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SOIL CONSERVATION:

INTRODUCTION

Soil provides the nutrients essential for plant growth, animal life, and millions of microorganisms. However, if soil becomes unhealthy, unstable, or polluted, the life cycle stops.

Soil conservation refers to the protection and management of soil resources to prevent their degradation and promote sustainable land use practices.

It is an important field of study and practice aimed at preserving the productivity, fertility, and health of soils for future generations.

Soil is a vital natural resource that plays a crucial role in supporting plant growth, water filtration, carbon storage, and providing a habitat for various organisms.

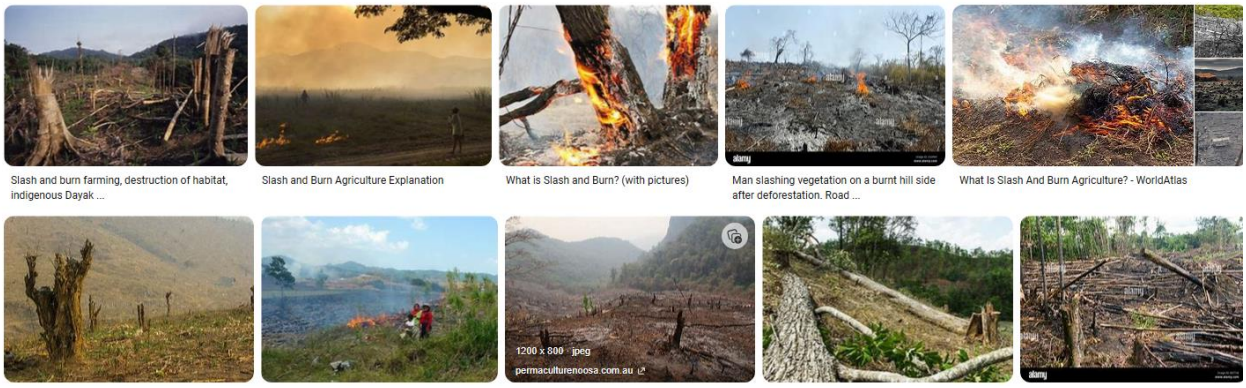
Threats to soil conservation

The primary threats to soil conservation are

Chemical contamination

The use of pesticides can contaminate the soil, as well as nearby vegetation and water sources, with harmful chemicals. In addition to contamination, chemicals used on crops can be toxic to important beneficial insects, such as bees, as well as fish and bird populations. A Good example `is the growing use of pesticides, herbicides and toxic fertilizers.

Slash and burn



Slash-and-burn farming is the practice of burning and clearing forests to make way for farmland. This method kills plant species and displaces wildlife from their natural habitats. Land cleared using slash and burn is only used while it's productive for farming. Once it loses its fertility, another patch of forest is identified for clearing. This unsustainable process repeats endlessly, preventing soil from recovering sufficiently to support healthy ecosystems.

Land overuse, overgrazing, etc.

Overuse of land can limit soil's ability to play its part in the global climate cycle. For example, overcutting forests and woodlands for timber and overgrazing pastures can far outpace the natural regrowth of vegetation, subjecting soil to increased exposure to erosion

Importance of Soil Conservation

Soil conservation is of paramount importance due to the following reasons:

Preserving Agricultural Productivity: Healthy and fertile soil is essential for sustaining agricultural productivity. Soil conservation practices help prevent soil erosion, nutrient depletion, and degradation, ensuring that the land remains productive for farming. By conserving soil, we can maintain high yields, improve food security, and support sustainable agriculture.

Protecting Ecosystems and Biodiversity: Soil is a crucial component of terrestrial ecosystems, supporting diverse plant and animal life. Soil conservation helps preserve natural habitats, including forests, grasslands, and wetlands, which are home to a variety of species. By protecting soil, we maintain the balance of ecosystems and safeguard biodiversity.

Water Quality and Quantity: Healthy soil acts as a natural filter, purifying water as it infiltrates through the soil layers. Soil conservation practices reduce runoff and erosion, preventing sediment and pollutants from reaching water bodies. By preserving soil, we maintain water quality, prevent contamination, and ensure the availability of clean water resources.

Climate Change Mitigation: Soils play a significant role in mitigating climate change through carbon sequestration. Healthy soils store organic carbon, helping to reduce greenhouse gas emissions in the atmosphere. By practising soil conservation, such as promoting organic matter content and reducing soil disturbance, we enhance carbon storage and contribute to climate change mitigation efforts.

Mitigating Soil Erosion: Soil erosion is a natural process, but human activities can accelerate it to alarming levels. Erosion leads to the loss of topsoil, which contains essential nutrients for plant growth. Soil conservation practices, such as contour ploughing, terracing, and cover cropping, help control erosion and preserve valuable topsoil, ensuring long-term land productivity.

Methods of Soil Conservation

There are several effective methods and techniques for soil conservation. Here are some commonly used methods: Grassed waterways

Grass water ways

 Grass water ways (sometimes also called grass waterways) are wide, shallow channels that are installed where water runoff usually concentrates in an agricultural field. They are planted with permanent vegetation, meaning they might be mowed, but the plants are never plowed or killed intentionally

Stone lines

 Stone lines are constructed along the contours to slow down the speed of runoff, reduce soil erosion, and enhance water infiltration. In addition, the stone barrier blocks and settles down the sediments transported from the upper slopes. Stone constructions are often used to rehabilitate eroded and abandoned land

Trash lines

Trash lines are ideally 0.5m to 1.0m wide and 0.5m high. Advantages of using trash lines They conserve top soil by trapping or reducing the speed of run-off. When they compose they turn into manure and boost soil fertility. Trash lines increase soil water infiltration since they tend to hold the water longer

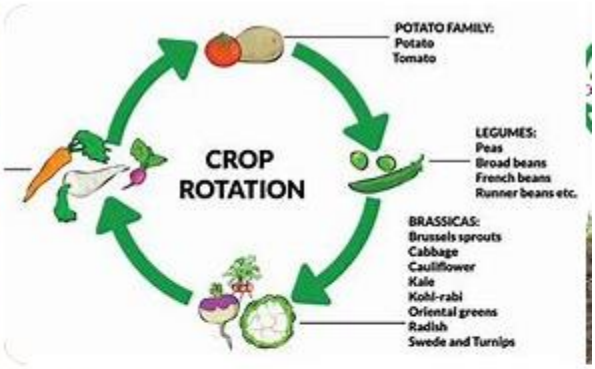
Bunds

Bund is an engineering measure of soil conservation, used for creating obstruction across the path of surface runoff to reduce the velocity of flowing water. It retains the running

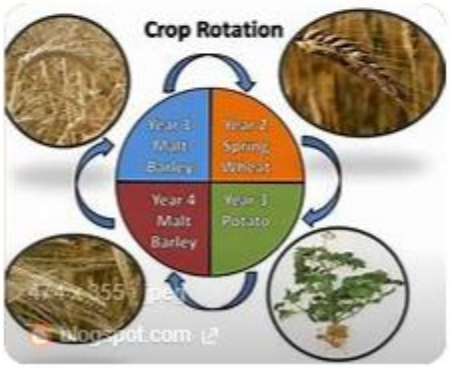
off water in the watershed and thus to helps to control soil erosion. Bunds are simply embankment like structures, constructed across the land slope

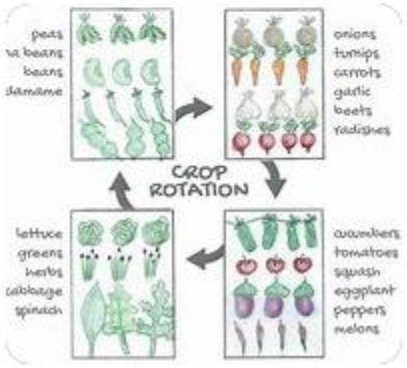
Crop rotation

Crop Rotation in Agriculture



Crop Rotation





Instead of planting the same crop year after year on the same plot of land, crop rotation involves planning out growing seasons for different crops. This method of sustainable agriculture requires long-term planning, with crops changed every season. In addition to improving soil health and organic matter, crop rotation reduces the need for fertilizer and pesticides, lowering costs. It also helps prevent excess chemicals from entering water supplies, improving water quality.

Contour Plowing:

Plowing along the contour lines of the land helps to slow down water runoff, reduce erosion, and retain moisture in the soil. This technique involves creating furrows or ridges that follow the natural contours of the land.

Terracing: Terracing is the construction of broad, level platforms on steep slopes. By creating terraces, water runoff is slowed down, allowing it to infiltrate the soil and reducing erosion. Terraces also help to retain moisture and provide flat areas for planting crops.

Windbreaks: Windbreaks are rows of trees or shrubs planted along the edges of fields or across wind-exposed areas. They help to reduce wind speed, minimize wind erosion and protect the soil. Windbreaks also provide habitat for wildlife and contrib
ute to biodiversity.

Strip Cropping: Strip cropping involves planting different crops in alternating strips or bands across a field. This method helps to break up the flow of water and reduce erosion. The alternating strips of different crops also help to improve nutrient uptake and reduce pest and disease problems.

Conservation Tillage: Conservation tillage practices involve reducing or eliminating the amount of soil disturbance during planting and cultivation. This includes techniques such as no-till, where seeds are planted directly into untilled soil, and reduced tillage, where minimal soil disturbance occurs. Conservation tillage helps to maintain soil structure, reduce erosion, and conserve moisture.

Cover Crops: Planting cover crops, such as legumes or grasses, during fallow periods or between cash crops, helps to protect the soil from erosion, improve soil fertility, and increase organic matter content. Cover crops also capture nutrients, prevent weed growth, and enhance soil microbial activity.

Mulching: Applying a layer of organic or inorganic material, such as straw, wood chips, or plastic, on the soil surface is known as mulching. Mulch helps to conserve soil moisture, reduce erosion, regulate soil temperature, suppress weed growth, and improve soil structure.



Conservation Buffer Strips: Buffer strips are areas of vegetation, such as grass or trees, established along the edges of fields, water bodies, or sensitive areas. These strips act as barriers, filtering runoff, reducing erosion, and preventing the movement of pollutants into water bodies.

Nutrient Management: Proper nutrient management is essential for soil conservation. It involves applying fertilizers based on soil nutrient testing and crop requirements to avoid over-application, which can lead to nutrient runoff and pollution. Balanced nutrient management helps maintain soil fertility, minimize nutrient losses, and protect water quality.

Soil Erosion Control Structures: Various physical structures, such as contour bunds, terraces, check dams and sediment basins can be constructed to control water flow, trap sediment, and reduce erosion in specific areas.

Wetlands restoration

This is defined as “removing a threat or preventing the decline of wetland conditions.” Wetlands provide a habitat for living creatures of all types. They also act as buffers, protecting farmlands from floods.

Forest cover reestablishment

In areas where soil has degraded, the reestablishment of forest cover can improve soil and restore ecosystem health. This method provides shade for crops and is particularly useful for forest farming which cultivates high-value crops, such as those used for medicinal purposes.

Earthworms

Earthworms are among the most productive organisms in soil. They digest plant matter, releasing essential nutrients into the soil, and their tunnel networks create air channels that help water move through the soil.

Benefits of Soil Conservation

Soil conservation offers numerous benefits that positively impact the environment, agriculture, and society. Here are five key benefits of soil conservation:

Sustaining Agricultural Productivity: Soil conservation practices help maintain soil fertility, structure, and health, leading to sustained agricultural productivity. By reducing erosion, nutrient depletion, and soil degradation, farmers can continue to produce high-quality crops and ensure food security for growing populations.

Preventing Soil Erosion: Soil erosion is a significant concern that leads to the loss of topsoil, which is rich in nutrients and essential for plant growth. Soil conservation measures, such as contour ploughing, terracing, and cover cropping, effectively reduce erosion, preserving valuable soil resources for future generations.

Enhancing Water Quality: Soil conservation plays a vital role in maintaining water quality. By preventing erosion, soil particles and pollutants are retained on-site, reducing sedimentation in water bodies. This leads to cleaner water, improved aquatic ecosystems, and enhanced drinking water quality for communities.

Mitigating Climate Change: Soil conservation contributes to climate change mitigation by promoting carbon sequestration. Healthy soils act as carbon sinks, absorbing and storing carbon dioxide from the atmosphere. Practices such as increasing organic matter content, implementing conservation tillage, and restoring degraded lands enhance carbon storage capacity, helping to mitigate climate change.

Conserving Biodiversity and Ecosystems: Soil conservation practices preserve natural habitats, including forests, grasslands, wetlands, and other ecosystems. Healthy soils support diverse plant and animal life, contributing to biodiversity conservation. By protecting soil, we safeguard the habitats and ecological balance of various species, maintaining the overall health and resilience of ecosystems.

Improves soil quality and productivity. Increased fertility improves crop yields, reduces the need for chemical fertilizers, and saves money.

Optimizes water infiltration. Better filtration increases water storage, preventing soil from drying out.

Provides food and shelter. Soil-producing vegetation provides nourishment to all types of animals and offers protection from the elements.

Soil conservation also helps to minimize the following:

- Loss of fertile and arable land, impacting crops and livestock production, as well as the economy
- Pollution and sedimentation flowing in streams and rivers, affecting fish and other species
- Erosion and environmental

Additionally, soil conservation offers indirect benefits such as improved water management, reduced flooding, and increased resilience to extreme weather events. It

also contributes to sustainable land use practices, rural development, and economic stability for agricultural communities.

Overall, soil conservation is crucial for sustaining agricultural productivity, preserving ecosystems, ensuring clean water resources, mitigating climate change, and promoting a healthier environment for present and future generations.

WATER HARVESTING AND STORAGE

Water Harvesting Techniques

Rainwater Harvesting

Harvesting can be even considered with water since we store rainwater for our future use.

Rainwater harvesting is the gathering and storage of rain rather than allowing it to run off. Rainwater is accumulated from a roof-like surface and redirected to a tank, cistern, deep pit, aquifer, or reservoir with percolation so that it seeps down and restores the groundwater.

Relying on rain fed farming still remains a major constraint for crop production.

Collecting water from ground run-off and rooftops to be reused in farms during dry seasons is one of the solutions to promote food security holistically. Here are some techniques to apply in water harvesting.

Shallow Water Pans

Water Ponds



Water Tanks


Sand Dams

By constructing a sand dam near a recurrent source of water, especially a river or where flow of water is not disrupted during wet seasons. This stops the run-off water, and traps it in the artificial reservoir allowing consistent water supply throughout the year. This technique is inexpensive and reaps full benefits as a long term solution.

Grey Water Recycling

Grey water makes up roughly 60% of household waste water. This waste water is from baths, sinks, washing machines and dish washers. As the cheapest and simplest technique, capturing of the grey water is done in a bucket or drain, and used for the farm or garden.

Contour Trenching

Also known as the *'fanya juu'* technique, trench contouring entails digging of trenches along contour lines where water flows down the hill and soil thrown upslope to form an embankment which traps the run-off water and sediment, while still penetrating the soil below.

Through this technique, though tedious in implementation and maintenance, crops can be grown in low rainfall seasons from the subsoil water reserve gathered.

Example of ‘Fanya juu’ technique

Fog Harvesting

Fog harvesting is best done at night and early mornings during the cold season in mountain faced regions or plains; e.g. Kajiado County and Coastal areas. Air is cooled to a point where it can no longer retain water vapour, hence forming ground level clouds.

These clouds (water droplets) are captured in a synthetic plastic mesh net, that is hoisted with two posts planted in the ground which drain the water in a gutter; then transferred in tanks. This technique is easy to replicate, cheap and the level of technology and maintenance is simple.

Groundwater Ponds

Using an artificial pond laid a few meters below the ground, increases the chances of a better harvest of rain water runoff. This water can be used for irrigation and livestock drinking water.

Compared to construction of a borehole, laying of a synthetic membrane on dug out grounds is cheaper, and traps the runoff water.

These ponds vary in size depending on the size of the farm. They are easy to manage and are cost effective.

Gutter Installation

This roof catchment system has been used for decades as a traditional means of water harvesting technique. The water can be harvested in small scale or large scale for the purpose of irrigation, livestock, drinking or all of the fore mentioned.

The size of the storage tank is dependent on the owners' financial ability and water usage.

With gutter installation, water runs down the strip iron sheets which are bent at an angle and nailed onto the roof, suspended with galvanized wires. The water is drained into a storage reservoir placed on the ground.


WATER

SQUARE FOOT GARDENING

Square foot gardening is the practice of dividing the growing area into small square sections, typically 1 foot (30 cm) on a side, hence the name. The aim is to assist the planning and creating of a small but intensively planted vegetable garden square allows you to get a high yield from a small area It's especially beneficial to gardeners who don't have much time or farm space. Square-foot gardening typically starts with a 4x4-foot raised garden bed filled with amended soil, then subdivided into 1-foot squares with markers like lattice strips. You then plant the appropriate number of plants in each square. (You determine this by plant size.) This method optimizes your space and reduces the effort needed to go from planting to harvest.

Preparing square foot garden

Follow this guide to square-foot gardening based on a grid of 1x1 foot squares and grow more vegetables than you can imagine—with less work.

Follow the steps below to start your square-foot garden.

1. Pick the Correct Location for Square-Foot Gardening

As with most vegetable gardens, a square-foot garden must be where the ground is relatively flat and gets at least 6 to 8 hours of full sun daily. Avoid low areas that may turn into puddles after a hard rain. You may want to choose a spot near your house to make watering, weeding, harvesting, and other garden chores more convenient and harder to overlook.

2. Build a Raised Garden Bed

The most common configuration for square-foot raised garden beds is 4x4 feet. At this size, most gardeners can reach the middle from any side. Plus, this size divides easily into a grid of sixteen 1x1-foot squares. Make your sides at least 6 inches deep. Growing root vegetables such as carrots call for sides that are 12 inches deep.

To make a 6-inch-tall raised bed for square-foot gardening in a flash, buy four planter wall blocks (which have 2-inch slots on four sides) and four 4-foot-long 2x6s at your local home center. Set the blocks approximately 4 feet apart on level ground to form a square. Connect two blocks by sliding a 2x6 board into the respective 2-inch slots. Repeat with the remaining boards and blocks to create a 4x4-foot frame in about 15 minutes. Use a more durable material such as pressure-treated lumber or cedar for a long-lasting frame.

3. Fill the Raised Garden Bed

You've built the frame for a raised garden bed; now you need to fill it with soil. You may be wondering if you need special soil for square-foot gardening. You can use what you have as long as you amend it (which is a good idea for any garden). First, loosen and aerate the ground soil. Then mix in enough compost (and extra topsoil if needed) to fill the frame.

Work compost into the soil at the rate of one-third by volume (such as a 2-inch layer of compost into 6 inches of soil).

Soil Amendments & Nutrients

If you want to be more scientific about it, you should test your soil to determine its composition. Once you have that information, add the right amendments in the correct proportions to achieve the best-growing medium for a vegetable garden.

Another option: Prepare the soilless mix advocated by Mel Bartholomew rather than amending your ground soil. Follow this formula: one-third compost, one-third peat moss, and one-third vermiculite. You'll need 8 cubic feet of it to fill a bed with 6-inch sides and 16 cubic feet to fill a bed with 12-inch sides. This mix is pricey, but it creates a weed-free bed that's high in nutrients and retains moisture.

Blend the ingredients well whether you amend the existing soil or create a new soilless mix. Some gardeners use a portable concrete mixer plugged into a household outlet to get a uniform texture and distribution of particle sizes. No mixer? No problem. Blend all the ingredients on top of a tarp, then shovel the mixture into the frame. To get a speedier start on planting, skip the mixing and fill the frame with high-quality bagged garden soil from a nursery or gardening center.

Once the bed is filled and you've raked the soil or soilless mix smooth, create a square-foot garden grid using lattice strips, PVC pipes, or even string. (Use nails or screws to attach the grid to the sides of the frame.) Being able to see each square-foot section clearly simplifies planting. If you like, cover the prepared garden with a thin layer of fine mulch to conserve soil moisture and slow down the growth of weeds.

4. Plant Your Favorite Vegetables

If you're building more than one raised square-foot garden bed, leave enough space between them to roll a wheelbarrow. The formula for planting is simple: one extra-large plant per 1x1-foot square; four large plants per square; nine medium plants per square; and 16 small plants per square.

Here's an idea of what you can fit in each square: one vine tomato, pepper plant, sukumawiki or eggplant; four bush tomatoes, heads of cabbage, or heads of lettuce; nine onions or beets; or 16 radishes. Zucchini needs nine of the 16 squares for just one specimen, but you can plant other vegetables in the remaining seven squares. Vegetables or fruits that spread (such as watermelons) require a separate bed.

Planting Seeds

If planting seeds, plant one seed per hole spaced appropriately for the mature plant. (Look on the back of the packet for instructions.) Poke a finger through the mulch into the soil, drop in a small amount of vermiculite, then the seed, and cover it with more vermiculite (a material that will help keep the seeds moist while it's sprouting). Mist the newly planted seeds daily, so the soil doesn't dry out. Once plants are established, water them approximately once a week.

Transplanting Vegetables

If you're transplanting vegetables from a nursery or gardening center, use the same spacing method mentioned earlier. Place plants in the dirt, leaving a shallow depression around each one to help hold water. You may want to shade newly planted vegetables to protect them from wilting. Water daily for a few days, and then remove the shade and water weekly.

5. Maintain Your Garden

Yes, square-foot gardening may take a little less work than traditional gardening, but you still have to pay attention to your produce.

Watering Schedule

You need to water when the soil feels dry, but you won't waste water on any exposed soil between traditional rows. Don't water from overhead. Instead, use a small container to water each plant individually—pouring the water into the depressions you made when you planted them. Don't panic; it will still take less than 10 minutes to water a 4x4-foot garden this way. If your schedule permits, water in the morning.

You'll need to water more often on days that are hot or windy because the soil will dry out faster.

Weeding Your Garden

Plan on weeding every week, but either pull weeds when they're small or use scissors to cut weeds off at the base instead of pulling them up by the roots or using a hoe. (You don't want to disturb the roots of vegetables growing nearby.) Make it easy on yourself by weeding every time you walk by the bed or only one square at a time. Because weeds

won't compete with your vegetables for nutrients, you probably won't need to fertilize.

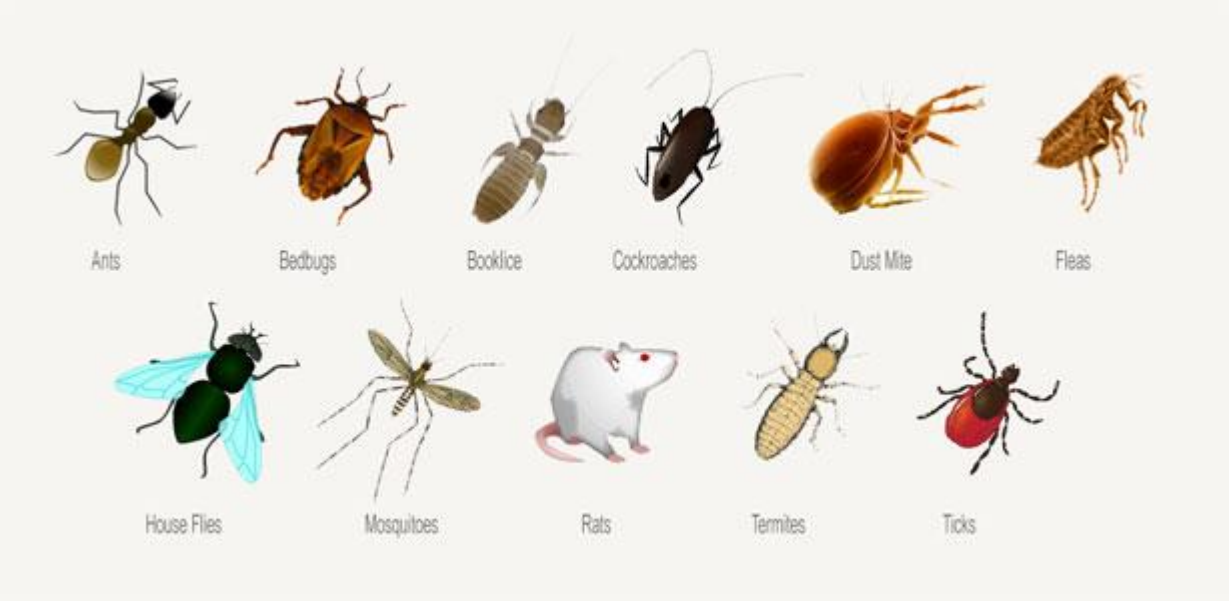
Pest Control

Inspect your garden daily to spot insect trouble early. Either hand-pick and destroy insects or spray the soft-bodied ones with insecticidal soap. Knock aphids off of plants by spraying them with a hose.

CROP MANAGEMENT

Crop pest

A pest can be described as any organism capable of causing damage to crop plant.



Types of Crop Pest.

Important pests of crop plants are grouped into the following classes:

(i) insect; (ii) birds; (iii) rodents; (iv) monkeys; (v) man; (vi) nematodes

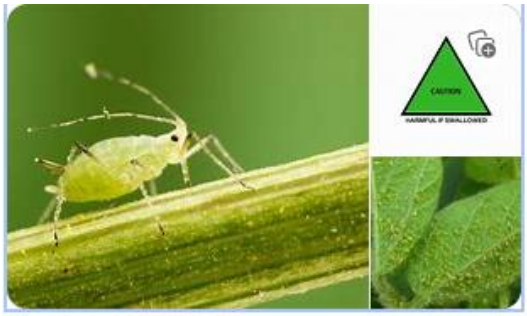
Classification of insect pests

Insects' pests can be classified into various groups based on their mode of feeding. These groups of insect pest include:

1. Biting and chewing insects;
2. Piercing and sucking insects;
3. Boring insects.
4. **Biting and Chewing Insects:** These insect (mouth-parts) which enable them to bite and chew plant Examples include: termites, grasshoppers, leaf worms, army worms, mantis, locust, beetles, etc.
5. **Piercing and sucking insects:** These insect pests possess strong mouthparts called proboscis stuck liquid from materials from plants' tissues. Examples include aphids, cotton strainers, mealy bugs, scale insects, capsids or mirids, white flies, etc.
6. **Burrowing insects:** These insects including their larvae are capable of burrowing into plant parts and destroying the tissues of the plant or fruits or seeds. Examples include: bean beetles, stem burrowers, maize weevils and rice weevils

Crop pests

Aphids



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Aphids > Diagnostic And Tips For Controlling Plantin

Aphids

Cut worms

Mesquite Cut Worms - Bosque

Variegated Cutworm - Potato - Ontario CropIP...

Managing Black Cutworms In Turfgrass

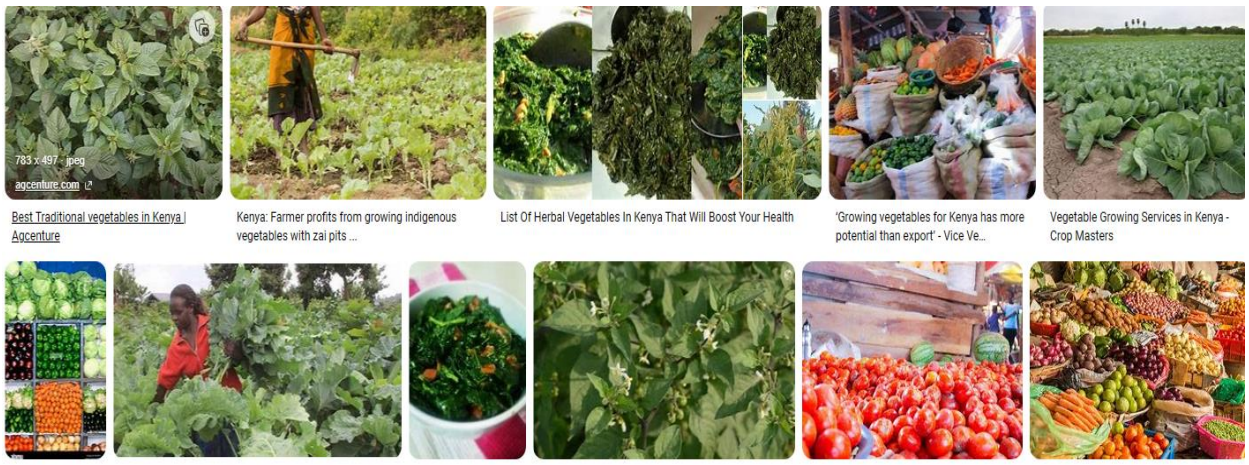
What Are Cutworms and How Do I Get Rid of Them? | The F...

Cutworms in Dealing with Cutworms - Garden.org

Cutworms: Identifying and Getting Rid of Cutworms

Caterpillar

Vegetables attacked by pests



- Kale
- Spinach...
- Tomatoes
- Onions ...
- Carrots ...
- etc

Effects or economic importance of insect pests in crop production

1. Insects pest destroy crops in the field through their biting, chewing, boring, sucking and defoliation activities

2. They cause reduction in viability of stored produce
3. Spot of injuries by insets may predispose crops to disease attact.

4. They increase the cost of production during the course of controlling them
5. They render vegetables and fruits unattractive and unmarketable

6. Some are carriers or vectors of diseases.
7. The profits of farmers are reduced
8. They reduce the quality of produce either in the store or in the field
9. They generally reduce the yield of crops
10. They can also cause total death of crop plants.

What you need to know about insects pests

Not all insects are pests. Some bugs are beneficial to the garden. These good guys are known as “beneficial insects,” and they can greatly benefit your garden by consuming pest insects that would otherwise feast on your plants.

Examples Of Beneficial Insects Include:

- Playing mantises
- Robber flies
- Hoverflies
- Assassin bugs
- Ground beetles
- Ladybugs
- Green lacewings
- Spiders
- Soldier beetles

How to Control Pests in Crops

Pests can be controlled by implementing:

- Chemical control;
- Cultural control, including crop rotation, use of locally adapted and/or pest-resistant or -tolerant varieties, sanitation, and the manipulation of planting and harvest dates to avoid pests;
- Biological control by using natural enemies of pests;
- Mechanical control through cultivation practices or pest trapping;
- Biotechnology. ..

Cultural Control:

By cultural control, it is meant those methods of planting, growing and harvesting a crop which will prevent or lessen insect damage. This method consists of a slight departure from the usual time of planting, sowing or harvesting the crops or changing the plan of crop rotation, weed control, disposal of the crop remnants after harvest. Planting good seeds and resistant varieties are very important in controlling some insect pests.

Since cultural methods are usually economical, they are especially useful against pests of low unit-value crops. Practices which reduce the chances of buildup of pest populations may hold them below the level which will cause economic damage. Such methods are particularly applicable to field crops and forests.

Knowledge of the life history or bionomics of a pest species is essential to the effective use of cultural control methods. The principle of the "weakest link" or most vulnerable part of the life cycle usually applies. The environment is changed by altering farming practices at the correct time so as to kill the pests or to slow down their multiplication. In this way, the method is aimed more at prevention than at cure. If the environment is unfavorable, the pest may not reach a population level which will cause serious damage.

Cultural controls are often used when chemical or biological methods have not yet been devised for an injurious species. Cleanup of the sources of infestation and changes in the planting or harvesting time are particularly important when no effective method of killing the pest is known.

However, these methods are also used in combination with other controls:

1. Control by Planting Pest Resistant Varieties:
Seeds of healthy plants preferably of a resistant variety only should be sown as far as possible. Certain varieties are naturally resistant or less susceptible to insect attack e.g. certain varieties of wild apples are immune to aphid attacks while most of the cultivated varieties are very susceptible. Hence, by interbreeding wild with cultivated variety, a strain can be evolved which yield good fruits and shall also will be immune to pests.

2. Tolerance to Insect Infestation:
A variety may be infected by insects yet survive and show less injury than others because of its ability to replace injured parts such as leaves and rootlets.

3. Ploughing in Relation to Insect Control:

The plough if used at right time is a good tool for combating many insect pests; it disturbs or kills them, eradicates weeds upon which they might feed and breed, exposes them to natural enemies or to weather control and buries them so deeply that few adults can emerge. A thorough stirring of the soil before planting is an indirect method for controlling the corn root aphids, because, it breaks up ant colonies, kills many aphids and prevents the growth of weeds on which they live until corn roots are available.

4. Clean Cultivation:

Clean cultivation means the removal of weeds, plant residues, and other materials from the fields and growing only healthy crops. The destruction of crop residues is a very good preventive measure for controlling certain species of insects e.g. caterpillars or beetles. The elimination of remaining effectively stops further insect breeding by cutting of their food supply and shelter.

Many insects infesting crops will develop on weeds which may or may not be related to these crops botanically. Hence, weed control is a good practice for reducing insect infestation. Damage due to Leptocorisa is very serious when paddy fields are surrounded by weeds which provide a good shelter to the pests till the ears have been formed in them.

Similarly various species of red hairy caterpillar, *Amsacta moorei, Amsacta collaris* and other species of this insect are polyphagous and lay eggs on a number of weeds and on emergence the caterpillars feed on the weeds and then migrate to the nearby fields of any crop.

5. Crop Rotation:

Crop rotation is effective as preventive measures against insects that feed on relatively few plant species or where the insects are incapable of long distance migration but crop rotation is useless against a general feeder. If one and the same crop is grown every year the insect population is bound to increase due to abundance of food material. On the contrary, if crops are grown in rotation or alternate years e.g. a crop of one plant family followed by that of different family e.g. barley grown in spring may be followed by legumes or pulses and then wheat in winter and so on.

The crops of the same family e.g. cotton, and lady's finger (okra) belonging to the same family Malvaceae must not follow same year. Mixed crops are sometimes useful as pests do not thrive in large number.

6. Flooding or Irrigation:
Where water is available, it is sometime possible to destroy insects by flood or irrigation of the field. Flooding rice fields destroys many sugarcane borers. Similarly other burrowing insects e.g. crickets, grasshoppers, beetles and bugs come out of the ground after flooding the fields. They either die their natural death or readily picked up by birds. Ploughing followed by heavy irrigation within 30 days destroys many pink boll worms. The sugarcane and wheat crops can be saved from the attack of termites by irrigation.

7. Fertilizing:
Nitrogenous fertilizers in some soils tend to increase the susceptibility of sorghum to damage by attack of some insects. As a result of proper manuring the plant growth is stimulated. The healthy and vigorous plants can easily resist the attack to which the weaklings would have surrendered.

8. Pruning and Thinning:
Some pests are normally carried from old crop to the new one. Pruning and thinning decrease the intensity of attack. Infested plant shoots and dead hearts must be immediately removed. Ratooning should be avoided and there should be plenty of intervals between harvesting a crop and sowing a new one.

9. Time of Planting and Harvesting:
Time of planting and harvesting has great influence on insect infestation e.g. early maturing cotton is not attacked by pink boll worm in areas where moth do not emerge early. Late planted wheat escapes oviposition by hessian flies in America because the plants do not emerge until most of the flies have disappeared as they are very short lived. Similarly early sowing of rice in the Punjab between the 3rd week of May and mid-June is helpful in protecting it from the attack of rice borer, Tryporyza incertulas so the time should be so regulated that the crop may not be worth the attack at the active period of the pests.

10. Closed Season:

An insect species limited in its feeding to one crop may be eradicated by not growing this crop for a year or two.

This has been done with success in isolated areas for eradicating the pink boll worm. Such a closed season consists in not growing cotton for a period of several months.

11. Destruction of Volunteer Crops:
Volunteer crops are those which grow from self-sown seeds, and stubble crops are those which sprout from roots or stubbles (stumps), may be a source of insect infestation and they should be destroyed by ploughing or other means.

12. Trap Crop:
A trap crop is a small planting often only a few rows, made somewhat earlier than the main planting for the purpose of diverting insects away from the main crop. The trap crop can either be harvested early or cut and used as fodder before a generation of the insect can be completed. Otherwise it will serve as a breeding ground for the pest which will then attack the main crop in large numbers. The plant species used for trap crop should be one that is very attractive to the insect. The preferred host plants can also be grown around the main crop and when the pest has appeared it can be cut and destroyed.

The other methods of cultural control are early cutting of crop, rate and depth of planting, sowing, separation of complimentary host plants, pasturing the heavy infected crops and drying out the soil etc.

Physical and Mechanical Control:
The protection of crops and foods from insect attack by physical and mechanical means is the simplest and most effective method. Such measures consist of destruction of insects by mechanical means, burning, trapping, protective screens or barriers, use of high or low temperature, soaking in water and drying.

1. Hand Picking:
When only a few plants are infected, certain large conspicuous species may be removed from the plants by hand and destroyed just by pressing the abdomen or dipping them in kerosenized water.

2. Mechanical Means:
A rotary blow has been found to destroy over 96% of white grubs as well as cut worms, army worms and other caterpillars. The cutting wheel is thirty two inches in diameter and fourteen inches wide and carries sixteen steel blades. It operates by power take off from a tractor at 150 rpm.

3. Trapping:
The insects may be turned into a tray by light and baits or the trap may be mobile and drawn across a field.

4. Light Traps:
The attraction of nocturnal insects to light is a common observation and the light traps have been invented and tested for killing crop pests. The attractiveness of an artificial light depends upon its candle power and colour. A yellow light will attract 60% fewer insects than a white light of the same candle power and brightness. The insects attracted by light may be destroyed as they hit electric grid or they may be drowned in water and oil after they have been turned into the trap.

5. Bait Traps:
Baits are a form of control whereby insects are attracted to a selected spot on which they can be easily removed. Bait traps have been found to be very effective in controlling the nocturnal insects like cockroaches, crickets, caterpillars and nocturnal moths.

6. Temperature Treatments:
(a) Low Temperature Control:
Low temperature extremes are fatal to insects of stored grains. Usually a temperature of 28°C or lower for at least several hours will kill most of the insects. *Tribolium confusum* can be killed in 24 h when exposed to subzero temperatures. Low temperatures are utilized for the control of insects in mills, warehouses and similar establishments.

(b) High Temperature Control:
High temperatures are also fatal to other species and can be used to kill them. Heating cotton seeds to a temperature of 65.5°C for 30 seconds will kill all pink boll worms in the seeds. Temperature of 48.8-51.6°C in all plants of a flour mill for 10-12 h will kill all insects exposed to such temperature.

Exposing the infested grains to the sun also kill all the adults of the stored grain insects.

7. Physical Barriers:
The protection of crops from insects by barrier is possible in case of crawling and migratory insects. Treated paper barriers and dust barriers are also used. Trenches are also used to stop army worms. Similarly water channels can be used for checking the migration of crawling insects.

8. Burning:
Although destroying insects by burning their shelters is sometime practicable, burning pastures and woodland to destroy insects should not be recommended. It has been found that such practices reduce soil fertility and increases soil erosion. Furthermore, it fails to destroy injurious species but does eradicate many beneficial forms.

Both cutting away dead hearts and burning them in time save valuable crops from destruction. Burning the field refuse and stubbles, are the other useful ways of pest control.

9. Sieving and Winnowing:
It is possible only for domestic purposes.

10. Flooding:
It is well known that a large number of insects breed and dwell in the soil, which may be destroyed by flooding the fields with water. There are several other simple methods through which a number of pest infestation can be controlled but the mechanical method of insect pest control involves a lot of labour like shaking the trees and killing the insects either in the larval or adult stages.

Biological Control:

The term biological control means control of insects by several biological agencies such as parasites, predators and pathogens. The introduction of sterile males in a normal population and use of sex attractants have been reported to bring about effective biological control.
The theoretical basis of the biological control defends on the existence of a natural enemy.

The effective natural enemy can be deduced to have the following characteristics:

(i) High searching ability,
(ii) High degree of host specificity or preference,
(iii) Good reproductive capacity relative to the host
(iv) Good adaptation to a wide range of environmental conditions.

The most essential characteristic is high searching ability. It should be borne in mind that a really effective enemy may be scarce in its native home because it regulates the host population at low level.
There usually is one best enemy for each species in a given habitat and one frequently is sufficient for complete biological control, often, however, a second or third enemy species may add to host population regulation and may in fact be necessary to achieve satisfactory biological control.

The best enemy species may differ for different host habitats. Hence there is generally no single best natural enemy extending throughout the range of a pest species.
With these qualities the introduced natural enemy by itself or in conjunction with other mortality factors is expected to prevent outbreak of the pest species or at least to drop down major population fluctuations.
The essential principle of biological control is to maintain a state of biological equilibrium of a living organism.
This biological equilibrium is normally maintained by a set of forces called environmental resistance.

Often the biological equilibrium of a living organism is disturbed either due to environmental or biotic factors and consequently a particular organism multiplies and spreads in a unlimited manner so as to assume the status of a pest. The inherent ability of an organism to survive and to reproduce within a given time and under optimal environmental conditions is known as biotic potential.
Biotic potential is a force opposed to environmental resistance. It takes into account the number of young produced per female in each reproduction, the number of reproduction in a given time and the sex ratio of the species.

Advantages of Biological Control:
Only a limited number of introduced pests have been successfully exterminated with chemicals. It would seem wiser in many instances to attempt a biological control programme which might reduce pest populations below the level which causes economic damage.

Biological control has the tremendous advantage that, if successful, it becomes self-sustaining and integrated into the normal environment of the control area.

If pest populations are reduced to the point where economic damage is negligible, the control programme is a success. Biological controls tend to be particularly useful on low unit-value crops where complete control may not be required or where chemicals are not recommended.

Pests of field and forage crops, forests, and range may be economically controlled by biological methods; chemical controls against such pests may be impractical.

A biological control destined to be fully effective will be easily and quickly established. If an imported parasite or predator is not established within three years of careful releases under good conditions for its development, the programme may be justifiably discontinued.

Types of Biological Control:

There are 4 main types of biological control viz.:
(i) Introduction of parasites,
(ii) Predators,
(iii) Pathogenic organisms such as bacteria, viruses and fungi etc. and
(iv) Removal of fertile males and creating sterility in males by gamma radiation and introducing these sterile males in a normal population. In addition to these 4 main types, there is a fifth type of biological control where the indigenous parasite of the locality is being utilized for this purpose.

1. Parasites:
Parasitic insects develop as larvae on or in a single host individual from eggs generally laid on, in or near the host and usually consume all or most of the host body, killing the host and then pupate, either within or outside the host. The free living adult parasite emerges from the pupa and starts the next generation a new by actively searching for host in which to oviposit.
They tend to attack only one host stage i.e. eggs, larvae, or pupae, although there is also some overlapping in certain cases, adult insects do not serve as hosts. Very often life cycles are commonly short, ranging from 10 days to 2 weeks or so in mid-summer but correspondingly longer in cold weather. In general, they all have great potential rates of increase.
According to the species one or more parasitic larvae may characteristically develop per host individual, thus we have either solitary or gregarious parasitism. Sometimes two different species of larvae develop from eggs laid in the same host. This is multiple parasitism. There is also ectoparasitism and endoparasitism, depending upon whether the larva develops externally or internally. The major groups occur in two orders of insects' viz. Hymenoptera and Diptera.

2. Predators:
Predator insects differ from parasitic ones in that the larvae or nymphs, as the case may be, require several to many prey individuals to attain maturity. The adults generally deposit their eggs near the prey population and after hatching the active mobile immature search out and consume prey individuals. This need of larvae or nymphs to search is an important distinction from parasitic forms whose larvae develop on a single host individual and thus have the advantage of not having to discover additional hosts.
Adults of many species are also predatory. There may be one or several generations to one of the prey. Larvae and nymphs as well as corresponding adults may be predaceous or only one stage may exhibit the habit.

3. Pathogens:
Pathogenic microorganisms attack insects and have life cycles more or less characteristic or similar microorganisms developing in other groups of animals. Insects are probably subject to as wide as variety of disease as are the vertebrates. Except for the fungi, disease organisms gain entry in the host via mouth or the digestive tract, i.e. the insect host must eat plant or other food contaminated with pathogen. In case of fungi, entrance is gained through the insect integument and free water or very high humidity is generally required.
Thus, fungi tend to be restricted to moist environments. However, fungi do have advantage of attacking sucking insects which because of the nature of their feeding on sap, tend to be fairly free of disease caused by microorganisms because they rarely ingest them. Virtually no insect disease organisms occur in mammals and none have been recorded from man. Thus they are safe to use in biological control even in large scale microbial spraying operations.

4. Genetic Methods:
Genetic pest control implies the manipulation and use of genetic material in a manner injurious to pest insects. The control of insect pest populations by the release of sterile males has been demonstrated with at least five insect species. This spectacular technique has been termed autocidal control and involves using an insect species to bring about its own self-destruction.

It is accomplished by irradiating laboratory reared males of the species to an extent sufficient to disrupt the genetic function of the sperm nucleus but not appreciably interfere with the normal ability of the male to mate or of the sperm to penetrate the egg of the female. However, such fertilized eggs fail to develop so a wild female mated with a sterilized male produces no progeny.
If sterile males are released in large enough number in relation to the wild population they will fertilize more females than will the wild males. The advantage is cumulative in each generation hence eradication may be achieved within a few generations under ideal conditions.
The boll weevil is reported to have been eradicated from a small isolated field by the release of chemically sterilized males.

Chemosterilants have been under intensive investigation but are not as yet practical. They offer the advantage of treating the wild population directly and thus avoiding the mass rearing necessary with gamma radiation.

Use of Pheromones:
The ability of an insect to locate a mate and to copulate once it has been found is often directed by natural specific chemicals produced by the insect called pheromones. Natural chemical attractants and mating stimulants have been shown to occur in many pest insects. They are often effective in incredibly small concentrations; one caged virgin female of the introduced pine sawfly attracted over 11000 males.
Some have been chemically identified and even synthesized. Its high specificity for particular target insects however makes this approach highly desirable. Such phenomena gave rise to the intriguing idea of using these natural or artificial pheromones to attract and trap insects, to lure them to contact poisons, chemosterilants or pathogens and to mask the location of females by saturating the environment with synthetic sex pheromones. Such techniques could offer highly specific control methods with little or no ecological side effects.

It appears that adequate control from pheromones or attractants probably can only result if they are so highly effective as to be able to reduce the pest population to low level in the treated area and are used over a large area so that immigration of the pest from the outside would not negate the effort. Pheromone traps are commonly used for controlling various moths Heliothis, Spodoptera, Leucinodes etc.

Chemical Control:

Recent discoveries of new synthetic insecticides have sparked exciting advances and major breakthroughs in the control of insect enemies. Chemicals have subdued pests that once caused wide spread crop destruction, death of domestic animals and epidemics of insect borne human diseases. The modern insecticides are both effective and reliable. The whole world is resorting to them more and more for the solution of many insect problems.

The chemicals which kill the insects by their chemical action are termed as insecticides. They are used for the protection of men, domestic animals, crops, agricultural products from the attack of insects when other methods fail to control the pests. Insecticides are seldom used in full strength but are formulated in a variety of ways to make them easier for application.

Formulations of Insecticides:

Following are the common formulations of insecticides viz.:

(1) Dusts,
(2) Granular formulations,
(3) Insecticide-fertilizer mixtures,
(4) Wettable powders,
(5) Solutions,
(6) Emulsifiable concentrates,
(7) Aerosoles,
(8) Fumigants and
(9) Miscellaneous formulations.

Whatever may be the formulations the poisonous chemical present in an insecticide must penetrate the vital organs and tissues of the insect and ultimately kill it.

(1) Dusts:

Insecticidal dusts are those powders which are used dry and mixed with or impregnated with certain organic materials or pulverised minerals (powders) such as talc, pyrophyllite, bentonite etc. These minerals are called carriers or vehicles since they carry the insecticide. Dusts are blown to deposit on plants by dusting machinery or blowers. Ground to a fine size, most dust will pass through a 325 mesh screen and range in size from 1 to 40 μ. The finished dust may be 0.1 to 25% active material. In dust form, in general, the toxicity of an insecticide increases as the particle size decreases.

(2) Granular Formulations:

These are similar to dusts except for larger particle size. The range of particle size in a granular product is designated by a two figures mesh classification e.g. 30/60 means that virtually all the insecticide granules will pass through a standard 30-mesh sieve while a negligible quantity will pass through a standard 60 mesh sieve.

Some of the common granular formulations are 16/30, 20/40, 24/48 and 30/60. Granular insecticides are generally used as dressings on or in the soil and may be applied with fertilizer spreaders or special granule applicators.

(3) Insecticide Fertilizer Mixtures:

Insecticide fertilizer mixtures may be formulated by adding granular insecticides to commercial fertilizers or by spraying insecticides directly on to the fertilizer. Such mixtures are applied at the regular fertilizing time to provide both plant nutrients and control of soil insects.

(4) Wettable Powders:

These are similar to dusts but they are meant to be diluted and suspended in water and used as spray. To make an insecticidal dust act in this manner a dispersing and wetting agent is added to the formulation. They are more concentrated than dust as they may contain as high as 75% toxicant.

(5) Solutions:

Many of the modern synthetic insecticides are insoluble in water but soluble in organic solvents. These soluble insecticides in solution form are used directly for insect control. They are however seldom used on plants because of their phytotoxic reaction.

(6) Emulsifiable Concentrates:

The most common and versatile formulation is the emulsifiable concentrate. This formulation consists of an insecticide, a solvent (for the insecticide) and an emulsifying agent. Mixing the concentrate with water forms an emulsion. The solvent used may evaporate quickly after spraying leaving a deposit of toxicant after the water has evaporated.

The use of an emulsifying agent serves several purposes; it makes possible the diluting of a water insoluble chemical with water, it reduces the surface tension of the spray thus allowing it to spread and wet the treated surface more effectively, helps the spray and make a better contact with the insect cuticle.

Generally oil soluble emulsifying substance is used. Normally emulsions are unstable and break up into their component parts. This action is termed breaking. For spraying on plants a quick breaking mixture is preferred. Since this results in heavier deposits of toxicant.

(7) Insecticidal Aerosols:

Aerosols are minute particles suspended in air or fog or smoke. The diameter of these particles range from 0.1 to 50 μ. The dispersion of insecticide into aerosol form may be accomplished by burning, vapourising with heat, atomizing mechanically or releasing through a small hole an insecticide that has been dissolved in a liquified gas. The last method of aerosol preparation gives the popular aerosol bomb.

(8) Fumigants:

Insecticides used in the gaseous form are known as fumigants. Fumigants are most often formulated as liquids under pressure and are held in tanks. When the liquid is released in open air it changes back to a gas, quite often fumigants are a mixture of two or more gases.

(9) Miscellaneous Formulations:

There are certain insecticides which are special formulations meant for specific uses. Often insecticides are stuffed in large pills and capsules and introduced into the stomach of animal. Insecticides may be mixed in shampoos, intended for use on house pets waxes for use on floors may contain an insecticide. Poison baits consist of toxicants combined with food stuff attractive to the insect pests. All these types of insecticides are special formulations designed for special purposes.

Synergists:

Some chemicals have the property of greatly increasing toxicity of certain insecticides. When the increased toxicity is markedly greater than the sum of the two used separately, it is termed a synergistic action. Most synergists have been used with pyrethrum or allethrin etc. Synergistic action is important because it provides a means for a more effective insecticide and it reduces the cost of control.

Legal Control:

Legal control is the lawful regulation of areas to eradicate, prevent or control infestation or reduce the damage caused by insects. This mainly involves the use of quarantines and pest control procedures. The central and state officials often work with local community or districts as in mosquito or locust control projects.

Crop Harvesting:

Harvesting: Have you ever wondered how we get food grains supplied neat and cleaned directly to the shop? Yes, farmers are using traditional and modern techniques for harvesting the crops grown. There are various stages to harvesting a variety of crops when the particular crop attains its maturity. Harvesting the crops at matured levels gives high income, and good quality produces.

If the crops such as pulses, cereals, oilseeds, etc., are left in the field for too long after maturity without harvesting, it can lead to the predisposition of pests. Let us explore more about what is the meaning of harvesting, its stages, and its importance in the below article. Continue reading to know more.

Define Harvesting

Harvesting is the method of collecting a ripe crop from the fields. It is carried out as soon as the plant attains average maturity concerning the useful requirement of seed, rhizomes, bulbs, tubers, stems, leaves, stalk or others with minimum losses.

1. Depending on the position of good grains in plants, harvesting is carried out with different strategies. It may involve: cutting, digging, picking, laying, gathering, curing and stacking.
2. The term harvesting also generally includes the immediate **post-harvest** practices such as threshing and winnowing.
3. **Threshing**: Threshing is the methodology of loosening the grains from the chaff after the crops are harvested. It can be done by hand or by using a machine to segregate all the grain seeds.
4. **Winnowing:** Winnowing is the methodology of segregation of grain seeds from the chaff using the help of the wind. Due to the wind, the lighter husks flies away, and the heavier grains fall.

Signs that crops are ready to harvest

To know when crops are ready for harvest, you need to look for the following signs

1. Chage in colour
2. Appropriate size

It is essential to know when crops are ready for harvest. If harvested too early, the produce may not reach its full potential in terms of taste, color, and market value. On the other hand, if harvested too late, the produce may be overripe, resulting in spoilage and food waste.

The term for the indicative signs of harvesting in crops is called maturity indices. Maturity indices are a set of indicators that tell us when our crops have reached their optimal stage for harvest, based on various factors like size, color, texture, or taste.

Here are some maturity indices for vegetables that are commonly sold in the local markets. These indices can serve as a guide for growers and consumers in determining the ideal time to harvest and purchase these crops for optimal flavor and quality.

Tomato

For local markets in the Philippines, tomatoes are typically harvested when they have reached the breaker stage, which is when the fruit has just started to change

color from green to red. This is because the market demand for tomatoes is usually for ripe, red tomatoes that are ready for immediate consumption.

It is important for growers to keep in mind that tomatoes that are picked too early will not ripen properly and may not have the desired flavor or texture. On the other hand, overripe tomatoes may be too soft and have a shorter shelf life.

Eggplant

Eggplants should be harvested at the right stage of maturity to ensure good quality and yield. Commercial maturity for eggplant is generally reached when the fruit has reached its full size and firmness, and has developed a glossy, smooth skin with a uniform color. The fruit should have a dark purple or black color, be firm to the touch, and have a slight give when gently squeezed. The calyx, or stem, should be green and firmly attached to the fruit. It is important to note that overly matured eggplants may have a bitter taste.

Squash

When the squash is ripe, its color becomes dull or matte, and it loses its sheen. Another indication is the hardness of the skin. When the skin of the squash becomes hard and difficult to puncture, it is a sign that it is mature and ready for harvest.

Additionally, the tendril near the stem of the squash plant starts to dry out and turn brown when the squash is mature. The leaves of the plant may also start to wilt or yellow when the squash is ready to be harvested.

Onion

Onions are ready for harvest when their leaves start to turn yellow and fall over. This is an indication that the plant has stopped growing and the bulbs have reached their full size. The outer skin of the onion bulb should also be dry and papery. Once the leaves have fallen over and the skin is dry, the onion bulbs can be pulled from the ground and left to dry for a few days in a cool, dry, and well-ventilated area. After drying, the onions can be cleaned, trimmed, and stored.

Garlic

The timing of garlic harvest is determined by the maturity of the bulbs, which is indicated by the drying and browning of the leaves. When approximately one-half of the leaves have turned yellow or brown and have begun to dry out, it is time to harvest the garlic bulbs.

Bitter gourd

Bitter gourds are harvested when they have reached a length of 4-6 inches and a diameter of about one inch. The color should also be dark green, which indicates that it is still young and tender. The seeds inside the bitter gourd should be small and white, which indicates that the vegetable is still young and has not yet matured.

Cucumber

Cucumbers are typically harvested when they are young and tender for best flavor and texture. Cucumbers intended for the local market are usually harvested when they are still green, although some varieties may have a slightly yellow or white coloration. Over-ripe cucumbers will turn yellow or orange and are no longer suitable for the market. Cucumbers intended for fresh consumption should have a crisp texture and a slightly sweet, mild flavor. Overly matured cucumbers may have a bitter or unpleasant taste.

It is important for growers and consumers to know the maturity indices of vegetables because it helps ensure that the vegetables are harvested at the optimal time for consumption or processing. For growers, knowledge of maturity indices can help them plan their planting and harvesting schedule, as well as manage their resources more efficiently. For consumers, knowing the maturity indices can help them choose the freshest and most nutritious vegetables, as well as get the best value for their money

Methods of Harvesting

There are three essential methods of cutting the crop or harvesting.

1. **Hand Harvesting/Manual Harvesting:** Hand harvesting is a method of gathering grains, fruits, vegetables, leaves, etc., by hand or manually.

Fig: Hand Harvesting

2. **Harvesting with Hand Tools:** Farmers use a few tools to harvest the crops. Small sickle, big sickle, and a small axe, etc., are a few examples of harvesting with hand tools.

Fig: Hand Tools Used During Harvesting

3. **Harvesting with Machinery:** Machine harvesting is the act or process of harvesting grains in large quantities by using modern harvesters. A modern harvester can combine with other huge machinery to cut and clean the grains at the same time.

Fig: Harvesting with Machinery

Stages of Harvesting Process

1. **Reaping:** Cutting down the mature panicles and straw that are grown above the ground is called reaping.

Fig: Reaping

2. **Threshing:** Separating the food grains, such as paddy, wheat, etc., from the rest of the cut crop is called the process of threshing.

Fig: Threshing

3. **Cleaning:** Cleaning is an important part of the harvesting process, which mainly involves how to remove dust, and immature and non-grain particles from the edible food grains.

Fig: Cleaning

4. **Hauling:** Hauling is the last process or step in harvesting. In this step, the food grains are moved to the threshing location.

Fig: Hauling

5. **Field Drying:** Field drying is an optional step. The field drying method is to leave the cut crops in the field and expose them to the sun for drying. Drying helps to loosen the grains from the raw grass.
6. **Stacking/Pilling:** Stacking is a method of storing the harvested crops in stacks or piles.
7. **Bagging:** Bagging is the last stage in the harvesting process. The threshed grains are left into gunny bags for transport and storehouse purposes.

Storage of Grains

Fig: Storage

Storage is the final step of agricultural practices. The harvested grains are deposited in warehouses for upcoming use and selling purposes. Therefore, a better storage protection process must be used to protect grains from rodents and insect pests. Cleaning, fumigation, and drying are done to the stockroom before the grains are stored or deposited. The grains are later transported to dissimilar places throughout the year.

Importance of Harvesting

1. Harvesting crops by using advanced technology reduces the wastage of grains and increases in quality and quantity.
2. The direction of cutting fruits, grains and vegetables are very important during harvesting to save the quality of the fruits and also, we should see that the tools used should not damage the plant.
3. Harvesting at the right stage enriches the quality of grains or seed protection.

Summary

Harvesting is the act of gathering the edible parts of the plant after they approach the stage of maturity. Harvesting of crops is done using many tools and types of machinery in the agricultural fields. The tools that are used while harvesting, such as sickle, axe, etc., to harvest the crops like paddy, wheat, maize, grass, etc. Hand harvesting, harvesting with hand tools and harvesting with machinery are the three harvesting methods. Reaping, threshing, cleaning and hauling are the four stages of harvesting. The importance of harvesting crops by using advanced technology reduces the wastage of grains and increases in quality and quantity.

Post-Harvest Management – Best Practices and Methods

Reducing post-harvest loss is critical. Great post-harvest management will help address the growing concerns around food sustainability.

What does post-harvest mean?

Post-harvest process is the stage that immediately follows the harvest. The final quantity and quality of the product depends on it.

Appropriate pre-harvest practices and harvesting the crop at the right time using adequate farming equipment are also important in order to optimize the overall post-harvest output. Additionally, post-harvest management includes various steps such as:

- ***Drying*:** This decreases the moisture levels to ensure safe storage and prevents grain germination. It also reduces the risk of fungal attack and contamination by aflatoxin, maximizing the quality of crops retained.
- ***Threshing/Shelling*:** Threshing or shelling of grains helps to reduce the required storage capacity and minimize the susceptibility of the grain to pests.
- ***Cleaning/Winnowing*:** This involves removing any foreign matter from the grain, such as leaf, stalk, or empty seeds, in order to optimize its market value.
- ***Storage*:** Protecting the grain from climatic changes and contamination by insects and pests is crucial. Various post-harvest grain storage methods can accomplish this.
- ***Transport*:** Grains sold to buyers are transported to warehouses or markets where they are made available to the common folk.

Minimize post-harvest losses and preserve produce by correctly following the steps above.

How does grain storage play a major role?

Agricultural products are stored before they are made available and accessible to the public. The storage process keeps grains, whether in bags or in bulk, in a storage structure. The structure, designed to protect the stored product for a short or long period, hosts the grains awaiting movement to other locations.

Grain storage occurs at three levels: producer's level, trader's level, and urban organization storage level. Storing it is necessary for the following reasons:

- To provide a *uniform supply* of food throughout the year. Grains are produced seasonally while consumption is a constant.
- To provide *reserve* for contingencies such as flood, drought, pandemics, and other calamities.
- To speculate a *good price* either in domestic or in export markets.

Hence storage is fundamental to the concept of food security.

What happens if grain storage is *improper*?

The main cause of deterioration of grain quality and decrease in grain quantity is improper storage. This can occur due to:

- *Weather changes*: Changes in climatic conditions such as rain, humidity, increased dampness, moisture; heat can harm the grain quality and seed viability.
- *Infestation*: Unfavorable environmental conditions can also make the grain more vulnerable to infestation by insects, pests, and molds.

Incorrect Grain Storage resulting in post-harvest losses

In fact, rodents and birds often attack incorrectly stored grains. They can not only feed on the grain, but also contaminate it with their urine, droppings, and hair/feathers.

These problems caused due to improper storage result in post-harvest losses in the form of:

- Weight loss of the agricultural produce.
- The grain is prone to rancidity or it may undergo sprouting, over-ripening if not stored properly.
- There is loss in quality and market value of the produce.
- Furthermore, the nutritive value of the grain also decreases.

What are *the correct* post-harvest storage methods?

Proper grain storage methods are the key to reducing post-harvest losses.

The quantity of produce and the duration of storage are important to choose the proper storage method.

- ***Storage in bags*:** Storing grains in bags is convenient for short-term storage when grains are intended to be moved early. Short term storage duration requires few measures against insects.
- ***Loose storage*:** Large quantities of grains can be stored in loose / bulk storage.

Requirements for correct storage are:

- ***A good storage site*:** Ventilate and keep the site cool. Have a strong roof to protect from high winds and rain. Ideally, raise the site off the ground to prevent ground water soaking into the stored grains.
- ***Produce in suitable condition***: Ensure that the crop going into the store is in good condition, cleaned and well dried. It is also necessary to store the grain at the right moisture content.
- ***Intake of grain is orderly and controlled:*** Maintain the air-tight barrier each time the storage unit is opened and closed.
- ***Quality maintenance ensured*:** Keep stored grains in the shade to protect them from rodents and birds.
- ***Security against theft and loss*:** Keep the storage area locked in order to limit access.
- ***Any loss is identifiable and accountable*:** Regularly inspect the store to maintain the condition of crops throughout the storage period.

Adherence to these requirements helps to know the quantity stored at any given time, decrease the grain loss during storage, and quickly recognize the causal agents of losses and accordingly control them.

Hermetic storage

Hermetic Bags by Save Grain Bags

A post-harvest storage technology, **Hermetic storage** protects grain by creating an oxygen-deficient and carbon dioxide-rich atmosphere that is incompatible with the survival or breeding of pests. It creates an airtight and moisture-tight barrier, preserving the agricultural products in their optimal form.