The main Greenhouse management practices

Chapter four

Soil preparation

1-Removing the remains of the previous crop to facilitate the plowing process and to remove hotbeds of diseases and insects

2- Plowing:
The first and most important process of preparing the land for agriculture, move the soil surface, break it up, and mix the organic maters present on the surface layer
The soil will be suitable bed for seed and plant growth.

3- Softening and breaking the soil particles:

This process is carried out to further soften the soil particles and break up the larger ones for the purpose of increasing the mixing and homogeneity of the particles with each other and to help uproot weeds.

4 - Leveling the land:
For the purpose of regular water distribution when irrigating the crop, by moving soil from high to low parts of the soil.

Tillage according to depth

1. Surface tillage: it is the one whose depth does not exceed (10-15 cm). The time to do it is in the spring and summer seasons.

It is used in the following cases:

- – When eradicating weeds and harmful weeds.
- - In the spring (after the land has been plowed deeply and moderately in the fall and winter) to loosen the soil after the spring rains.
- - To bury seeds and fertilizers that are scattered on the ground.
- - After harvesting and mulching the grains (transferring the ears of corn from the field to the threshing floor) in order for the earth's crust to break and its moisture to remain stored in it.

2- Medium tillage: It is the depth that ranges between (15 - 25 cm). And the time to do it is in the winter. It is used in the following cases:

- - When burying farm manure and slow-release fertilizers.
- - When preparing the land to plant winter grains or summer plants such as potatoes and cotton.

3- Deep plowing: It is the one whose depth reaches (25-35 cm). The time to do it is in the fall. It is used in the following cases:

– To grow plants with vertical roots, such as turnips, carrots, and beets.

- When preparing lands to plant vines and trees.
- - To break wasteful fields and break meadows.
- - To create nurseries.

4- Excavation التنقيب: It is digging the ground in the form of parallel, tandem trenches at a depth of (35 - 100 cm) or more in order to prepare the land for nurseries and tree farms and to plant grape vines.

And the time to do it is in the fall.

Excavation may be harmful if the layer beneath the soil is poor or differs from the upper layer of soil by having many stones or lack of fertility, in which case it is sufficient to plow deeply and not touch it.

Planting

1. Seed planting

while many seeds can be sown directly in the greenhouse in fall or spring and actually grow best from natural weather fluctuations, other seeds are much more finicky and require steady temperatures and a controlled environment to germinate.

By starting seeds in a greenhouse, farmer should provide a stable atmosphere for seeds to germinate and seedlings to grow.

2. Transplanting Seedlings

- Seedlings are ready for transplanting when their first or second true leaves have developed.
- The first (lowest) set of leaves typically seen on aseedling is the seed leaves or cotyledons.
- True leaves develop after the seed leaves and have the shape of the mature plant's leaves.
- Seedlings should be transplanted as soon as they reach the first or second true leaf stage for several reasons. At this stage, the seedling root system is sufficiently developed so that the seedling can become established after transplanting.
- Spraying fungicide as Dianon to control damping off disease
- Spraying insecticide as confidor for insect

Important service operations for crops

- There are many agricultural service operations that are conducted for crops after planting, with the aim of achieving optimal production. These operations include:
- 1 – Replanting: It means replanting failed holes in which seed germination did not occur or those seedlings that died after transplanting. Usually the farmer perform this process before irrigation, and then the land is irrigated immediately after that. It is necessary that grafting be carried out using the same seeds or seedlings.

- 2 – Thinning slippers: It means leaving the appropriate number of plants per unit area or the appropriate number of them in one hole, and it is carried out after germination when the plant forms leaves. The goal is to prevent plants from competing with each other for water, nutrients, and light, and their crowding may be a source of the spread of pests.
- 3 – Cultivation between plants: It is intended to remove bushes and weeds from the field so that they do not compete with the main plant for water, food, and light, in addition to the fact that they may be a home for many diseases and insects.
- 4 – Mulching: It is the use of plastic of different colors to cover the soil in which vegetable crops are planted

Irrigation

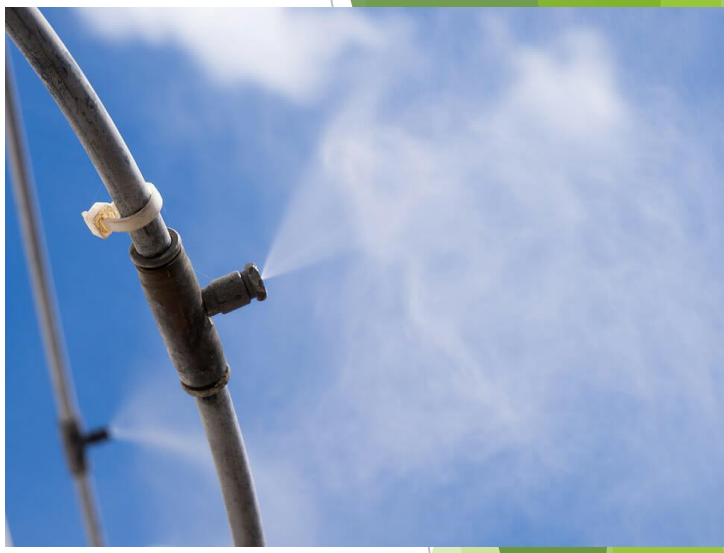
Types of irrigation system for greenhouses:

1. (Over-head) sprinklers

- This irrigation system is usually used for crops that tolerate wet foliage.
- Overhead sprinklers utilize pipes placed above the plants and fitted with nozzles that can be adjusted to varying spray ranges. The sprinklers could be install in-ground (think lawn sprinklers) but in greenhouses it's more common to mount them to the ceiling.
- A sprinkler system saves time but it should be checked often to ensure it is working properly. Overhead sprinkler systems work best for watering small transplanted plants until they are ready to be placed in a garden or flower bed.

2. Misting (spray) system

- This system is great for large greenhouses and propagating seedlings. It is the best option for a greenhouse with lots of seeds that need regular watering.
- Misting systems only release small amounts of water droplets (mist). Sprinklers, on the other hand, use a lot more water when running and are only used for a short time. Misters can either run for longer or automatically spray every 15 or 30 min (depending on your needs).
- Having a misting system can decrease the temperature in the greenhouse which can be quite useful in summer or in warmer climates. Misters are also the perfect choice for tropical plants because it will increase the humidity.



3. Drip irrigation systems

- The drip system is preferable because it is scalable to any size and good for all purposes. It is basically a hose with multiple heads (emitters) that release water at set intervals throughout the day.
- A drip irrigation system can be set up on the surface or buried within the soil. The heads should be close to the plants for efficiency.
- This system releases slow drips of water over time so plants do not dry out. This also minimizes water waste. It requires water pressure, so is often combined with a solar-powered pump from a water butt and can be completely automated.
- The drip system is very useful for greenhouses of any size, as they can be scaled perfectly up or down.

Use of automated irrigation systems

- 1. Saves time

This is **the** reason why people pick automated irrigation. Once set up properly, it'll do its job and you can take care of other things with your newly won time.

No more manual watering and you don't even have to be present when your plants are getting watered.

- 2. Focus on caring for plants and harvesting

Sure, watering is part of taking care of plants but you could use that time to check on your plants, weeding, feeding,

3. Improves efficiency

Automatic systems provide precise coverage, eliminating concerns of over or underwatering your plants. Timers can be set for daily or weekly watering and at times of low evaporation.

- 4. Cost-effective

An automated system ensures that water is allocated effectively so your plants get watered at the ideal time and with the ideal amount.

Crops irrigation requirement

- The amount of water which evaporates from wet soils and plant surfaces together with the plant transpiration is called evapotranspiration (ET). Its value is largely determined by climate factors, such as solar radiation, temperature, humidity and wind, and by the environment. Out of the total evapotranspiration, evaporation accounts for about 10 percent and plant transpiration for the remaining 90 percent. Crop water requirements encompass the total amount of water used in evapotranspiration.
- Alternative approaches for estimating the evapotranspiration, such as the radiation, Penman and pan methods, are presented in FAO Irrigation and Drainage Papers Nos.
- Reference evapotranspiration (ETo) represents the rate of evapotranspiration of green grass under ideal conditions.

- The most practical method for determining ETo is the pan evaporation method. This approach combines the effects of temperature, humidity, wind speed and sunshine. The best known pans are the Class A evaporation pan (circular)
- The evaporation from the pan is very near to the evapotranspiration of grass that is taken as an index of ETo for calculation purposes.

- In order to relate ETo to crop water requirements (ETc), the specific crop coefficient (kc) must be determined:
- ETc = ETo x kc.
- The crop coefficient (kc) depends on the crop leaf area and its roughness, the stage of growth, the growing season and the prevailing weather conditions.

kc values for different crops at various growth stages:

Crop factor (kc) for seasonal crops (average figures)

Crop	Initial	Crop development	Mid-season	Late and harvest
Bean (green)	0.35	0.70	1.0	0.9
Bean (dry)	0.35	0.75	1.1	0.5
Cabbage	0.45	0.75	1.05	0.9
Carrot	0.45	0.75	1.05	0.9
Cotton	0.45	0.75	1.15	0.75
Cucumber	0.45	0.70	0.90	0.75
Eggplant	0.45	0.75	1.15	0.80
Groundnut	0.45	0.75	1.0	0.75
Lettuce	0.45	0.60	1.0	0.90
Maize (sweet)	0.40	0.80	1.15	1.0
Maize (grain)	0.40	0.75	1.15	0.70
Melon	0.45	0.75	1.0	0.75
Onion (green)	0.50	0.70	1.0	1.0
Onion (dry)	0.50	0.75	1.05	0.85
Pea (fresh)	0.45	0.80	1.15	1.05
Pepper	0.35	0.75	1.05	0.90
Potato	0.45	0.75	1.15	0.75
Spinach	0.45	0.60	1.0	0.90
Squash	0.45	0.70	0.90	0.75
Sorghum	0.35	0.75	1.10	0.65
Sugar beet	0.45	0.80	1.15	0.80
Sugar cane	0.45	0.85	1.15	0.65
Sunflower	0.35	0.75	1.15	0.55
Tomato	0.45	0.75	1.15	0.80

Crop factor (kc) for permanent crops

Crop	Young	Mature
Banana	0.50	1.10
Citrus	0.30	0.65
Apple, cherry, walnut	0.45	0.85
Almond, apricot, pear, peach, pecan, plum	0.40	0.75
Grape, palm tree	0.70	0.70
Kiwi	0.90	0.90
Olive	0.55	0.55
Alfalfa	0.35	1.1

Fertilizing Greenhouse Crops

- Maintaining adequate nutrition is among the most critical aspects of producing greenhouse crops.
- The frequency of fertilizer applications influences plant growth. In some cases it is important to supply nutrients at peak periods of vegetative or reproductive growth.
- A constant feed program may also be modified so that nutrients are applied at every other irrigation. This approach may be necessary under conditions of high soluble salts.
- The balance of plant nutrients is important in producing vigorous, efficient plants. In some cases when nutrients are out of balance severe deficiencies or toxicities may occur. Therefore it is important to consider both the source and amount of fertilizer used.

- **Selecting Fertilizers:**

1. Mono fertilizers

Super phosphate, Ammoniac ….

2. Compound fertilizer

Several “complete” fertilizers are available from commercial sources for the production of greenhouse crops.

These provide N, P and K in the balance desired (i.e. 15-16-17, 20-20-20 etc.).

However, many growers “custom blend” fertilizers from several different sources to achieve the best balance for plant growth.

- Selecting the type of fertilizer to be included in a nutritional regime is a key to optimum plant growth. **The following is a brief description of the nutrients frequently used:**
- **Nitrogen (N)** – is often thought of as the most important element in a nutritional program. However it is only one of several essential elements to plant growth. The most common sources of N used in liquid feed programs include: ammonium nitrate, calcium nitrate and potassium nitrate.
- **Phosphorus (P)** – is another element required in relatively large quantities for plant growth. However, over supplies of P may render other nutrients insoluble and therefore unavailable for plant uptake. Phosphorus is generally supplied in nutrient solutions by phosphoric acid or in some cases superphosphate may be incorporated in the growing medium to supply P.
- **Potassium (K)** or potash is used by the plant in a number of ways, but is primarily required in water relationships. Among the many greenhouse crops produced, poinsettias are notably heavy feeders of K. The most common source of K in liquid feed programs is potassium nitrate, however other sources may be used.

- Secondary and Micronutrients a “complete” nutritional program must take into consideration the secondary and micronutrients as well as N, P and K (macronutrients). These two classes of elements generally include: calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), zinc (Zn), copper (Cu), manganese (Mn), boron (B), molybdenum (Mo), and chloride (Cl). Although many of these may be inherently supplied by the growing medium, others require supplemental application.
- Both secondary and micronutrients may be included as a component of a liquid feed program. However, many growers pre-incorporate these into the growing medium. Dolomitic lime is perhaps the most common source of Mg used in this manner. There are also several commercial blends of micronutrients which may be incorporated into the growing medium.

NPK Fertilizer Required by Plant Types

Different plants have varying nutrient requirements, and the ideal NPK fertilizer ratio can depend on the specific plant type or category. Here is a detailed breakdown of NPK fertilizer ratios required by different plant types:

- **Leafy Green Vegetables**

Leafy green vegetables, like lettuce, spinach, and kale, love nitrogen (N) because it helps them grow lots of lush leaves. They need a fertilizer ratio with a higher number for nitrogen, like 3:1:2. For example, a fertilizer with the ratio 15-5-10 or 20-6-12 would work well. This means there is more nitrogen compared to phosphorus (P) and potassium (K), which supports leafy growth while still providing essential nutrients for root development and overall plant health.

- **Fruiting Vegetables**

Fruiting vegetables, such as tomatoes, peppers, and cucumbers, need more phosphorus (P) and potassium (K) to help them produce lots of flowers and delicious fruits.

They require a fertilizer ratio with a lower nitrogen (N) number compared to phosphorus and potassium. A good ratio is around 1:2:2, like 5-10-10 or 10-20-20.

This ensures a balanced supply of phosphorus and potassium for flowering, fruit development, and healthy plants, while preventing excessive leafy growth.

- **Root Vegetables**

Root vegetables, like carrots, beets, and radishes, put their energy into growing strong and healthy roots. They benefit from a balanced supply of all three nutrients: nitrogen (N), phosphorus (P), and potassium (K).

A recommended fertilizer ratio is around 1:2:2 or 1:3:3, such as 10-20-20 or 15-30-30.

This means the numbers for phosphorus and potassium are higher, providing the necessary nutrients for robust root growth and nutrient storage, while maintaining a moderate nitrogen level for overall plant health.

- **Flowering Plants**

Flowering plants, such as ornamental flowers, roses, and flowering shrubs, need a well-balanced nutrient supply to support healthy growth and beautiful blooms.

A good fertilizer ratio for flowering plants is around 1:1:1 or 1:2:2, like 10-10-10 or 10-20-20. This means all three nutrients – nitrogen (N), phosphorus (P), and potassium (K) – are provided in similar proportions.

This balanced ratio supports proper vegetative growth, strong root systems, and abundant and vibrant flowering.

Fertilizer	Fertilizer & Element Percentage	Amount/Gal	N	P	K	Ca	Mg	S	Cl
Potassium Nitrate	13.75-0-44.5 (36.9K)	1g	36	97	–	–	–	–	–
Potassium Sulfate	0-0-50 (41.5K, 17S)	1g	–	–	110	–	–	45	–
Muriate of Potash	0-0-60 (49.8K, 45Cl)	1g	–	–	131	–	–	–	119
Mono Potassium Phosphate	0-22.8-28.7	1g	–	53	75	–	–	–	–
K-Mag of Sul-Po-Mag	0-0-22 (18K, 11Mg, 22S)	1g	–	–	48	–	29	58	–
Mono Calcium Phosphate	0-46-0 (20P, 13Ca)	1g	–	–	–	34	–	–	–
Calcium Nitrate	15.5-0-0 (19Ca)	1g	–	–	–	50	–	–	–
Ammonium Nitrate	33.5-0-0	1g	41	–	–	–	–	–	–
Ammonium Sulfate	21-0-0 (24S)	1g	88	–	–	–	–	–	–
Urea	46-0-0	1g	55	–	–	–	–	63	–
Nitric Acid	7)% HNO3 (15.5N)	1g	121	–	–	–	–	–	–
Diammonium Phosphate	18-46-0 (20P)	1g	41	53	–	–	–	–	–
Phosphoric Acid	75%H3PO4 (0.363g.P/ml)	1 ml	47	96	–	–	–	–	–
Gypsum (Calcium Sulfate)	(18.6Ca, 14.9S)	1g	–	–	–	49	–	39	–
Epsom Salts	(9.9Mg, 13S)	1g	–	–	–	–	26	34	–

Name & Formula of Material	N-P-K	Analysis Others
Ammonium Chloride NH_4Cl	25-0-0	0
Ammonium Nitrate NH_4NO_3	33.5-0-0	0
Ammonium Phosphate (di) $(NH_4)^2HPO_4$	21-53-0	0
Ammonium Phosphate (mono) $NH_4H_2PO_4$	11-48-0	1.4% Ca, 2.6% S
Ammonium Sulfate $(NH_3)^2SO_3$	20-0-0	24% S
Calcium Nitrate $Ca(NO_3)^2$	15-0-0	37% S
Sodium Nitrate $NaNO_3$	16-0-0	0
Urea $CO(NH_2)^2$	45-0-0	0
Urea-Formaldehyde	38-0-0	0
Superphosphate $CaH_4(PO_4)^2$	0-20-0	18% Ca
Treble Phosphate $CaH_4(PO_4)^2$	0-42-0	12% S

Irrigation & Nutrition monitoring & Control

Computer uses:

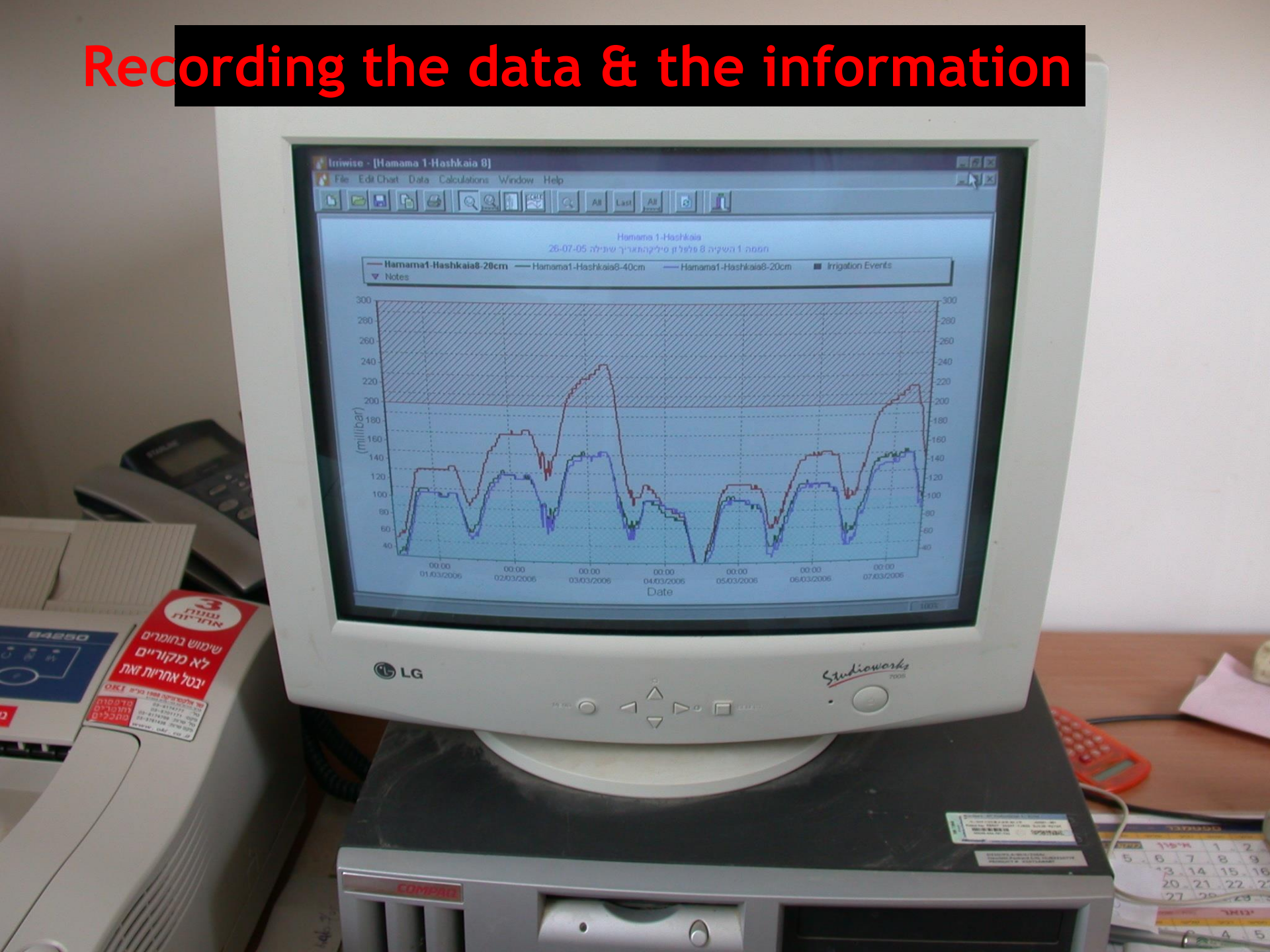
- Fertilization: Proportional or Quantitative
- Flushing of filters
- Opening / Closing of valves
- Controlling pumps
- Responses: Alarms, changes
- Control from remote site
- Connection to sensors
- Recording


Regular Head Control

Mix Tank & Fertigation advanced

Control of irrigation & nutrition in green houses, by tensiometers & extractors

Recording the data & the information



Pesticide use

What are Pesticides?

- Pesticides are chemical substances that are meant to kill pests.
- In general, a pesticide is a chemical or a biological agent such as a virus, bacterium, antimicrobial, or disinfectant that deters, incapacitates, kills, pests.
- plant protection product.
- It is commonly used to eliminate or control a variety of agricultural pests that can damage crops and livestock and reduce farm productivity.
- The most commonly applied pesticides are insecticides to kill insects, herbicides to kill weeds, rodenticides to kill rodents, and fungicides to control fungi, mould, and mildew.

Effects of Pesticides

- The toxic chemicals in these are designed to deliberately released into the environment. Though each pesticide is meant to kill a certain pest, a very large percentage of pesticides reach a destination other than their target. Instead, they enter the air, water, sediments, and even end up in our food.
- Pesticides have been linked with human health hazards, from short-term impacts such as headaches and nausea to chronic impacts like cancer, reproductive harm.
- The use of these also decreases the general biodiversity in the soil. If there are no chemicals in the soil there is higher soil quality, and this allows for higher water retention, which is necessary for plants to grow.

Advancements in Technology of Pesticides Use

- **Use of Drones for Spraying**

A drone used for spraying is equipped with almost all the parts of a ground sprayer, including a tank and a pump to push pesticides through the hoses to nozzles

- **Ultra-low volume sprayers**

Ultra-low volume (ULV) spraying is a common and advanced spraying method and considered a most effective and standard technique control of locust using chemicals and is also extensively used by farmers of cotton crops to control pest and insects. ULV sprayer is designed to create very small droplets (50 to 150 $\mu L/m^2$), which help for uniform coverage with low spray volumes. Ultra-low volume (ULV) fungicide application sprayer was first developed as thermal fogging. The objective of ULV sprayer to reduce the fluid application rate, drift, and wastage of chemicals while increasing insect and diseases control.

Spraying machines was developed for labor save in greenhouses

Safe use of pesticides

- Time
- Doze
- Safe period
- Type
- Wear special clothes
- Face mask

- Low need for pesticides

In greenhouses

Crop harvest

VEGETABLE HARVESTING PRINCIPLES

The following general principles are intended to give the gardener a framework for when and how to harvest vegetables:

- **Harvest for peak flavor and nutrition**. Many vegetables, such as beans, peas, summer squash, and turnips, are at their peak of taste and nutrition when they are tender and immature. Other vegetables, such as tomatoes, melons, and winter squash need to be allowed to completely ripen on the vine so that their flavors can become fully developed.
- **Harvest for size**. Size is generally a reliable indicator of maturity, but it takes a little practice to know when some vegetables are just right for picking. Because there may be some variance in vegetable varieties, always check seed packets or any information that is provided with purchased transplants for guidance on mature vegetable sizes.

•**Harvest often.** One of the biggest mistakes a gardener can make is neglecting to harvest vegetables regularly. Unpicked beans can go from tender to tough in no time at all. A zucchini that was just 2 inches long a couple of days ago can be an overripe 2-foot long club today. Keep in mind that the goal of the plant is to reproduce. If vegetables are allowed to grow to full maturity and are not harvested, the plant will stop producing.

•**Harvest with the right tools.** Some crops, such as lettuce, kale, and peas can be either pinched or gently snapped off with your fingers. Vegetables that don't easily separate from the plant should be cut off. A dedicated pair of scissors is ideal for snipping off some vegetables, such as beans. A sharp knife or hand pruners should be used to harvest crops with tougher stems, such as eggplants and cucumbers. A garden fork is an ideal tool for harvesting potatoes and root crops.

•**Harvest under the right conditions**. Vegetable quality is at its highest at the time of harvest and begins to decrease rapidly thereafter. The best time of day to harvest most vegetables is in the early morning after the dew dries. This is when they are at their sweetest and juiciest. Avoid picking vegetables in the heat of the day, especially leafy vegetables, which can wilt immediately.

•**Handle plants with care**. Keep vining plants properly trellised so that the weight of maturing vegetables doesn't cause the plant stems to bend or break. Avoid tugging or ripping a vegetable from the plant. This can damage the plant and provide an entry point for diseases. Also avoid working among vegetables during wet weather to inadvertently spread fungal and other diseases among plants.

•**Harvest the outer (larger) leaves of leafy vegetables first**. Lettuces and some other leafy vegetables sprout from the center of the plant. Unless you are harvesting the entire plant, pick the larger, outer leaves first and leave the tiny new growth in the center to continue developing.

Thank you