Good Agricultural Practices Guide

to Reducing the Impact of Land Degradation and Climate Change within the Framework of Farmer Field Schools

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Guide content:

Guide Introduction:

Agriculture is the backbone of food security and economic development in many countries around the world. However, agricultural systems face significant challenges due to land degradation and climate change, exposing farming communities to significant environmental and economic risks.

Land degradation is a direct result of unsustainable agricultural activities, such as excessive use of chemical fertilizers, soil erosion, and inadequate management of water resources, and climate change exacerbates these challenges through increasing temperatures, changing rainfall patterns, and the high frequency of natural disasters.

Under these circumstances, farmer field schools stand out as an effective tool in building local capacity and increasing farmers' awareness of sustainable farming methods and good agricultural practices.

This guide aims to empower farmers through interactive education and community engagement to improve land management and enhance their resilience to climate change. Field schools rely on sustainable and innovative technologies that contribute to increasing agricultural productivity without negatively impacting the environment or natural resources.

This guide focuses on how to neutralize agricultural land degradation by providing practical and sustainable solutions that farmers can adopt and addresses the effects of climate change and how to adapt to them, contributing to improving agricultural production and reducing environmental risks in the long term.

This guide presents a set of agricultural practices that farmers can apply on their farms and have a role in reducing the impact of climate change on agriculture in addition to its impact on reducing agricultural land degradation.

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Part I

1- Farmer Field Schools

Introduction:

The agricultural sector in Jordan is one of the important economic sectors, due to its good contribution to the GDP, as it is not possible to achieve economic development without an effective agricultural sector, and to achieve development and effectiveness in the agricultural sector, there must be an integrated agricultural extension that works to bridge the gap between research results and farm applications at the farm level.

Guidance is an educational process or a tool or a means to guide the targeted to change their behavior and direction for the better and better by providing them with more information and knowledge and convincing them to adopt them voluntarily, guidance plays the role of mediator between the targeted and the scientific authorities in the transfer of information and knowledge from the scientific authorities and various sources of science to the targeted as well as transfers problems from the targeted to the competent authorities to research in solving them and then deliver them to the farmer.

Agricultural extension uses many ways to achieve its objectives, and the methods of agricultural extension are many and numerous, and they vary according to the social, economic, and cultural conditions of each society.

Traditional approach: where the extension department has central authorities that control the flow of information and extension services to farmers in different governorates.

- Training and visit curriculum: Here, extension workers are periodically trained on specific techniques and communicated to farmers. The training is conducted by specialists and then the extension agents communicate it to the farmers.
- Rural development approach: It is a guiding approach that serves agricultural development issues among farmers by adopting rural development issues so that development is integrated, for example, if a village suffers from the problem of thirst, agricultural extension must contribute to solving this problem along with the transfer of agricultural techniques.

There are pioneering approaches and methods in the field of disseminating applied knowledge to the Jordanian farmer, including through the establishment of farmer field schools, which can be considered a modern and effective participatory extension method based on the principle of

adult education and field training for farmers. The FSFS model combines expertise from multiple sources (research farmers, extension staff and other partners. FFFS is a full-season field training program involving 15-20 farmers growing the same crop and the training activities follow the various stages of crop development and procedures. Related Management This program can also be applied to livestock production, climate change and integrated farm management systems. During this, the farmer who is a member of the Farmer Field School could identify the problem, analyze the agricultural ecosystem, experiment, economic analysis, conservation and make appropriate decisions within local conditions. All these outputs help in one way or another to contribute to achieving food security, improving the nutritional status of the local population, implementing, and developing sustainable agricultural practices and improving opportunities for exporting agricultural products in small groups that give greater credibility and confidence to the agricultural product.

What is a farmer field school?

Farmers Field School (FFS)

- It is an applied guidance method for group learning, as learning in this case is not through a classroom in a regular school, but in an open school for applied education at the farm level that aims to stimulate innovation at the local level to achieve sustainable agricultural development.
- The Farmer Field School (FFS) is a season-long field training program that tracks training activities various stages of crop development and related control measures.

The main elements of the field school for farmers:

- Joining a group of farmers (15-20) farmers.
- Each field school has a facilitator who manages the field school.
- It depends on field training, experimentation and participation and lasts for a full agricultural season (from planting to harvest and perhaps until after harvest and marketing, meaning that the farmer who joins the field school follows all the stages that the crop goes through).
- Farmers Field School participants have regular meetings during the growing season.

- At each meeting, farmers conduct an analysis of the farm's ecosystem to identify the existing reality and identify problems and interventions required.
- Participants in the Farmer Field School conduct a study in which they compare traditional practices with modern practices that will be passed on to farmers (field study).

General objectives of farmers' field schools:

- Providing means and methods that contribute to the development of farmers' practical experiences and solving their problems related to the management of their farms and crops.
- Develop and adapt integrated crop management methods according to local conditions.
- It offers farmers the opportunity to form farmer groups to work together on many agriculture-related topics such as marketing.
- Accustom farmers to experimentation and practice instead of receiving recommendations.
- It can turn into a program to start social activities.
- Strengthen and strengthen the relationship among farmers.
- Developing the relationship between the agricultural extension and the farmer

Developing the skills and capabilities of farmers in identifying their needs and solving their problems

Philosophy of Farmer Field Schools:

- The Farmer Field School model combines experiences from multiple sources (farmers, researchers, extension staff and other partners) in one program, the Farmer Field School, and based on the presence of these experiences in one session, these experiences are exchanged among the attendees, so each farmer has his experience gained through his agricultural work, which is proud of that experience that he possesses, and that we should not reduce those experiences, so the knowledge and experience are mutual between all attendees and not in one direction.
- Farmers in the field school are not just listeners, in field schools' farmers master the principles necessary to apply integrated management to their crops and become experts.

Facilitator at Farmers Field School

facilitator (supervisor)

- It is a person who has sufficient experience to supervise the farmers' school and provide learning opportunities through experience and participation and the facilitator can be a specialist in agricultural extension or from other agricultural specialties and has experience in agricultural extension and preferably has experience in the crop intended to implement the field school on it.

Characteristics of the facilitator (supervisor):

- To be cooperative and have the desire to deliver information to the farmer in a manner that suitable to the farmer.
- To be a good listener to farmers' opinions, suggestions, and experiences.
- It should be flexible in guiding farmers and responding to their needs in organizing school activities and helping them to strengthen their skills and enhance their knowledge and abilities to deal with problems and how to devise appropriate solutions to address them.
- Correct guidance of the group and ensure that everyone participates in activities and discussions.
- Ask various suggestions, ideas and questions that help the group develop itself.

The role of the facilitator (supervisor)

- Organization of the field school.
- Supervising activities related to school meetings.
- Take care of basic administrative matters.
- Follow up the agricultural records of the field school and keep a copy of them.
- Maintain constructive relationships with local government employees.

Requirements for organizing the Farmer Field School from the supervisor:

- Locate the school.
- Make baseline estimates well in advance, determine material needs and organize timely procurement.
- Conduct preparatory meetings.
- Identify potential participants and select them in discussion with the community.
- Identify (with the participants in the Farmer Field School) endemic problems to address in the school and identify a field of study, preferably owned by a member of the Farmer Field School, and decide with the participants, the subject of study in the field.
- Develop a preliminary outline of the curriculum for the Farmer Field School
- Planning meetings (with school participants).
- Invite some referring people (if necessary).
- Respect local customs and traditions.

Selection of participants and location of the farmer field school and the crop

Choosing a place

- When choosing the location of the farmer field school, it must be taken into account that the place of gathering with farmers is close to the field study and close to the control, as well as taking into account how close it is to the farmers members of the field school as well as easy access to the site and it is preferable that the site be close to the facilitator.

Crop selection

- Also, the type of crop grown in the region and the prevailing agricultural practices must also be taken into consideration and whether there is room for improvement in the current practices or not.
- Also choosing a type of crop that is planted in the area and farmers face problems in growing it and we should not choose a crop in an area to make a field school on it and it is not grown in this area unless the goal of the field school is to introduce the cultivation of this type

Selection of participants

The presence of a group of farmers who have the desire to join the field school, and their number is between 15 to 20 farmers. They are the focus of the school and meet periodically to discuss farm-related topics and local field problems. Since the school is based on the use of participatory learning arts and that the participants, whether women or men, are mature adults and have great experience and different skills in their field of work, so their learning of new things is a bit difficult and needs to refer to their skills and experience to employ them within the school curriculum and benefit from them in adult education.

characteristics of farmers joining the *farmer* field school:

- To be a farmer and grow the crop that will be taught by the Farmers Field School.
- Be interested and have a genuine desire to join the Farmer Field School.
- Be able and willing to learn.
- To be a decision-maker on his farm.
- To have the same interest.
- Be cooperative.

- The appropriate number of participants is 15–20 participants, larger groups tend to be chaotic or disinterested, and small groups can suffer from poor development of discussion and exchange of experiences.

Background and needs assessment.

- Basic information is information about farmers, the problems they face, current agricultural practices, inputs, and outputs of the agricultural process, as well as general farm data.
- A need assessment is a list of farmers' needs needed to conduct agricultural operations and is part of "problem identification." Needs assessment is often conducted as part of the background information collection process because the needs of agriculture are the subject of the next step after the tabulation of current practices.
- How do you collect basic information?
- Informal interviews: informal meetings/open discussion with one or more farmers to gather background information,
- Formal interview with questionnaire: Formal meeting, preferably with one farmer, using questions from a pre-prepared questionnaire.
- Agricultural calendar: Work is usually done as a group with farmers to prepare an agricultural calendar showing the main activities, problems, opportunities, and practical solutions each month/season.

When to collect basic information?

- Before the start of the season, when choosing the location of the school and participants. The early collection of this information provides sufficient time to plan the FFSS training curriculum, field study and special topics. Etc.

Who collects information?

- Moderator, jointly with other supervisors and/or the national program coordinator

How to use basic information?

- In addition to the objectives outlined above, the background information can be used in a session with the farmer group to prioritize the different needs identified, and to identify topics to be studied at the Farmer Field School.
- One of the topics can be chosen for a field experiment, and some other useful topics can be adopted as small experiments or "special topics" within the school curriculum.

Planning a field study

- Before planning the curriculum for the Farmer Field School, it is necessary to collect basic information to identify the main problems of farmers in the area and with this information the supervisor and the farmer group can choose the study items in the school.
- It is imperative to set a set of study goals: what participants in the Farmer Field School should know, or should they do after school.
- The supervisor develops an introductory curriculum for the Farmer Field School, based on basic information, study objectives, and the number of meetings planned.
- The field study can be an open field or an agricultural greenhouse, and it is important that the area is like the comparison field, which means the field in which the field study will be compared and in which the farmer applies traditional activities.
- When planning the field study, specific objectives must be set for the evaluation process at the end of the field school, i.e., one of the objectives should be, for example, increasing production or reducing the use of chemical fertilizers.

Basic elements of the field study:

- Title of the study.
- Background (why is the topic important for this farmer group?).
- Hypotheses (ideas for testing).
- Field study objectives (educational and technical objectives).
- Time required to conduct the field study.
- Materials necessary for the implementation of the field study.
- Procedures or methods of conducting the field study.
- Discussion questions/guides.
- Suggestions for evaluation/economic analysis/conclusions.

Farmer Field School Curriculum

- Each FFS meeting has activities that form the focus of the meeting and the agenda of the meeting so that these activities are part of each FSFS meeting:
- First, there will be a presentation by one of the farmers of the summary of the previous meeting and the recommendations that were made during the previous meeting.
- Second, the group of farmers is divided into small groups 4–5 farmers each group.

AESA

Analysis of the agricultural ecosystem reflects the reality of the farm (field study) through the tour conducted by farmers inside the farm or in other words observation, study, analysis, and discussion of the reality of the field and decision-making of the actions to be implemented.

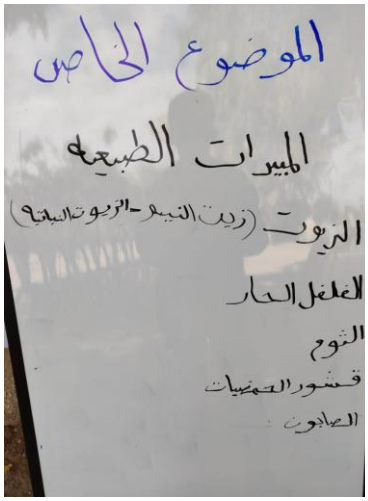
- What do the members of the Farmer Field School implement by analyzing the agricultural ecosystem:
- The field school has a field of experiment or field study in which the school conducts its activities in addition to a witness field to compare the results and in the school, everything related to environmental conditions and management, service and protection of the crop is learned.

- A large group is divided into small groups (4-5 plantations in each group).
- Go to the field of study and examine all factors related to the crop (field of experiment) everything related to the environment of the field of experiment (plant development - irrigation - fertilization - weather conditions - diseases - insects - incidence - humidity so that observations are taken by the groups and bring samples
- View notes by each group
- Analyze field observations from groups.
- Summarize field conclusions on large size paper and discussion in groups.
- Make the appropriate decision to solve the problems in the experimental field.

All observations and decisions are documented in the field school record.

Special Topic

- An activity that is carried out to learn a special topic related to crop service and management, study and discuss other topics according to the need of the group and is explained by the supervisor or others and it is possible that the special topic includes any activity chosen by the members of the field school, whether related to the subject of the field school or outside that and the special topic does not exceed its time 10 minutes to 15 minutes and it is possible to implement the facilitator or Who deems it appropriate for that topic and there are many special topics that can be implemented and the most important thing is that they are based on the desire of the members, they can be related to plant production:



- ✓ Soil analysis and land preparation for planting
- ✓ Watering and fertilizing
- ✓ Crop pests, pest control and integrated pest management.
- ✓ Agricultural crops, varieties, and their specifications
- ✓ Or any topic related to soil and improving its quality.
- ✓ It can also be related to animal production and any related topic or beekeeping or any other topic of interest to member farmers.

Group Dynamic

- ✓ Learn activities that increase the group's ability and development to make the right decision.
- ✓ These activities give a refresher break to the group and include a specific activity aimed at stimulating the mind and reaching a set goal.

Conclusion and evaluation of the meeting

- At the end of the field school session, the meeting of the farmer field school is evaluated, where the results obtained during the meeting are presented, and the

problems observed and the recommendations for the farm that the farmer will implement before the next meeting are presented.

- Schedule the next meeting
- Determine the theme for the next meeting.

Agricultural Records in the Field School

- The following records are recommended to be kept and updated by the supervisor at each Farmer Field School meeting.

✓ Background: Basic data of the participants, and their traditional agricultural practices.

✓ Attendance record for each meeting: Number of dropouts (and reasons) and/or new members joining during the school.

✓ Record of agricultural operations on the farm and includes all agricultural operations conducted by the farmer from irrigation, fertilization, control, and others.

✓ Economic data (to be able to perform an economic analysis at the end of the study).

✓ Agricultural Ecosystem Analysis Form

✓ Field study data (field study records)

✓ Samples of agricultural records that can be used in Annex 1

Field School Evaluation

Evaluation of the field school's agricultural field activities and the adoption of new practices by farmers are important parts as these assessments can be conducted through a variety of tools and methods that consider aspects such as effectiveness, efficiency, impact, and sustainability.

Steps and tools for evaluating field activities and adopting new practices:

Setting goals and indicators

✓ Goal setting: Clear and specific goals should be set for field school activities, such as increasing productivity, improving crop quality, or reducing input use.

✓ Identify indicators: Set indicators to measure success, such as increasing production, improving product quality, reducing production cost, or improving resource management.

Data collection

✓ Quantitative data: such as crop productivity, production costs, water consumption, and fertilizer and pesticide use.

- ✓ Qualitative data: such as farmers' views on field activities, their satisfaction with the results and their evaluation of new practices.

Data Analysis

- ✓ Quantitative data analysis: Compare data before and after the implementation of field activities to assess improvements in productivity and resource efficiency.
- ✓ Qualitative data analysis: Analyze feedback and feedback from farmers to understand how they are adopting new practices and how effective they are from their point of view.

Overall Assessment:

- ✓ Comprehensive evaluation: Conduct a comprehensive assessment of all field activities to measure the extent to which the objectives set have been achieved.
- ✓ Adoption assessment: Measure how well farmers have adopted new practices and whether they plan to continue using them.

Drawing lessons learned

- ✓ Analysis of successes and challenges: Identify factors that contributed to the success of field activities and the adoption of new practices, as well as challenges faced by farmers.
- ✓ Making recommendations: Make recommendations for improving future activities based on lessons learned.

Documentation and publication

- ✓ Documentation of results: Documentation of all results and experiences gained in detailed records and reports.
- ✓ Dissemination: Disseminate findings and good practices across the media and farming communities to raise awareness and motivate other farmers to adopt new practices.

Part II

2-Land degradation neutralization.

Agricultural land degradation:

Definition of agricultural land degradation

- ✓ In other words, degradation is every quantitative and qualitative change in the soil that would temporarily or permanently disable its ability to be or continue to be an environment suitable for plant growth, and consequently the area becomes unsuitable for human living, so improvement and degradation are opposites, meaning that improvement is the opposite of degradation..

The degradation of agricultural land divided to.

- ✓ Temporary deterioration: It is a qualitative deterioration that can be improved if its causes are removed and its manifestations are treated, and this type constitutes a negative impact that worsens over time if left without care or attention and needs to be known and evaluated its grades and types to effort and experience. Any delay in resisting temporary deterioration makes treatment more difficult and more expensive.
- ✓ Permanent deterioration: It is a comprehensive deterioration that is difficult to replace what was lost because of it, even if it is partially replaced, because the deterioration here is an irreversible quantitative deterioration of what it needs from large non-economic spending and desertification is one of the forms of comprehensive degradation, hence it is clear that the deterioration varies in its causes, features, degrees and economic impact as well.

Reasons leading to the degradation of agricultural land:

- ✓ Deforestation: Deforestation is both a type of degradation and a cause of other types of depletion, particularly decreasing water. Deforestation itself is not considered degradation, it becomes a source of degradation when the threatened land is sloping or when it has shallow soil that is subject to erosion, followed by poor land management.

- ✓ Over-logging: Rural people cut trees for timber, fuel and other materials, and the excess has led to erosion by water and wind, making agricultural land less suitable for agricultural crops.
- ✓ Insufficient land rest periods: Mobile agriculture has been a form of land use, while low population density has allowed for land respites, but short rest periods have now made the land unsustainable.
- ✓ Overgrazing: Overgrazing directly leads to a decrease in the quantity and quality of vegetation, which in turn leads to a decrease in the physical properties of the soil and resistance to erosion?
- ✓ Inappropriate agricultural rotations: As a result of economic pressures, farmers have adopted intensive, grain-based agricultural cycles rather than more balanced ones.
- ✓ Unbalanced use of chemical fertilizers: When soil fertility decreases, farmers try to maintain a high level of crop production through fertilizers, but this has led to an imbalance of nutrients in the soil.
- ✓ Low inherent soil fertility: This means that the origin of soil material is low in terms of plant nutrients, in addition to areas with heavy rainfall that lead to a change in mineral ratios and thus this imbalance leads to degradation of agricultural and pastoral lands.
- ✓ Unfavorable climate: Irregular climate in agricultural land (which relies on natural rainfall as a source of plant irrigation) and unevenly distributed rainfall affect cultivated crops or damage due to heavy rains during the rainy season.
- ✓ Soil erosion: This is a cause of soil degradation and is an important problem that must be addressed to maintain proper soil quality and usability for a long time.
- ✓ Climate change and variability. This affects land degradation processes by changing temperature patterns, rainfall, evaporation, and wind. They also increase the frequency and intensity of extreme weather events such as droughts, floods, heat waves and storms. These events can cause direct damage to the land, such as landslides, mudflows and desertification, or indirect damage, such as crop failure and pest infestation.

Types and manifestations of deterioration and how to treat it:

Chemical Degradation

- ✓ Chemical degradation is due to the accumulation of salts in the soil and groundwater sector and the concentration of these collected salts in the surface layer of the soil where most of the root activity of the soil surface plants is concentrated and thus degraded.
- Chemical degradation of soil is measured as follows:

1. Soil salinity: It is expressed by the high degree of salt concentration in the topsoil extract at saturation with mmol/cm units at 25 °C.
2. Alkalinity of the soil: expressed by the increase in the percentage of sodium exchanged.
3. pH: high or low
4. Toxicity: expressed by the high concentration of toxic elements in parts per million (ppm)

- The processes of collecting salts in the soil and the high ground water level are the result of a few factors, the most important of which are soil properties and topography, as well as climate and human activity, all of which are complementary or opposite.
- As a result, what is known as soil secondary Salinization occurs, which leads to a decrease or loss of soil fertility due to the accumulation of easily soluble salts that are harmful to the plant in the root zone in cultivated lands.

- ➢ Secondary Salinization: occurs in stages.
- ✓ Seasonal patches begin to form during the summer, where we find plants in these spots that are not as intensive as required and do not grow at the normal rate.
- ✓ This is followed by the formation of permanent patches of secondary salinity patches that are found in the upper parts of the soil and secondary Salinization processes occur mainly in areas with poor natural drainage and most irrigation systems in areas with hot climates such as plains and valleys are usually characterized by inefficiency and this leads in the absence of adequate natural drainage to raise the ground water level to the critical level
- ➢ Secondary Salinization spots can be treated with the following agro technical procedures:

- Conducting soil leveling operations
- Add improvers and then deep plowing with a plow under the soil.

- Soil Strip Washing
- Regularity of watering
- Growing intensive crops such as alfalfa in the presence of a good drainage network

Physical Degradation

It occurs to the soil because of the impact of a number of processes overlapping with each other often lead to a lack of porosity of the soil and there are several phenomena on the occurrence of physical damage to the soil, namely.

- Glaciations of the soil surface to form an impermeable layer or hard crust (endocrine layer).
- Reduced porosity or compaction of soil due to the use of heavy agricultural equipment.
- It also leads to damage to seed mulch and low germination rate.
- The formation of an impermeable layer at the depth of tillage because of continuous plowing at a fixed depth, which is followed by lack of aeration and the inability of the roots to extend or irrigation water to penetrate.
- We can judge the degree of physical damage from estimating the percentage change in the bulk density of the soil and its permeability rate.

Biological Degradation

There is a strong and direct relationship between biological degradation and physical degradation as biological degradation results mainly from the lack of organic matter in the soil and we must differentiate between fresh organic matter (not resistant to decomposition) and humus (resistant to decomposition) as biological degradation means the mineralization of organic matter resistant to decomposition, i.e. humus

- Manifestations of biological degradation:
- The soil turns lighter because of the lack of organic matter in it.
- Lack of earthworms and soil biology in general.
- Lack of response to fertilization.

The treatment of biological degradation by continuously adding organic matter to compensate for the continuous loss of humus is a protection at the same time from physical degradation if the physical properties of the soil have not already deteriorated because of the mineralization of organic matter.

Main effects of land degradation:

- Environmental impacts: Land degradation reduces the land's ability to provide ecosystem services, such as carbon sequestration, water regulation, soil composition, nutrient cycling, and biodiversity conservation. Land degradation can also create feedback loops that exacerbate degradation processes and climate change impacts. For example, land degradation can lead to the release of greenhouse gases that contribute to warming. Thermal, which in turn can increase the risks and effects of land degradation.
- Socio-economic impacts: Land degradation affects the livelihoods and well-being of people who depend on land resources and can lead to reduced food production, increased poverty, and inequality, and undermine health and education. Land degradation can also have negative effects on the national and global economy, such as loss of income, trade, and investment opportunities, increased public spending and debt, and reduced growth and development potential.
- Cultural and ethical implications Land degradation can affect the cultural and spiritual values and identities of people who have a strong attachment to the land.

Sustainable Land Management:

❖ In sustainable land management, practices that not only enhance the productivity and profitability of land but also ensure its longevity and ecological balance are increasingly resorted to.

- Zero Tillage Agriculture: This practice involves minimal soil disturbance, maintaining permanent soil cover, diversifying plant species, improving soil health, water retention, and biodiversity, for example, farmers in semi-arid areas may adopt a no-till farming approach to prevent soil erosion and conserve water.
- Planting forest trees (Agro forestry): Integrating trees into planting systems can provide shade, function as a windbreak, and enhance soil fertility by fixing nitrogen.
- Water management: Efficient use of water through techniques such as drip irrigation and rainwater harvesting can significantly reduce water waste.
- Soil fertility management: The use of compost, green manure and biofertilizers can improve soil structure and fertility and may use agricultural residues by making compost to enrich the soil, reducing the need for chemical fertilizers.

- Integrated Pest Management (IPM): IPM promotes the growth of a healthy crop with minimal disruption in agricultural ecosystems and promotes pest control mechanisms in more than one way.
- Crop rotation and diversity: Crop rotation and cultivation of a variety of species replenish nutrients and break pest and disease cycles.
- Crop coverage: Propagating cover crops such as alfalfa in the off-season protects against erosion and adds organic matter when plowed back into the soil.

Land degradation neutralization and its importance:

- Land degradation neutrality refers to the concept of maintaining or improving the quality of land resources while ensuring sustainable land use practices. It aims to balance land degradation and restoration, leading to the conservation and sustainable management of land ecosystems.
- From an environmental perspective, land degradation neutrality is critical because it helps preserve biodiversity, protect natural habitats, and preserve ecosystem services. By preventing further degradation and promoting recovery, we can protect the health and resilience of our ecosystems and ensure their long-term sustainability.
- From a social point of view, neutralizing land degradation is equally important. Degraded land often leads to low agricultural productivity, food insecurity and displacement of land-dependent communities for their livelihoods. By seeking to neutralize land degradation, enhance food security and promote sustainable agriculture.
- Economically, land degradation neutrality also plays a significant role as degraded land not only hinders agricultural productivity but also affects other sectors such as tourism and infrastructure development.

Measuring land degradation neutrality:

To measure "land degradation neutrality" (LDN), there are three global indicators to monitor, evaluate and complete reports on land restoration and degraded ecosystems, combating desertification and achieving the goal of "land degradation neutralization".

1-Vegetation

2- Land productivity.

3- Carbon stocks installed under and above the soil.

Types of agricultural soil in Jordan:

Ajloun Governorate

In Ajloun Governorate there are the following main types of soil:

1- Mediterranean Red soil prevails in the eastern and central atmosphere of the region, where the amount of rain exceeds 350 millimeters, and iron oxides rise, and it is famous for its red-brown color because it contains humus, and terrarosa soil (Terra Rosa) is one of the most important types spread in these parts and the depth of this soil decreases in the eastern parts, while it increases in the central parts, especially the flat ones, and this type of soil has spread tree cultivation Fruitful as the cultivation of food grains, especially wheat and corn, spread in the western parts of them?

2- Mediterranean Yellow soil: It prevails in parts where the amount of rain ranges between 250 and 350 mm. The areas where there are very steep and low vegetation cover of trees, where their plants are limited to grasses, which is a transitional area between the red Mediterranean soil and the soil of the yellow plains, has prevailed the cultivation of food grains, especially barley, in this type of soil.

3- Yellow Soil (Steppe): It covers the sloping parts on which rain falls ranging from 100 to 200 mm.

4- Flood fan soil: It is located at the foothills of the heights "feet of the mountains" and the estuaries of the side valleys, as is the case in the flood communities that are located near Sleikhat and Faqaris and include flood deposits from different rock formations, the most important of which are: lime, marl and conglomerite(The depth of the soil ranges between 3-5 meters and spread in this soil the cultivation of food grains as rain-fed agriculture, and the cultivation of vegetables and fruit trees as irrigated agriculture.

Mafraq Governorate

The soil with its natural, morphological, and chemical characteristics complements the water in importance in terms of providing opportunities to exploit the Badia regions located within the province of Mafraq and there are three types of soils prevailing in the province and they follow the material of origin that consisted of:

Type I: From soils is of basalt origin.

The second type is of limestone origin.

Type III: of sandstone origin.

Most of these soils are similar in their natural and chemical properties due to the similarity of the conditions of their formation and the components of the topsoil are characterized by a high percentage of medium fine granules, especially celts, in addition to the presence of calcium carbonate and low content of organic matter, where the topsoil becomes solid and incoherent in the summer and because of that it is exposed to drift by the wind and when the soil gets wet, it disperses and disperses its grains and weakens its cohesion with each other and then closes the pores, which reduces the permeability of the soil surface to water, so rainwater collects And stagnate on the surface, which leads to rapid loss as a result of evaporation and thus reduce the process of water penetration to reach the lower sector of the soil and in these cases increases the flow of water on the surface, sweeping with it the soil and accordingly decreases the ability of the soil to provide plants with their water needs because of the lack of water stock in them, so the growth of plants becomes weak and the growing season is short due to the speed of drying of plants.

The content of the Badia soil of organic matter is low and does not exceed $1-1.5\%$ and leads to low concentration of organic matter to weak vegetation and plant cover and the conditions of drought and high temperature help to oxidize organic matter and loss of soil, which causes low and poor natural and chemical properties of the soil, thus weakening the construction of the soil, which leads to a low rate of permeability and weak ability to store water and provide plants with it.

The spread of saline and alkaline lands is characteristic of arid and semi-arid areas and what increases the spread of these lands in the Badia regions is the increase in evaporation rates and the movement of salts in the soil sector to the top and their accumulation in the surface layer of them and salts directly affect plants so that they lead to a high percentage of sodium in the soil and the demolition of soil construction and reduce its permeability, which leads as a result to the death of plant roots and is Lands of limestone origin are poor in nutrients already and the prevailing activities and practices in the exploitation of Badia lands increase the depletion of nutrients such as overgrazing, which leads to poor vegetation cover and low soil content of organic matter, which is the main source of providing nutrients, so the addition of phosphate and nitrogen fertilizers contributes to the supply of Soil with essential nutrients such as nitrogen, phosphorus and potash and thus to double plant growth.

Part III

3-Farmers' practices and their impact on agricultural land degradation:

Farmers' malpractices that contribute to agricultural land degradation:

Unsustainable agricultural malpractices are all practices that lead to a disruption in the content of organic matter in the soil and decrease from the ideal levels and this violation will lead to the reduction or unavailability and flow of appropriate nutrients to maintain soil fertility and meet the requirements of sustainable production and improve it and thus disturb Environmental sustainability. Agricultural practices that lead to water loss and lack of permeability into the soil, the inability of plants and the biological body to benefit from this water and damage the natural discharge of water.

farm management level:

- Failure to document and record agricultural operations and activities due to the lack of a farm register.
- Burning agricultural crop residues, which leads to the loss of an important provider and damage to soil biodiversity?

agricultural rotation:

- Successive cultivation of crops and monocultures, specifically the non-practice of diversification, overlapping and mixed crops, and reliance on one or two types of crops.
- Not adopting the agricultural rotation system sometimes or adopting the wrong systems of the agricultural cycle, especially those that do not include the presence of legumes and the continued cultivation of crops that deplete the soil and deplete it dangerously and accumulate pathogens in it.

sustainable soil management:

- Deterioration of soil fertility due to the intensive use of hybrid or genetically modified seeds that need substantial amounts of nutrients and large amounts of water and the lack of use of local or municipal seeds.
- Compaction of the soil due to the use of heavy equipment and machinery.

- Some land reclamation activities sometimes cause loss of natural vegetation and organic matter and destroy soil structure.
- Keep plastics in the ground and do not remove them after harvest.
- Lack of periodic soil analyses to monitor physical, chemical, and biological properties and to determine the level of fertility.
- Use of chemical soil sterilizers

water management and irrigation:

- The use of untreated wastewater in irrigation, which causes soil pollution and harm to public health and the environment.
- Weak adoption of low-cost rainwater harvesting techniques such as contour tillage, crescents, and others.
- Non-adoption of the principle of soil washing requirements in the calculation and scheduling of irrigation.
- Random and non-programmed irrigation, which depends on calculating plant needs and evaporation quantities.
- Irrigation with wastewater from olive presses (zebar) and random disposal of zebar during the olive harvest season, either by throwing it in torrents and valleys or on the soil.

chemicals (fertilizers and pesticides)

- Adding chemical fertilizers intensively and without knowing the actual needs and what organic fertilizers can provide, and this is due to the lack of fertilization programs based on knowing nutrient levels through soil analysis.
- Excessive use of chemical pesticides and chemical soil sterilizers in intensive cultivation.
- Farms do not adhere to the safety period when spraying pesticides for agricultural crops.
- Failure of the farmer to comply with the specified quantities and times for chemicals (fertilizers and pesticides) added to the soil.
- The use of chemical fertilizers of unknown origin and inappropriate.
- Failure to apply integrated agricultural pest management systems.

- In weed control, which is one of the most difficult agricultural operations, many farmers resort to the use of herbicides and a small percentage of farmers other methods such as manual control, hoeing and tillage. In addition, the widespread use of herbicides is an agricultural and environmental problem due to the lack of strict compliance with the instructions for use and the safety periods stipulated in the instructions for the safe use of pesticides.
- Sterilization of the soil with chemicals or using sunlight with chemical pesticides and not using environmental control systems

tillage:

- Intensive, frequent, and exaggerated tillage (sometimes up to 5 tillage per year) damages the soil environment and its sustainability.
- Wrong and incorrect tillage such as plowing perpendicular to contour lines and with inclination in sloping lands.
- Intensive tillage at inopportune times leads to compaction of the soil and the formation of a hard layer under the soil surface.
- Frequent deep tillage on an annual basis.
- Failure to adhere to appropriate tillage dates.
- Using tillage badly, such as plowing the soil with the residues of agricultural crops completely and leaving the soil surface exposed and uncovered.

organic fertilizers

- Do not add or reduce organic fertilizers.
- Add untreated organic fertilizers, fertilizers of unknown origin and ingredients.
- Add organic fertilizers (compost) packed in bags or packages that do not contain a label or label indicating the type of fertilizer, its production destination, and the analysis of its components.
- Do not add soil conditioners when needed to address specialized problems.
- Adding raw animal manure that is not fermented, undecomposed or of unknown origin at inappropriate times raises temperatures and kills the staple crop, and the lack of fermentation means that unwanted weed seeds and weeds have not been eliminated.

Good Farmer Practices That Reduce Agricultural Land Degradation in Protected Agriculture

farm management:

- The existence of a farm record is necessary and essential and is considered one of the requirements of good agricultural practices in many countries of the world and there are specific models that depend on the exporter of the agricultural product and the type of product.
- Make sure to update the data and information in the farm registry on an ongoing basis.
- Make sure that the register includes a statement of the type of crops, whether organic or intended for export, all periodic soil and water analysis reports, and all additions and practices of uses of organic and/or chemical materials.
- Your good management and preparation of a plan to manage the production process and the implementation and application of agricultural operations plans for the crop properly increase your profits and reduce the costs of production inputs , and the plan includes soil preparation, plant nutrition and weed control operations that must be carried out before the start of the season and documented in the farm registry.

agricultural rotation

- Use the agricultural rotation system and ensure that legumes are one of the elements of the cycle and avoid the agricultural cycle that involves leaving the land fallow without planting.
- Integrate animals into crop rotations and take advantage of the reuse of crop residues by grazing on the same farm.

Sustainable soil management

- If you have any doubt that the soil, for the farm or garden, is contaminated, you should seek professional advice from the competent guide, in the light of which samples will be collected and soil, crops and compost sources will be analyzed, and there are legal limits that should not be exceeded for the maximum content of heavy metals, such as lead, copper, zinc, cadmium, arsenic, mercury and some other organic compounds.

- Inspect the soil periodically to facilitate the preparation of fertilization programs, especially regarding nitrogen, phosphorus, and potassium.
- Keep the soil covered with a protective layer (mulch or mulch) of straw, crop residues, plants, or plastic to maintain soil structure, prevent the growth of unwanted weeds and reduce water evaporation.
- Reduce soil disturbance by reducing any practice that leads to reducing the level of organic matter in the soil and the deterioration of soil health in general.
- Using the method of solar soil sterilization before the beginning of the season and reducing the use of chemicals, appropriate measures must be taken to increase efficiency, such as taking care of smoothing and leveling the soil surface and raising soil moisture to the level of 70% before the sterilization process in order to ensure the best results

water management and irrigation

- Monitoring the quality of water used in irrigation through periodic water inspection and matching the results with the level of elements in the soil and the needs of crops of nutrients (consultation of the agricultural advisor).
- Determine the amount of water required for irrigation with moisture tensile devices (tenchometer) for better programming of irrigation.
- Choosing the right and most efficient irrigation system will reduce water consumption and increase your profits.
- Choosing the right time for irrigation avoids the evaporation of a large amount of water.

agrochemicals

- Before using agricultural pesticides, you must first consult the competent agricultural advisor who is present in all departments of agriculture in the governorates to determine the pest and the type of pesticide appropriate to combat it.
- Add some chemical fertilizers containing nitrogen, phosphate, or potassium to some organic fertilizers to compensate for the lack of these elements, and this is done after consulting the agricultural advisor and analyzing the organic fertilizer.
- When any pest or weed appears, it is recommended to use integrated control techniques or use pesticides formulated from environmentally friendly organic ingredients, but if chemical pesticides are used, care must be exercised and the

instructions must be applied accurately and the safety periods specified for each application must be respected.

- Use mechanical weed control techniques wherever possible, such as the use of Cutter Weed Portable. This machine, which can be easily carried and moved due to its light weight, is an effective method of mowing weeds and is considered an economical, easy, and safe alternative to the use of herbicides and tillage if it is caused by weeding.

tillage

- Tillage is an essential part of soil preparation for planting, and often there are several types of tillage and includes deep primary tillage and secondary tillage (smoothing, chopping, and furrowing), and usually organic fertilizers and basic chemical fertilizers are added with tillage. Some farmers plow before the season and between seasons several times, the number of which in some farms may reach 5 time, which is high. Therefore, it is recommended to:
- Reduce frequent and excessive tillage to a minimum (one or two tillage), to maintain soil building and reduce soil compaction and to ensure the mixing of organic matter additives, soil stirring and furrowing.
- Tillage in open irrigated crops is twice higher than in irrigated crops protected once.

agricultural techniques

- Take care to remove weeds mechanically as much as possible to preserve soil and environmental biodiversity.
- It is preferable to use the elevated terrace system to save water.
- Selection of varieties based on an understanding of their characteristics, including their responsiveness to planting time, productivity and quality, market demand and nutritional value, resistance or tolerance to disease and stress, their ability to adapt to climate and soil and respond to agrochemical fertilizers.

organic fertilizers

- Know the types of compost available in the markets and the factories that produce it and what are the strengths and weaknesses of each product.

- The addition of organic fertilizer improves the quantity and quality of agricultural production and maximizes the benefits in soil stability and continuous supply of nutrients.
- Be sure to add fertilizer well before the planting date, especially when using the elevated terrace method.
- Be careful not to dispose of or burn the remnants of the previous crop and manufacture your farm compost by exploiting these plant residues.
- Plant agricultural residues are added, in some cases, that are not decomposed early during the autumn before the rains and the beginning of winter and long before the growing and activity season, because the organic matter needs a long time to decompose, and the decomposition products become valid and easy to absorb by the roots of plants or trees with the beginning of the growing season in spring.
- Because organic fertilizers rich in elements such as cattle and sheep manure and poultry manure contain a high percentage of available nitrogen, the addition should be in late winter or spring when crops are able to use nitrogen efficiently.
- Decomposed and fermented plant agricultural residues can be added to the soil at any time required, with caution not to add them on hot summer days or in the event of low moisture in the soil because this may lead to burning plants, especially if the salinity is high in fertilizers.
- Do not mix, prepare, and use organic fertilizer within 10 meters of any surface water pool, including water streams and irrigation channels or 50 meters from the water source (well or spring).
- It is advisable to adopt the means of aerobic composting in fermentation after mixing the manure with other organic residues.

Good Farmer Practices Reducing Agricultural Land Degradation in Rain-Fed Agriculture

field service and tillage:

- Reduce frequent and excessive tillage to one tillage before the planting season and includes mixing added organic matter, stirring the soil, and furrowing and this avoids compaction of the soil.

- Tillage is important to facilitate the collection of as much rainwater as possible in the winter, save soil moisture in the spring, kill weeds that compete with the plant for moisture, and the times of tillage that is preferred to be reduced to a minimum depend on annual rainfall rates and soil quality (heavy or light, rich or weak).
- The use of conservation tillage, which is the retention of plant residues above the ground, whether by partial tillage or scattering of plants after plowing and smoothing.
- Use manual hoeing or portable grass clipping to get rid of weeds. However, if this cannot be done, weed chemicals are sprayed in a timely manner to give the main crop the opportunity to benefit from organic fertilizers more.

agricultural style and type of crops:

- Applying agricultural rotation systems suitable for rain-fed agriculture because most types of soil are suitable for summer rained agriculture, but it is recommended to consult agricultural extension and early planning, and it is recommended to adopt the quadruple agricultural rotation.
- Choose drought tolerant crops that need low amounts of water, and this increases your profit and reduces production input costs.

utilization of rainwater and supplementary irrigation

- Use water harvesting techniques to collect rainwater and increase water reserves in the soil. It is recommended that such practices should be adopted, especially in areas and seasons with precipitation below 400 mm per year, including:
- Contour tillage
- Establishment of contour retaining walls.
- Construction of canals that direct the water course towards trees.
- Dig ponds around the stems of trees.
- Digging agricultural collection wells to collect rainwater and use it for irrigation.
- Use supplementary irrigation, wherever possible, which studies have shown positive results on productivity, especially when adding organic fertilizers where fertilizers increase the soil's ability to retain water and provide nutrients to the tree.
- For Albaali (not irrigated) olive trees, supplementary irrigation includes:
- Olive irrigation is during the months of July to September.
- In general, rained trees need 3 cups per tree or about 70 cups per acre.

- Irrigation methods suitable for olives are numerous, including basins, trenches, barrels, and drip.

fertilization in rain-fed crops

- Be sure to fertilize the land for the summer season during the winter and must develop a work plan for the farm before the planting season and adhere to the instructions of agricultural extension regarding fertilizing the land a month before the season so that the rains dissolve the fertilizer and prepare for planting seeds.
- The optimal date for adding non-decomposing organic fertilizers and plant agricultural residues to fruit trees and vegetable crops is during the autumn before the rains and this early addition of these materials before the beginning of winter and long before the growing season and activity to give the opportunity and sufficient time to decompose and become decomposition products valid and easy to absorb by the roots of trees with the beginning of the growing season in spring.
- It is preferable to add fermented organic fertilizers before the planting season.

Part IV

4-Climate change and climate change adaptation in the agricultural sector

Climate Change:

- What is meant by climate change: It is the change in climatic factors and conditions resulting directly from human activities that release large quantities of greenhouse gases into the Earth's gaseous atmosphere as a result of the industrial revolution, and the high growth rates in many developed and developing countries due to many uses harmful to the environment, especially the use of fossil fuels (oil, gas and coal in power generation.
- It can be said that the issue of climate change is one of the most important environmental issues at the present time, due to its link and direct impact on various vital sectors, including agriculture, water, energy, health and transportation, where scientific evidence has begun to indicate the link between greenhouse gas emissions resulting from human activities and the risk of global climate change.
- Climate change is the result of anthropogenic intervention by the release of greenhouse gases and greenhouse gases into the Earth's atmosphere using fossil fuels, energy generation and use, deforestation and burning, agricultural activities, land-use changes, industrial processes, and other sources.
- This phenomenon resulted from the increasing concentration of a group of gases called greenhouse gases or greenhouse gases in the Earth's atmosphere, and unlike industrial gases, greenhouse gases have existed in the Earth's atmosphere naturally for millions of years in specific proportions, collectively constituting less than 1% of the atmosphere, which is enough to form a "natural greenhouse phenomenon" that maintains the earth's temperature at the normal or required level and essential for life, without which the earth's temperature will drop To 30 m below that normal level.
- However, human activities have affected the levels of greenhouse gases in the atmosphere by finding new sources or by interfering with natural sinks.
- One of the most important risks of global warming to the environment

✓ is the rise in temperature and therefore the disruption of the climate system?

- ✓ Changes in rainfall rates and distribution
- ✓ A clear change in rainfall rates and seasons and this variation varies from region to region. While rainfall in some areas is higher than normal, it is sometimes significantly lower than in others, which will lead to many problems in water resources, many droughts in some areas and devastating floods and hurricanes in others.
- ✓ It also affects the process of cultivation and crop production and the possible food shortages and other consequences.
- ✓ Rising temperatures will also lead to melting ice at the poles and rising sea levels.

Reasons of climate change:

Natural reasons

- Volcanoes erupt where they emit greenhouse gases.
- Dust storms in arid and semi-arid regions suffering from degradation of vegetation cover and lack of rainfall.
- The phenomenon of sunspots, a phenomenon that occurs every 11 years because of the disturbance of the magnetic field of the sun, which increases the thermal energy of the radiation emitted by it.
- Cosmic rays caused by the explosion of some stars, where they hit the upper atmosphere of the Earth and lead to the formation of radioactive carbon.

Industrial reasons

- Gases emitted from various industries such as oil refining, electric power production, cement production plants, battery factories, car exhaust and generators.
- Outputs of agricultural activities such as chemical fertilizers, deforestation, and logging (trees, which are considered one of the most important means of absorbing greenhouse gases)
- Gases emitted from wastewater, especially methane, which is ten times more dangerous than carbon dioxide.

Temperature and precipitation:

Precipitations:

Jordan is an arid country with rainfall ranging from 50 to 500 mm per year depending on the location. The amount of rainfall decreases from north to south and from west to east. The annual average in the eastern highlands in the Ajloun Mountains reaches 400–600 mm, and decreases to 300–600 mm in the Balqa Mountains, 200–350 mm in the Moab Mountains, and 100–300 mm in the Sharah Mountains, and the annual rate in the northern part of the fault is 300–400 mm but decreases to 100–200 mm north of the Dead Sea and 50–100 mm. In the Dead Sea area north of Wadi Araba. The southern part of Wadi Araba and the Gulf of Aqaba receives less than 50 mm. Rainfall varies from year to year, while occasional light snowfall is limited to highland areas (including Amman). Average rainfall in Jordan Appendix 2

Average temperatures :

Average temperatures show an inverse pattern; they are rapidly increasing from intermittent plateaus to extremely low, gradually increasing from the intermittent plateau to the eastern edges of the Eastern Sahara, and gradually decreasing from north to south in line with the increasing altitude.

Impacts of climate change:

Impacts of climate change in general

- Within 50 years, the number of people suffering from drinking water shortages will rise from 5 billion to 8 billion.
- Decline in agricultural yield: It is obvious that any change in the overall climate will affect local crops and thus reduce food stocks.
- Declining soil fertility and worsening erosion, changing plant habitats, increasing drought, and changing precipitation patterns will exacerbate desertification and automatically increase the use of chemical fertilizers and thus toxic pollution will worsen.
- Pests and diseases: Hot temperatures create favorable conditions for the spread of pests and insects that transmit diseases such as mosquitoes that transmit malaria.
- Sea level rise: The rise in global temperature will lead to the expansion of the mass of ocean water in addition to the melting of huge glaciers such as the Greenland massif,

and this potential rise will pose a threat to coastal communities and their agriculture, in addition to freshwater resources on the coasts and the presence of some islands that will be flooded.

- The accelerating frequency of climate disasters: the high frequency of droughts, floods, storms, and others harms societies and their economies.

Impacts of climate change on the agricultural sector

In recent years, clear changes have been observed in the weather in the region in general, including.

- There is a decrease in the annual rainfall.
- The increasing dispersion in the dates and quantities of rain and the number of rainy days is also noted.
- There is also a noticeable change in the pattern and intensity of rainfall.
- About temperatures, we notice a rise in temperatures in general.

These changes have clear effects on agriculture.

- Lack of groundwater recharge leads to a clear and significant shortage in the quantities of water available for irrigation.
- Obvious lack of cultivated areas
- Give up the cultivation of certain crops that need substantial amounts of irrigation water.
- The dispersion and irregularity of rainy seasons and the lack of rainfall directly affect the cultivation of field crops and other rain-fed crops.
- They lead to confusion in the usual planting dates for some crops.
- As well as high temperatures clearly and directly affect the amounts of water needed for different crops due to increased transpiration and evaporation as it has a direct relationship to the behavior of the crop and its growth and may affect flowering and fruit contract.

5- Climate change adaptation and soil quality improvement measures in the agricultural sector:

1-Soil sterilization in irrigated crops

The first step of any successful cultivation is in the soil, if the soil fertility and specifications are good, the cultivation is successful, and if it is otherwise, the results are bad, and if the soil is bad, intervention and measures must be taken to improve the quality of the soil.

There are signs, from which the farmer can infer problems in the soil, including:

1. Difficulty digging holes in the soil while it is wet or dry.
2. Wilt seedlings that we grow despite being watered repeatedly.
3. The appearance of signs of nutrient deficiency on the plant from yellowing and others.
4. The appearance of signs of salinity on the soil.
5. Water collects on the surface of the soil or runs away.

Causes that may affect soil quality:

1. Not following an agricultural cycle commensurate with the soil of the farmer
2. Planting soil-stressed crops continuously
3. Non-dependence on the addition of fertilizers, whether organic or chemical
4. Poor soil preparation before planting
5. Spread weeds continuously and do not get rid of them.
6. Lack of knowledge of crop fertilizer needs and irrigation quantities.
7. Speed in the processes of preparing and cultivating the land, as sometimes cultivation is conducted without appropriate preparation processes.

As a result of intensive cultivation inside greenhouses, many endemic pests appear and spread within the soil, which sometimes leads to affecting cultivated plants and reducing their production and death sometimes, and in order to reduce and avoid the impact of such pests, the sterilization process of the soil is carried out.

Soil sterilization methods:

Chemical sterilization:

There are many methods and chemicals that can be used in soil sterilization are present in the markets and many farmers use them, but these materials are costly from a material point of view to farmers in addition to their negative impact on human health, plants, the environment and the soil and that the use of these materials must be very careful in addition to the availability of sufficient experience in their use.

Solar sterilization:

It is to exploit the heat and rays of the sun in heating the soil, which is moist and covered with plastic strips for a period of time extending from 5 to 6 weeks, and the exploitation of the rays and heat of the sun here in order to combat soil pests and weed seeds, whether by killing and eliminating them or weakening them, and it is clear from the name that they take place in the summer months when the temperature is high enough to complete and succeed Through experiments, it was found that the best period for thermal sterilization is the period between the beginning of June and the end of August.

Basic elements of solar sterilization in greenhouses:

- Plastic cover: The plastic is made of polyethylene with a thickness of 60 to 80 microns.
- Soil moisture: The soil should be sufficiently moist, and these serve to increase the sensitivity of target organisms to heat and improve the thermal conductivity of the soil.
- Soil temperature: A temperature rise above 50°C at a depth of 10 to 15 °C is sufficient for the success of the solar sterilization process within 4 to 6 weeks.

How to perform the correct thermal solar sterilization:

- Disposal of the remnants of the previous crop and then plowing and smoothing the land.
- Distribute organic fertilizers before chopping and smoothing the soil.
- The ground must be leveled, and no obstacles or depressions left in it.
- The land must be irrigated abundantly to the field capacity because this irrigation is necessary to transfer heat to the required depth as well as to germinate weed seeds and pathogens and remove them from the dormant phase.
- The terraces are made in case we want to plant on the terraces.

- The soil surface is covered with transparent plastic while keeping the plastic from tearing during the mulching process.
- The width of the plastic is 4–5 m and transparent and contains the U.V.A material that gives it softness and resistance to sunlight.
- The duration of sterilization should be at least 6 weeks and may reach two months.
- Plastic should be flat and in contact with the soil surface throughout the sterilization period.
- The land must be left for 2 to 4 days after the end of the sterilization period and the plastic is lifted before planting.
- Planting should be done after lifting the plastic without moving the soil.

Important note in the solar sterilization process, the soil must be kept moist by irrigating the soil every 3 days.

Features of thermal solar sterilization:

- The cost of thermal sterilization is lower than other sterilization methods.
- It does not pose any danger to its employees or to the environment.
- Simple, easy to implement and requires no experience.
- It does not leave any harmful side effects for the plant.

2-Planting with raised bed

- It is an agricultural process carried out by the farmer after he plows the land and smoothed it automatically, as he makes high bed above the ground instead of planting the crop in low furrows, as this method has many disadvantages, the most important of which is in the event of an increase in irrigation, excess water cannot be drained, which affects the growth of the crop and its infection with diseases, and it is possible that the farmer does it manually

Benefits of planting on raised bed

- Discharge of excess water
- Contributes significantly to raising production.
- and provide a suitable environment for root growth.
- Reduce the amount of water used.

Preparation of bed

- ✓ Dig a trench 3–4 feet (1 meter) wide and at least 40 cm deep, and the length of the terrace shall not be limited and shall be limited by the area of the available land and the location of the terrace.
- ✓ The layer of earth that was taken from the terrace is set aside because it will be used later the soil surface, as it is known that the surface layer of the soil is the fertile layer because it contains many elements, organic matter, and beneficial microorganisms.
- ✓ If the soil is shallow or hard and rocky, the elevated terrace above the soil surface can be created by building the basin of bricks or stones.
- ✓ A layer of dry tree branches is placed pruning residue in the lower tier of the trench tub)
- ✓ A layer of unfermented animal manure is added at the bottom of the trench trough above the layer of twigs and with a thickness of at least 20–25 cm.
- ✓ This layer is covered with the surface layer of earth that was extracted when digging the trench at the beginning of the preparation process.
- ✓ The drip irrigation network is extended on the surface of the terrace if the irrigation process is to be done with drip irrigation networks) as this is recommended because drip irrigation reduces the amounts of water needed for irrigation and keeps it in the root area of cultivated plants.
- ✓ The surface of the terrace is covered with a layer of straw or shavings 5–10 cm thick to reduce evaporation preserve moisture in the soil and prevent weed growth. It is recommended that the straw layer be free of weed seeds, and it is better to use white straw machines or coarse wood shavings.

Bed Specifications

1- The width of the terrace is approximately 1 meter to facilitate the process of serving the terrace from outside it (from both sides without having to walk in it).

2- The drip irrigation line shall be fixed on it, according to the type of crop to be planted, its requirements for irrigation water, and the recommended distances between one plant and another. According to the amount of water for one irrigation spring and the distance between irrigation springs.

3. It is recommended that the irrigation network be spread in lines (the lines are regular on the terrace depending on the type of crop.

4 The distance between the lines (lines) is 15 – 20 cm or depending on the type of crop and its requirements).

3-Planting with mulch

Agricultural Mulch: It is a soil cover that aims to raise the temperature by 3–5 degrees Celsius and maintain moisture , including industrial agricultural plastic "nylon" and natural dry plant residues, as well as its multiple colors and objectives of use.

Natural mulching: It is done by covering the soil with dry plant residues or leaves, stems and (sawdust) to maintain moisture and raise the temperature.

Benefits of planting with mulch

- ✓ It prevents high evaporation and retains moisture in the soil for the maximum possible period.
- ✓ Maintains temperature which helps plants grow quickly and early.
- ✓ Natural recycling of agricultural residues by protecting plants and then decomposing them with soil to elements suitable for the soil.
- ✓ It loosens the soil and makes it more aerated because of the mixing of topsoil with plant residues.

Industrial Malash (plastic) Malash is made of agricultural plastic "nylon" with a thickness of 15–35 microns and aims to imitate the natural preservation of moisture and raise the temperature of the soil and sometimes surpasses it by many things as it is easy to use and durable and multiple colors and each color has a specific goal.

The purpose of using nylon:

1- Maintain moisture by preventing evaporation through the nylon layer and condensation of water at night.

2- Maintaining high temperature, which means early planting of vegetables.

3. Prevent weed growth to protect plants from competition.

4- Expelling insects from the surroundings of plants and protecting them from the transmission of diseases.

5- Reduce the use of pesticides and chemicals on plants.

Types of mulch

1- Transparent mulch: This type is used in the early spring to protect plants from low temperature in addition to maintaining humidity. In this species, weeds may grow around plants.

2- Black mulch: This type is used in the summer with the aim of protecting plants from drying out, maintaining moisture, and preventing the growth of weeds completely around the plants.

3- Multi-colored mulch: Some of them are yellow, this type is used to protect plants from drought, maintain moisture, and prevent the growth of weeds completely around plants to protect plants from insects, as some insects are attracted to it away from plants. The silver mulch is found from the top and black from the bottom and aims to expel insects by distracting from the light. And there are a lot of colors that each of them aims for something to protect the plants.

4-Irrigation networks with balanced pressure

The regular pressure irrigation system is one of the most important modern systems to adapt to climate changes, as this system aims to reduce the volume of consumption and loss of water used in irrigation operations within agricultural fields by relying on water drainage technology by 3 to 4 liters per hour, and this system works under fluctuating pressure conditions, which enhances plant health and reduces diseases and pests associated with increased humidity.

Table 1: Shows the difference between conventional and balanced pressure drip irrigation network.

Balanced pressure drip irrigation network	Conventional drip irrigation network	Pointer
The volume of water flow is equal and uniform	Large water flow volume varies according to inclination and pressure	Water Flow
Flow depends on balanced pressure	Flow depends on gravity	Flow direction
Little flow for large areas	Large flow amount for small spaces	Flow quantity and wipers

- ✓ A balanced irrigation network provides the plant with specific, equal amounts of water and nutrients along the branch lines of the network.
- ✓ Self-cleaning system with ample filtration area improves resistance from clogging in the network making the system highly resistant when using low quality water.
- ✓ Ensure uninterrupted drip operation.
- ✓ Plant growth is even and has a regular pattern.
- ✓ lack of onset of diseases

5-Drip irrigation systems.

Advantage of drip irrigation system:

- ✓ High efficiency due to low water consumption
- ✓ Reduced losses compared to other methods.
- ✓ High efficiency in distribution
- ✓ The possibility of adding fertilizer to the plant through this system with high efficiency
- ✓ The philosophy of drip irrigation is focused on supplying the plant with its need of water through small eyes called points that are very close to the plant through flow rates of 4

liters / hour and there are eyes of 8 liters / hour so that the roots get their need of water well as nutrients.

- ✓ Although this system is one of the best irrigation systems, it faces many problems as a result of clogged eyes, and the reason for this is due to the deposition of calcareous materials in the eyes, which hinders the exit of water from them, and thus there becomes a defect in the distribution of water and a defect in the efficiency of the irrigation network, which greatly affects the plant and production, as you notice this through the vegetative growth of plants, as the plant whose points are When it is closed, its growth is bad, and from here the farmer should pay attention to the maintenance of the irrigation network in order to continue to obtain high efficiency

Irrigation Network Efficiency testing:

- ✓ Irrigation efficiency:

1. There is often talk about raising the efficiency of irrigation water use, and what is meant here is the available means that can be followed and applied to obtain the highest benefit from the use of the water unit, and among these means:
2. Choosing the right planting dates and the right crops
3. The use of modern irrigation methods and techniques
4. Determine the appropriate watering dates.
5. The introduction of agricultural methods and methods that directly contribute to improving soil quality.

- ✓ Improving irrigation practices can lead to:

1. Reduce the costs of access to water use.
2. Reduce production costs.
3. Increase farm profit by reducing production costs.

In order to obtain the appropriate distribution of irrigation quantities through the irrigation network, the farmer must periodically maintain the irrigation network and clean it of any plankton or dust in it, and the farmer must check the efficiency of the irrigation network and the distribution of flow in the points as follows: The farmer prepares several empty packages and opens the irrigation network with a period of up to five minutes We choose randomly distributed areas inside the greenhouse and at the same time we put the packages under the points for a period Equal and then we remove the bottles at the same time, and the quantities of water in

each bottle are compared if they are close, the distribution is good and otherwise there is a defect in the irrigation network or blockage in the points.

Irrigation Network Maintenance:

- As we talked earlier, the blockage in the points is due to the accumulation of impurities or calcification, so one of the most important things that the farmer can do to alleviate this problem is to install a filter before fertilizer, as this filter cleans the water and purifies it from all impurities that can intoxicate the points
- Maintenance of the network before the planting process, where the farmer after spreading the irrigation network and connecting and equipping it opens the ends of the lines for a quarter of an hour to clean them of all the plankton and impurities that are inside them.
- The irrigation network can be cleaned by adding phosphoric acid at a rate of 10 liters per d.
- Before using the irrigation network, the farmer can soak it in a tank containing hydrochloric acid at a concentration of 15%.

6- crop rotation

What is meant by the agricultural cycle is the system of arranging the cultivation of crops in a specific piece of the farm, as it is a result of the intensive exploitation of the land by planting it with more than one crop per year that affects the quality and fertility of the soil and spreads pests and diseases as well as weeds

The importance of the agricultural rotation:

- The successive cultivation of a particular crop in a certain area leads to the deterioration of the yield because of the deterioration of fertility and the depletion of certain nutrients from the soil.
- In the case of preparing a crop rotation program at any farmer, it is important to apply the principle of agricultural rotation, which should be on the same plot of land.

Problems caused by soil stress:

- Planting the same plant in the same place leads to the absorption of the same primary nutrients, resulting in large amounts of nutrients without use.

- Planting the same plant in the same place leads to the exploitation of one layer of earth and leaving the rest of the layers unexploited, which can be exploited by other plants.
- Planting the same plant in the same place helps the spread of diseases specific to that cultivated plant and these diseases become stronger and difficult to resist.
- Planting the same plant in the same place leads to the growth of weeds for that plant and over time it becomes difficult to eradicate.

7-Integrated pest management

It is a set of different control methods and methods that work in parallel that does not harm human health and the environment and ensures that the pest numbers remain below the critical economic limit while maintaining the existing natural balance between these pests and their vital enemies, and aims to reduce pest damage while maintaining the safety of the environment

Objectives of the Integrated Pest Management Program:

1. Reducing the use of agricultural pesticides
2. Maintaining vital enemies and ecological balance
3. Maintaining high-quality and competitive products free of pesticide residues or few residues that fit the permissible limit and within the international conditions for this.
4. Maintaining human and animal health
5. Reducing production costs and raising the level of product income

Elements of integrated agricultural pest management:

First: Agricultural Control

1- Seedling: These seedlings must be from a reliable source and be free from infection with any agricultural pest, considering the purchase of varieties tolerant of agricultural pests spread in the region if possible.

2- Weeding inside the greenhouse: where weeds inside and near greenhouses are a host for many pests, so it is preferable to remove weeds with extraction instead of using herbicides

3- Improving plant cultivation conditions through good fertilization and planting plants at appropriate distances that do not hinder the freedom of growth and do not hinder freedom of

movement, with good ventilation of plants, as this method improves plant growth and increases its life in addition to reducing the appearance of some pests in it.

4- Soil sterilization: In the event of a pathological infection in the soil last season, solar sterilization should be used with the addition of fermented municipal manure during the sterilization process because this helps to raise the temperatures of the soil and thus eliminate many soil pests.

5- Use of the agricultural rotation: What is meant by the agricultural rotation is the system of arranging the cultivation of crops in a particular piece of the farm. Recently, as a result of the intensive exploitation of the land and its cultivation with more than one crop per year without relying on a system of agricultural rotation and relying on the use of chemical fertilizers to meet the need of various crops, pests and diseases spread, as well as weeds, so the farmer resorted to the use of chemical pesticides to combat pests and diseases, as well as weeds Which negatively affected the presence of natural enemies of those diseases and insects.

Second: Mechanical Control:

1- Hermetic closure of the greenhouse using insulating mesh, where insulating nets are used to prevent the entry of insects such as aphids, whitefly, and thrips into the plastic greenhouse through ventilation holes, doors, etc.

2- Use double doors

3- Remove plant residues, as the remnants of previous crops are a source of infection with pests with incomplete and complete phases as well, so the remnants of these crops must also be disposed of. For best results, the inside of the greenhouse should be left clean and free of any residue for at least a week before starting to plant the new crop, as this period eliminates the different phases and starves the entire phases.

4 - Suspension of color traps for the early detection of various insect infestations, as this method helps reduce the spread of pests, as blue traps are used to monitor thrips and bile for the white butterfly

Pay attention to the cleanliness of the suspension threads or replace them if possible because they are considered a source of some pests.

Third: Biological Control:

- Biological control is defined as the use of natural enemies to reduce pest populations in a crop, and includes the use of predators, parasites, and pathogens.

Fourth: Chemical Control:

- The use of chemical pesticides in the integrated management system is an integral part of this system, as their use is considered the last option and works in conjunction with other means. Chemical control is defined as how toxic chemicals are used, as humans resort to them when other natural and applied methods fail to control pests and reduce their damage.

8-Water harvesting techniques.

The concept of water harvesting techniques:

- It is the process of collecting and concentrating rainwater or running water from large areas to smaller areas to make the most of it.
- Water harvesting depends on the process of collecting rainwater in the harvesting area to be used in the same area to:

✓ Increased moisture content of soil containing trees.

✓ Increase the content of ground moisture and increase the duration of its presence in the soil.

✓ To recharge groundwater or collect it in wells for storage and later reuse such as supplementary irrigation.

- There are many economically viable waters harvesting techniques for use in irrigating crops and rehabilitating agricultural land.
- Components of water harvesting systems: All water harvesting systems consist of the following main elements:

✓ Collection area, which may be small water collection areas or large water collection areas depending on the available areas.

✓ Flow area, which may be natural areas or areas made with manual interventions or automated equipment.

✓ Storage area, which may be the surface such as ponds and dams, soil, or subsoil such as wells.

- The objective of the water harvesting system in place, which may be agricultural, domestic, industrial, or environmental.

What are the objectives of rainwater harvesting?

- Stabilizing the soil and protecting it from erosion caused by strong winds or water runoff (especially stormy rains).
- Reduce the speed of water flow.
- Contribute to the rehabilitation of agricultural lands.
- Increase the ability of the soil to retain water in quantity and duration.
- Rainwater collection and reuse for supplementary irrigation, especially at the time of rainfall
- Improving the quality of irrigation water used in agriculture.
- Increase production in quantity and quality and reduce the cost of production inputs, especially water, for farmers.
- Preserving plants and trees, especially in times of drought, high heat, and lack of rainfall
- Preserving biodiversity and ecology by providing favorable conditions for the living and reproduction of various organisms.

Water harvesting techniques.

- It is a set of activities conducted by the farmer to collect rainwater and increase water reserves in the soil. It is recommended that these practices are necessary, especially in areas and seasons where the precipitation rate is less than 300 mm, where water collection is relied on in the tree planting area in addition to the area of harvesting water from the soil surface in the surrounding area, which increases the amount of water harvesting stored around the tree.
- These include:

Contour tillage (against the inclination of the land)

- Contour tillage is a permaculture technique used in sloping areas to reduce soil erosion and conserve water resources. This technique relies on tilling the land in a way that follows the lines of the natural terrain or "contour", i.e., the horizontal edges of the land, rather than tilling in a straight line across the slope.
- Benefits of contour tillage
- Reduce soil erosion: By tillage through the slope instead of downward, contour tillage helps reduce surface water runoff, reducing soil erosion.

- Water conservation: This technology contributes to improving water absorption in the soil, as the grooves consisting of tillage trap and distributes water evenly, which helps provide the moisture necessary for the growth of plants.
- Improve soil fertility: Helps reduce the loss of the nutrient-rich surface layer of the soil, which maintains its fertility and enhances crop productivity.
- Increase productivity: By conserving soil and water, contour tillage can improve crop productivity.
- Environmental sustainability: By reducing erosion and soil loss, this technology contributes to preserving the environment and supporting agricultural sustainability.

Contour retaining walls.

- These walls help prevent soil erosion, improve slope stability, and manage rainwater and runoff.
- Importance:

1. Prevent soil erosion: These walls stabilize the soil and prevent it from slipping or eroding due to running water or gravity.
2. Water management: Helps regulate the flow of rainwater, by reducing the speed of runoff and collecting water in basins.
3. Improve the use of sloping land for agriculture, increasing usable areas.
4. Infrastructure protection: can protect roads, buildings and other infrastructure from damage caused by landslide.

- Benefits:

1. Improve land stability: Increase the stability of sloping lands and make them usable.
2. Reduce environmental losses: Prevents soil erosion and protects the environment from the effects of erosion and avalanches.
3. Increase agricultural areas: Enable the use of sloping areas for agriculture, which increases productivity.

Ponds around tree stems

- Ponds around tree stems, also known as "irrigation basins", are circles or low areas that arise around the base of a tree for several agricultural and environmental purposes.
- The benefits of ponds around tree stems:

1. Water harvesting: Helps collect water around the base of the tree, increasing the amount of water available to the roots of the tree.

2. Reduce evaporation: Helps reduce water evaporation from the soil, ensuring that water is available for a longer period, especially in dry areas.
3. Nutrient orientation: When fertilizer or organic matter is added, these nutrients are directed directly to the root zone.
4. Prevent soil erosion: Helps stabilize the soil around the tree, reducing the risk of soil erosion, especially in sloping areas.
5. Root Protection: Helps protect surface roots from drying out by providing a layer of soil that locks in moisture.
6. Enhanced ventilation: Improve ventilation in the root area through loose soil in the aquarium, which promotes root growth.

Drilling collection wells:

- Digging agricultural collection wells to collect rainwater and use it for irrigation during the summer.

9-Supplementary irrigation

- Supplementary irrigation is the compensation of water shortages for agricultural crops by providing some irrigation when rainfall is trapped at specific critical growth stages.
- Supplementary irrigation is complementary to the role of rainwater in securing the crop's need for water necessary for growth and obtaining good production, as the crop depends mainly on rainwater and since rainwater is usually insufficient and often its distribution is not regular, crops are exposed to periods of thirst that greatly affect their productivity.

Basic principles of supplementary irrigation:

- ✓ Provide irrigation water to rain-fed crops to obtain reasonable productivity.
- ✓ When rainfall is the main source of rained crops and insufficient for the plant supplementary irrigation is given to increase and stabilize productivity.
- ✓ The primary purpose of supplementary irrigation is to give the least amount of irrigation water during critical periods of crop growth that allows for reasonable production.

Supplementary Irrigation Management:

- ✓ The important considerations for supplementary irrigation under good water management are when, how and how much to irrigate, i.e. aims to introduce the concept of providing sufficient water to the plant in a timely manner and not to over-irrigate, as the common belief among farmers is to give irrigation water in large quantities in order to obtain greater yields.

Methods of supplementary irrigation:

- ✓ Using drip irrigation networks with a fixed plastic water tank so that a plastic tank of 5 m 3 or 3 m 3 is placed in the farm and linked to the irrigation network (drip) and then irrigate trees or plantings in quantities and at appropriate intervals.
- ✓ It is possible to use plastic or iron water drums with a capacity of 100 liters or 200 liters, and this method is used to irrigate trees so that holes are made at the bottom of the barrel by a nail and fill these barrels and place them next to the trees, as this method provides moisture to trees over a whole week

Supplementary irrigation for olive trees:

- ✓ Supplementary irrigation is an irrigation system used to provide plants (such as olive trees) with additional amounts of water in addition to what they get from natural rainfall.
- ✓ Supplementary irrigation is especially important in areas with dry climates or in years with little rainfall, as it helps improve productivity and maintain tree health.

Factors on which the amount of water needed by olive groves depends:

- ✓ The most important of which are the climatic conditions prevailing during the year.
- ✓ Soil type, depth, and natural qualities
- ✓ The size of the trees, their number per dunum, and the amount of the crop
- ✓ In addition to the variety and the type of seedlings planted
- ✓ Therefore, olive trees are most successful in areas where rainfall is higher than 400 mm.
- ✓ Areas with 500 mm rainfall are considered the minimum commercial olive production under rain-fed conditions. One olive tree needs 3 cubic meters of complementary irrigation water distributed over 6-4 irrigations during the summer and after the fruit set,

considering rainfall rates, soil type, and the nature of the area where the olive tree is located. This method can lead to an increase in the weight of the harvested fruits by about 164%, oil production by 200% and oil content in fruits to 120% compared to olive trees grown under rainfed conditions only and irrigation can be divided into 10 irrigations so that the tree is given in each irrigation 300 liters

10-Conservation Agriculture

- Conservation agriculture is an alternative method based on stopping tilling the land or minimal soil movement while preserving as much crop residues as possible and following the agricultural cycle, thus reducing soil degradation and renewing its fertility, preserving scarce water sources and ensuring the effective use of natural resources and agricultural production inputs while achieving an increase in crop production and reducing costs to reach sustainable levels of production while preserving the environment.

basics of Conservation Agriculture

- Not tillage or moving the soil at a minimum reduces the compaction (compacting) of the soil and the destruction of its structure, reduces erosion, improves permeability and saturation of the soil with rainwater and increases its moisture stores, as well as encourages the activity of beneficial organisms and increases the content of organic matter in the soil and saves effort, time and money.
- Retention of residues of the previous crop (organic cover) Maintaining crop residues or part of them contributes to reducing water erosion and wind erosion, improves water permeability in the soil, reduces evaporation, maintains soil moisture, limits the growth of weeds, increases the content of organic matter in the soil, improves its fertility and physical properties, and creates a suitable environment for beneficial soil organisms such as earthworms (biotillage).

Benefits of Conservation Agriculture

- Increase agricultural yields (grain, straw, green fodder) and improve their quality.
- Ensure the stability of productivity especially in dry seasons.
- Improving the properties of the soil, renewing its fertility, and maintaining moisture in it for as long as possible.

- Reduce planting costs (tillage and fertilization costs).
- Overcoming the problem of labor and energy shortages in poor communities.
- Preserving the safety of humans and the environment.

11-Using organic fertilizing

- Organic matter constitutes 5% of the composition of agricultural soil and plays an important role in determining the fertility state of the soil and its ability to retain water and nutrients.
- The lack and decline of organic matter is a negative indicator of low soil fertility in addition to its weak ability to cope with climate stress such as drought, high temperatures and other elements of climate change.
- Working to compensate for the lack of organic matter in the soil by adding decomposed humus is a good agricultural practice that plays a significant role in restoring the soil's ability to face severe climate changes and increase its productive capacity.
- Humus (compost) is one of the recommended additions to compensate for the lack of organic matter in the soil and as a good alternative to high-cost chemical fertilizers with negative damage to the soil, it is possible to take advantage of the surplus natural materials on the farm such as crop residues, pruning products, foliage and animal waste in the work of Al-Makmora, where these products are fermented and analyzed by beneficial bacteria and converted into humus, where it is added to the soil before the rainy season and mixed with tillage.
- Compost humus is one of the best organic fertilizers and compost differs from chemical fertilizer in that it fertilizes and thus improves the breeding structure.
- The compost preparation process is an aerobic bacterial fermentation process of organic matter and to complete successfully, it needs active fermenting bacteria, and it also needs suitable environmental conditions, especially the appropriate temperatures and sufficient humidity that keep the bacteria active and effective.

Compost stack component:

- Fresh or old cow dung (animal manure): One of the best types of dung, but sheep, sheep, chicken, and rabbit manure is also considered good.

- The compost pile needs a little dirt because it contains the bacteria necessary for the process of decomposing organic matter and thus composting.
- Old herbs and plants from the garden, cut weeds if they have not been sprayed with a chemical herbicide.
- Kitchen waste from vegetables, fruits and fallen foliage.
- You should also avoid adding meat, oily substances, bones, fats, sweets, chopsticks, and diseased plants to your compost pile.
- The period required for organic matter in the pile to decompose and become humus depends on the type of material used and on the appropriate climatic conditions (hot weather, good humidity and ventilation, a good mixture of organic matter) and if these conditions are provided, humus may take about three months to complete.
- In cold, dry conditions and when the carbon-to-nitrogen ratio of the materials used is high, the period required to obtain humus may extend to more than six months.
- Mature and good humus has a granular composition and smell like the smell of the soil and its color is dark brown to gray so that we cannot distinguish its original components except for the branches, and the size of mature humus has shrunk to less than half of its original size, you can use humus to fertilize the soil by transferring it directly to the soil after its maturity, and it must be mixed with the soil as soon as possible by plowing the soil, because leaving it on the soil surface will lead to the loss of many of its nutrients due to rain or hot sunlight.
- Humus is mainly used to preserve, fertilize and improve the condition of the soil, especially in small fields or gardens where vegetables are grown that need good and fertile soil, knowing that good humus is rich in beneficial organisms and nutrients required by the plant, which, if available, increases its immunity against parasites and many pests. As a result, compost improves soil structure and increases its water retention capacity, as well as deepening the plant's roots in the soil.

Compost preparation:

- First: Find a suitable place for the compost pile, whether in a sunny or shaded place, knowing that you need a land area of at least 1 square meter and you can collect the various organic materials available at home in the form of a pile in a place in the garden that is not exposed to air currents and it is preferable to be between plants or trees or

in the shade, to preserve moisture in the pile. The average size of the pile can be 1 cubic meter, i.e., 1 meter long, 1 meter width and 1 meter Pile height smaller than this size is prone to cold and drought. If the amount of waste is very large, we can set up a rectangular pile. You can also collect organic matter in a hole away from the house to avoid drying out, so that the depth of the pit does not exceed 60 cm to ensure ventilation, otherwise anaerobic conditions arise, and the problem of odors arises. Pits are used in dry areas to prevent organic matter from drying out and to retain proper moisture in them. Instead of digging, you can use a barrel or a large box.

- Second: When starting to build the pile, it is advisable to place the branches of old trees at the bottom of the pile to ventilate from the bottom. Organic matter is then added in layers of different types so that they are not thick. When soft plant material is added, the layer thickness is less than 2 cm, while the animal manure layer is less than 10 cm from In the first lower layer, you can place plant materials and kitchen waste on top of the bottom base Compost consisting of twigs Plant materials consist mainly of Leaves, weeds, grasses and crop residues It is useful to have among the plant materials some fresh green plants, as well as some dry old plants, such as foliage from last year.
- Third: Green plant materials must be left to wither slightly because they contain a high percentage of moisture, while coarse plant materials straw, for example, it is preferable to break them or cut them into smaller pieces before using them, the length of one piece is not more than 5 cm, knowing that organic matter decomposes faster if they are small pieces, so cut large and hard pieces, such as cauliflower plants and watermelon peels, into pieces the size of apples, and it is preferable to cut soft leaves, while wooden materials must be moistened before adding them to the pile. It is recommended to sprinkle lime (limestones) evenly over each layer of plant material and kitchen waste by a small cup, to speed up the decomposition process, and then add a layer of animal manure. No more than 2 cm thick Note that the manure in the compost pile will provide the nutrients needed by the plant, which will then have a balanced food. Finally, add a layer of soil, no thicker than 1 cm and then sprinkle it with water. You can add the available organic matter to the pile gradually, so that you put the additives on the edges of the pile and not on its top, and whenever you have plant material, about 10 cm thick

again, add some lime and animal manure And the soil respectively, and do not forget to spray water weekly on the pile.

- Fourth: While building the pile, and when it reaches a height of about 50 cm, you must start making ventilation holes by pushing some bars, sticks or vertical wooden stems into the pile, so that you move them while pushing them under the pile to expand the opening. If dry matter is used too much, water should be added after each layer of soil added to the pile. If necessary, you can increase the moisture of the pile by spraying it with a little water, but if the moisture is high, you can Control them by increasing the amount of dry matter or stirring the pile.
- Fifth: The pile must be stirred to make the materials in the middle reach the surface and vice versa, considering mixing dry materials with wet or green during stirring. Turning the pile correctly helps improve ventilation and thus speeds up the decomposition process. The pile is usually stirred after two or three weeks, when the temperature begins to drop and the process of turning must start from the top down, so that the material is moved from one place to another and mixed during stirring. It must be ensured that the materials on the edges where the low temperature is turned over to the center of the high temperature pile and thus ensure their sterilization. The pile can be stirred again three weeks later. It also fluctuates a third time after three or four weeks. All materials in the pile must be exposed to heat to kill harmful germs, insects, and seeds and to speed up the decomposition process. Stirring helps in ventilating the pile, knowing that the repetition of the process of stirring on it prevents the process of anaerobic fermentation) and keeping the materials moist by spraying water on them pleasant the smell of fertilizer and it is necessary to be careful not to make the pile too wet, so that the nutrient-rich water does not collect at the bottom and waste and moreover the pile must be protected from rain.
- Sixth: Let the pile decompose for a period of time as a result of decomposition Water, carbon dioxide and heat are released, and during the process of decomposition by microbes that feed on organic matter, the internal temperature of the pile rises between 70 - 60 degrees Celsius, killing the majority of harmful seeds and pathogenic germs. Here, it should be noted that the compost pile decomposes more quickly if its top shape is hollow and slightly concave. Bottom. This shape helps to trap the water that will be filtered Along the pile, towards the bottom.

- Seventh: At the end of the summer season, that is, at the beginning of autumn, add to the pile all the old plants and crop residues that you uprooted, knowing that the speed of decomposition of the pile is greater if it is turned over before winter, by moving it, from top to bottom with the creek shovel, and turning it into a new pile, so that what was at the top becomes at the bottom of the pile. When you are done with this process, moisturize well and let it settle. You will be able to use a ripe compost pile next spring.

12-Growing drought-tolerant/adaptive crops

Traditional high-yield varieties are characterized by their high requirements of water and nutrients, in addition to their poor tolerance to harsh climatic conditions from high temperatures and dry winds in flowering and contract periods, and therefore the productivity of these varieties decreases with the conditions of climate change and agriculture may fail in some seasons, resorting to trying to find varieties with high genetic capabilities to withstand harsh climatic conditions is the first choice for adaptation to climate change.

Suitable conditions and requirements for the cultivation of domestic (municipal) varieties:

- The agricultural needs of domestic varieties differ from those of improved and introduced varieties with the following:

1. Lack of water needs, ability to withstand drought conditions, and ability to produce within low rainfall rates and therefore more tolerant of climate change conditions.
2. Lack of need for nutrients, as these varieties give reasonable production in low and medium fertile lands.

Use suitable seeding or seedling rates:

The seeding rate or the number of seedlings expresses the number of plants that are supposed to be present per unit area of the field, the increase in the number of plants beyond the appropriate limit, especially if the field resources of water and nutrients are limited, leads to increased competition between these plants for these resources in addition to competition for space and light, which reflects negatively on the growth, development and productivity of the crop. Proper management in these conditions requires reducing the number of plants per unit area by reducing seeding rates this allows all plants to adequately take their needs from the resources of the field.

Planting on the optimal date:

The date of planting is an important factor in the ability of the crop to make optimal use of the resources of the field, especially water, which rainwater is the main and often only resource in rainfed crops, which are characterized by fluctuation and scarcity of quantities, especially in recent seasons, the early date of planting crops dependent on rainwater enables the crop to benefit from the first autumn rains, which increases the chances of success and development of the crop.

13-Intercropping and crop diversification

Due to the limited land area and the main objective of securing the family's requirements for different crops, it is necessary to diversify the cultivation and exploit every small part of the land either by ecological crops (between trees or mixed agriculture (more than one crop at the same time).

Advantages of intercrops and mixed crops

- ✓ Control the spread of pests.
- ✓ Distribute production over the longest possible period during all seasons of the year.
- ✓ Minimize the economic risk inherent in relying on one type of crop.
- ✓ Mixed crops should be selected with complete care and prior knowledge of the behavior of each plant and its positive and negative effects on the neighboring plant.
- The cultivation of mixed or conjugated plants is an essential part of diversified and overlapping agriculture, and this technology contributes to hindering pests and controlling their spread by planting different and diverse plants overlapping so that they serve each other after planting them next to other plants.
- Intercropping is an agricultural method that involves growing two different crops simultaneously at a very close distance in the field and alternately with each other.
- The first and most obvious advantage of intercropping versus monoculture is the promotion of biodiversity and moreover the number of pests decreases with the intercultural system, where different pests are attracted, and in some cases pests compete with each other, and if the intercultural decision is made wisely there can be synergy between the two crops and this means that the biological composition and

characteristics of one plant may benefit the other plant (e.g. a tall plant may provide shade for the other plant).

- What is the difference between crop rotation and intercropping: Intercropping means planting two different plants at the same time in the same field, while rotation means planting two or more crops one after another.

Advantages of mixed farming systems:

- Improving soil quality by sequencing trees, grains, legumes, roots, tubers, and vegetables
- Mitigating heat waves by providing shelter for crops when trees are planted.
- Diversify farmers' crops and food and improve food security for the whole family.
- Provide additional job opportunities for men and women to manage diverse fields and landscapes that cannot be managed by large mechanical devices.
- Conservation of pollinators and natural enemies

14-Using deep irrigation

- Deep tree irrigation is a technique that aims to deliver water directly to the deep roots of trees instead of the soil surface this method helps promote the growth of strong and deep roots of trees and reduces water loss due to evaporation or runoff.

Advantage of deep watering:

- Improved root growth: Deep irrigation pushes tree roots to grow deeper into the soil in search of water, making trees more drought resistant.
- Reduce evaporation: Since water reaches directly to the depth, deep irrigation reduces water loss by evaporation from the soil surface.
- Better use of water: The amount of water used is reduced compared to traditional surface methods where irrigation is concentrated in the places where water is most needed, i.e., deep roots.
- Limit weed growth: The surface layer of soil is not moistened, reducing the chance of weeds that exploit moisture to grow.

How to apply deep watering:

- Use of special irrigation pipes or systems: vertical pipes or deep irrigation pipes are laid that are planted in the ground next to the tree to a depth that reaches the roots. Then the water is delivered directly through these pipes to the required depth.

When is deep watering used?

- ✓ In arid and semi-arid environments: where water shortage is a problem, deep irrigation helps to make the best use of limited water resources.
- ✓ With trees: this method helps to develop a strong root system capable of supporting the tree in extreme conditions.
- ✓ Reduce surface irrigation: to reduce evaporation and improve efficiency.
- ✓ Reduce water consumption: Deep irrigation helps improve water use efficiency, making it ideal in water-stressed areas.
- Tools used: Deep irrigation pipes: specially designed for this purpose, up to a length of about 60 cm, dug for them and placed next to the seedlings, they are open from both sides from the top and bottom, and water is placed inside them with holes that allow water to be distributed slowly to the depth of the soil.

15-Fermi Compost fertilizer

- Fermi Compost is a biological organic fertilizer in the form of gray to black waste produced from worms.
- Phenotype: It is an organic fertilizer in the form of granules (humus) tends to black color.
- Fermi Components
- Worm droppings, which come out of the worms after feeding on organic residues and are processed and secreted enzymes, hormones, and amino acids inside the digestive system of the worm.
- Organic remains decomposed in the environment of worms by fungi and microorganisms.
- Fermi Compost contains billions of bacteria that are beneficial to plants and soil.
- Benefits of Fermi Compost: Fermi Compost has an organic mixture of macro and zero elements with natural plant hormones such as auxin and some enzymes and plant

organic acids, in addition to this rich diversity of microorganisms from bacteria and fungi that enrich the soil and work to revive it.

- Leads to increased land fertility and helps aerate the soil.
- Increase the soil's ability to retain water and nutrients and improve its properties.
- An increase in the speed of germination of vegetable and fruit seeds provides a suitable environment for root growth.

✓ Increase the productivity of crops of all kinds.

✓ Increase the proportion of organic matter.

✓ Facilitate plant absorption of nutrients.

Appendix (1) Agricultural Records:

Public Register of the Farm: General information:	
	Farmer Name
	Phone Number
	Governorate
	Area (village)
	Farm coordinates
	The association to which it is affiliated (if any)
	Crop:
	Crop name
	variety
	Cultivated area
	Number of seedlings
	Agricultural pattern
	Planting history
	Type of cultivation (open/protected)
	Planting method (ground / pending)
	Irrigation method and system
	Irrigation method (drip / sprinklers / ponds)
	Number of rows
	Distance between planting lines
	The distance between seedlings in the line
	Point flow rate/sprinkler

:Fertilization record ✓

Total costs of fertilizer additive/d	Price per unit of fertilizer (JD per kg/ liter)	Amount of fertilizer (kg/ liter) per dunum	Fertilizer name	Date Added	Type of fertilizer used (liquid/ solid)	Type of fertilizer used (organic/chemical)	Fertilization date (pre-planting/ post-planting)

:Irrigation record ✓

notes	Total costs/JD	Price m3	Total quantity m3	Watering duration One minute	Amount of water added m3/dunum	Morning/ evening	date of watering

:Pesticide Registry ✓

notes	Total costs/JD	cost	quantity	targeted pest	Pesticide Name	Morning/ evening	Date of use

Record of other inputs :(Seedling - seeds - equipment rental - transportation costs - labor wages

notes	Total costs/JD	cost	Unit price	Number of units	unit	kind	date

:Production records ✓

notes	Total costs/JD	Unit price	Total unit	Unit box\kg	quantity	Morning/ evening	Date of harvest

Costs and profits:

profit sales−payment	sales	payment					
		total	others	Agriculture input	irrigation	pesticides	fertilizers

:Appendix 2 farmer Field School Member Register

:facilitator **:activity** **:Farmer field School Name**

crop	city	governorate	phone	name	number

Appendix 3 Attendance Record:

Governorate: **city:** **facilitator:** **activity:**

day\date

signature	crops	phone	name	number

Appendix 4 Field Study Record:

area	crop	facilitator	city	Governorate
Name of FFS	**Number of farmers**	**duration**	**year**	**Name of the farmer**
TECHNIQUES USED PRACTICES:				
OBJECTIVE				

:Appendix 5 Final Report

TOTAL area	crop	facilitator	city	Governorate
Number of meetings	Number of farmers	duration	year	Name of the farmer
				TECHNIQUES USED PRACTICES:
				OBJECTIVE
				Special topics
				Group dynamic
				exercise
				goal
				The result of using technique on
profit		**Yield quantity**	**quality**	**input**
The most important outputs (the most important problems – achieving goals – the percentage of technology adoption among farmers				

Farmer Field School Evaluation Form

- ✓ School Name:
- ✓ Site:
- ✓ crop:
- ✓ facilitator:
- ✓ **objectives**

Disagree	neutral	agree	subject
			The goals of the field school were clearly defined from the beginning
			The content of the field school was useful and met my desire
			The training materials were neat and well organized
			Easy-to-access educational materials
			Technologies are easy to use and accessible to everyone
			The field school met what I needed.
			The time and time of the meeting allocated for training is sufficient and convenient for me.
			Special topics that met my needs
			The special topics were according to the choice of the farmers
			The special topics were as chosen by the facilitator

Facilitator Assessment

Disagree	neutral	agree	subject
			The facilitator was well prepared and prepared.
			The facilitator was knowledgeable and knowledgeable about the topics raised.
			The facilitator encouraged participation and interaction
			The time allotted for training was sufficient.

Adopting technologies

Disagree	neutral	agree	subject
			The agricultural techniques applied in the field school were by group selection
			The agricultural techniques applied in the field school were to solve a problem that we suffer from
			I will apply and adopt technologies on my farm in the future
			I will pass on what I learned in field school to other farmers.
			Need to try techniques before applying them
			The technologies offered are not applicable and expensive

Conclusion:

- ✓ The Farmer Field Schools Handbook is an essential tool in supporting farming communities to increase their awareness and enhance their capacities in facing the challenges of agricultural land degradation and climate change by focusing on field education and sustainable agricultural practices where farmers can gain knowledge and skills that enable them to improve their agricultural productivity and conserve their natural resources.
- ✓ Neutralizing land degradation is a common goal that requires the cooperation of all parties, including farmers, agricultural experts, and governmental and international institutions, to adopt smart and environmentally sustainable agricultural practices, such as improving water management, natural fertilization, and preserving biodiversity, thus reducing the negative effects of climate change on the agricultural sector.
- ✓ The solution lies in integrating science with traditional knowledge, enabling rural communities to take effective steps towards sustaining their land and protecting their environment for future generations.

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