of cultivated plant species; varying productivity across seasons.
7- The use of chemical fertilisers in large quantities, which increases production costs.
8- The survival of farmers and their families on the farm is constantly threatened by low productivity, profit margins and insufficient income.
9- Traditional agricultural production systems are characterised by poverty and want, and there is an increasing migration of young people to the city.

Benefits of conservation **agriculture**

1- It reduces labour requirements.
2- It saves time
3- It reduces the need for agricultural machinery, and so reduces machinery wear and fuel consumption.

4- Improved long-term productivity.

5- Improved surface water quality.

6- Reduced soil erosion.

7- Greater soil water content.Greater soil moisture retention

8- Improved water penetration

9- Decreased soil compaction.

10- Improvement of the amount and activity of soil biological organisms.

11- Reduced emissions of carbon gases

12- Reduced air pollution.

Host: What is the effect of No-tillage conservation agriculture on different soil characteristics?

Presenter: There is sufficient scientific evidence in many countries around the world to show that:

Conservation agriculture conditions result in more organic matter, nitrogen, phosphorus, potassium, calcium and magnesium in the soil. They also recorded higher PH values and higher nutrient retention capacity.

The effect of conservation agriculture on the physical properties of soil: The application of conservation agriculture increases the rates of water infiltration, leading to a significant reduction in the loss of water by runoff and soil erosion (Roth, 1985)). It increases the soil's water content, increases the soil's temperature, and maintains the stability of the aggregate landmass. It also increases the density of the soil. Combined, these characteristics increase the yields of crop species compared to conventional farming systems.

Effect of conservation agriculture on vital soil characteristics: By not using ploughs, the nests and canals built by microorganisms are preserved, which increases the number and activity of soil living organisms compared with the traditional farming system. Leaving plant residues above the soil surface in the conservation farming system helps secure the food necessary for the life and reproduction of soil living organisms. It can be said: Soil fertility is primarily related to its biological activity, the latter being determined by the amount of plant residue left over the soil surface. Conservation agriculture also helps increase water content in the soil and maintain an appropriate temperature in the soil, which is one of the most important terrestrial environmental requirements for the reproduction and activity of living organisms.

Environmental impact of conservation agriculture: Extensive soil preparation processes accelerate the metallisation of organic matter and transforming plant residues into carbon dioxide gas (CO_2). This CO_2 is released into the atmosphere, contributing to increased concentration of atmospheric pollutants and leading to climate change. Numerous research has shown that soil carbon is often rapidly lost in the form of CO_2 minutes after extensive soil tillage. The amount of carbon lost depends on the number of times, and the intensity, of the farmer.

But we find that there are many economic and social constraints to the spread of conservation agriculture.

1. Adequate agricultural equipment: The appropriate seeds, which all types of equipment can plant (planting on lines) (sunflowers, maise, sorghum, etc.), must be developed, along with winter small grain crops (planting on lines) (wheat, barley, etc.). So that the farmer does not have to buy two pieces

of equipment, which is a considerable material burden for him, especially for the medium to small-size farms. These bi-purpose seeds help with applying agricultural cycles and the cultivation of green cover crops during winter/summer. Leaving the land uncultivated leads to a significant spread of weeds, which increases the cost of disposing of the weeds.

2. Adequate herbicides: The early years of direct-seeding technology are often difficult due to the high prevalence of weeds. They are all the more difficult if the appropriate weed pesticides, information on identifying them, and ways to control them are not available.

3. Mental Change: A farmer first has to change his thinking before he can think about changing his mind. First, farmers, technicians, researchers and extension workers must change their view of conservation agriculture and move away from destructive farming. They must move closer in thought and practice to the sustainable agricultural production system, such as conservation farming. We will struggle to apply direct seed technology as long as thinking in the agricultural field remains traditional.

4. Knowledge: A significant challenge for farmers in moving from traditional farming to farming without a farmer is how to control weeds. To cope with this new situation, they must understand herbicides, weeds, and methods of recognising and controlling herbs.

Herbicides: Comprehensive books should be available describing all the herbicides available on the market and their chemical properties, toxicity, quantity to be used per hectare, and a list of the weeds they're effective again. Without this, farmers, technicians, agricultural extension workers, and even researchers cannot progress with conservation agriculture.

Weeds: A brochure should contain photos of weeds scattered throughout the area for easy identification. It also shows the herbicide that is most effective for combatting them.

Herbicide application technology: Spraying herbicides is a difficult task for a farmer. It requires determining the volume of water per hectare, spraying pressure, the amount of pesticide flow, the speed of the tractor and the capacity of the tank and the amount of pesticides needed to obtain the recommended rate of active substance in the unit area of land. Unless the farmer is provided with simple and clear information about how to spray pesticides and calibrate sprinklers, the process of weed control will be inefficient, even if the most effective herbicide is used.

Host: Do you think this system can be applied directly in Syria?

Presenter: When implementing this, we must take the following main points into account:

1. Soil: Before adopting the direct-seeding technique, a chemical analysis of the soil must be done to determine whether the soil is acidic or alkaline. If the soil is acidic, the farmer should add lime before applying direct seed technology. It may be the last chance to add lime to the soil and investigate the possibility of forming the solid surface skin. In general, a hard surface crust is not a real problem in a conservative farming system. The vegetation stops rain from falling directly on the soil surface, preventing the formation of a surface crust. Generally, if the soil is poorly drained, then it is not suitable direct farming. Checking the rough terrain of the soil surface is difficult. Direct seeding machines do not work well if the land is not levelled correctly.

2. Mulch cover: The process of permanently covering the soil surface with a thick layer of plant residue is fundamental to the success of the direct cultivation system. If you don't understand the importance of leaving plant residues on the soil surface, you don't understand the conservation agriculture system. Most research indicates that at least 6 - 10 tons of dry matter should be left from green coverage crops per hectare per year. This helps to discourage the growth of weeds. The dense vegetation helps conserve water in the soil by reducing the area of the soil surface that is directly exposed to the sunlight, thus preventing the loss of water by evaporation and preventing the significant rise in soil temperature. It also improves the physical, chemical, and biological characteristics of the soil, and therefore the fertility of the soil. Generally, plant residues must be symmetrically distributed over the soil surface. Harvesters must be designed to disperse plant residues evenly over the entire area. Unfortunately, harvesters seldom take this point into account, and plant residues are spread in significant quantities in the middle of the field. In contrast, there is very little around the edges of the field.

Host: We talked about soil fertility, organic fertilisers and conservation agriculture, but are there any tips from a soil conservation doctor?

Currently, many research organisations and centres call for the necessity of soil conservation. My advice is one of the most important things to follow to preserve the soil:

1- Restructuring land through terraces to conserve water within the soil. Runoff of rainwater from elevated to low-lying areas is one of the reasons for soil erosion. Contour ploughing is also feasible, and troughs from annuals can be sown, and parts of steep slopes can be flattened.
2- Appropriate soil cover: To protect it from water evaporation, droughts, and erosion, farmers should leave part of the crop to protect the soil from water evaporation.
3- 3. Persisting in the shallow soil tillage: To protect it from drift, many peasants plough the soil with a deep plough to obtain the rich layers of valuable elements and raise them to the surface for use, but this affects the soil.
4- The use of modern irrigation techniques like drip irrigation protects the soil from dehydration and drift.
5- Reclamation and cultivation of agricultural land to protect it from desertification. Encouragement of early cultivation to protect crops from agricultural pests and thus reduces the use of pesticides.
6- Protecting the soil from agricultural pests through an integrated treatment system. For example, using predators or pathogens, viruses to fight agricultural pests, flooding the soil with water, or burning crop residue.
7- The application of environmentally friendly agricultural systems to protect the soil from pollution.
8- The use of organic fertilisers to improve soil quality rather than chemical fertilisers and pesticides.
9- Encouraging people to plant trees and other plants and reducing urban sprawl, which destroys the soil.
   Raising awareness among farmers about appropriate agricultural methods and modern methods to conserve soil and encouraging them to adopt such methods as the conservation agriculture system we have referred to.