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A Resonance in Agriculture

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APICULTURE

An Income Elevation

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About us

"Times of Agriculture" is agriculture monthly e-Magazine initiated for the purpose of providing information about recent innovations and technologies in agriculture and allied sectors. This e-Magazine gives a platform to dignitaries like scientists, researchers, scholars, students and innovative farmers to share their views and vivid ideas about agriculture. The main objective of this e-Magazine is to provide an open access platform for authors to get on the soapbox and spread awareness regarding the technologies and awareness in agriculture sector by e-publishing articles addressing the upcoming needs in the field agriculture.

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AGRICULTURE

UPDATES

DR. CYNTHIA ROSENZWEIG
Receives
World Food Prize 2022

World Food Prize Foundation announced the name of World Food Prize laureate 2022, **Dr. Cynthia Rosenzweig** of the United States.

Rosenzweig was selected for the award for her research **to understand the relationship between climate and food systems and forecast how both will change in the future.**

In 2021, Leading nutrition expert *Dr. Shakuntala Haraksingh* won the prize.

'GM WHEAT' RESISTANCE TO SALINITY & WATER SCARCITY

Egyptian Atomic Energy Authority (EAEA) has announced that agricultural research scientists at the authority's site in Inshas city, Bilbeis, Sharqia Governorate, have begun harvesting a new strain of genetically modified (GM) wheat. ***Dr. Amr El-Hajj, the EAEA's Director-General, cultivation of this strain could increase Egypt's local wheat production by 33%, reducing the need for imported wheat.***

MADHYA PRADESH
TOPS THE CHART IN AREA UNDER NATURAL FARMING

Union agriculture minister **Narendra Singh Tomar** recently told India's **total 38 lakh hectares of natural farming**, 17.31 lakh hectares are under cultivation in Madhya Pradesh alone. Madhya Pradesh has over half of the entire area under natural agricultural crops, making it the leader among other states.

In February, the state administration decided to practice natural farming along the Narmada, which is considered the state's lifeline, based on a proposal in the Union budget to encourage chemical-free farming along the Ganga.

'Kisan Bhagidari Prathmikta Hamari'

Union Agriculture Minister launched the *"Kisan Bhagidari, Prathmikta Hamari"* Campaign under Azadi Ka Amrit Mahotsav during 25th – 30th April 2022.

"Kisan Bhagidari Prathmikta Hamari" campaign is being dedicated to strengthening the farming community. Lakhs of farmers, many MPs and other public representatives and scientists participated through fairs in **731 Krishi Vigyan Kendras** and other agricultural institutions across the country.

As part of *"Kisan Bhagidari Prathmikta Hamari"* Krishi Mela at each KVK was organised in association with Agricultural Technology Management Agency (ATMA).

'SAVE SOIL' Sadhguru to address leaders from 195 nations at UNCCD

Spiritual leader, who is currently on a **100-day lone motorcycle journey through Europe, Central Asia and the Middle East as part of the 'Save Soil' initiative,** is the keynote speaker for the 15th session of the Conference of Parties **(COP15) at UNCCD.** The theme for the session "Land, Life, Legacy: From scarcity to prosperity".

At present on his 30,000-km motorcycle journey, Sadhguru is meeting global leaders, scientists, environmental organizations, soil experts and others to "press for urgent policy-driven action to save soil from becoming extinct".

NATIONAL PANCHAYATI RAJ DAY

celebrated on 24 April 2022

When the Panchayat Raj is established,
public opinion will do what violence can never do
—— Mahatma Gandhi ——

National Panchayati Raj Day is a national holiday in India that honours the Panchayati Raj system.

Every year on April 24th, it is commemorated. The day was initially observed in April 2010.

JHARKHAND AGRICULTURE LOAN WAIVER SCHEME

Jharkhand Agriculture Director Nisha Oraon informed that the state government is waiving loans worth Rs 3.34 crore benefiting 906 farmers per day under the **'Jharkhand Agricultural Loan Waiver Scheme.**

Objective:

To relieve the farmers of the State of short-term agricultural credit from the debt burden, improve the credit worthiness of the crop loan holder, ensure credit for the new crop, prevent migration of the farming community and strengthen the agricultural economy.

WORLD VETERINARY DAY HELD ON 30TH APRIL 2022

This celebration was created by the World Veterinary Association in 2000 to be celebrated annually on the last Saturday of April.

Back in 1863 the beginnings of the World Veterinary Congress were established by ***Professor John Gamgee*** from the Veterinary College of Edinburgh.

By 1959, the World Veterinary Association was established with the mission of focusing on animal health and welfare.

FASAL BIMA PATHSALA

Government of India will conduct **'Fasal Bima Pathshala'** under ***'Kisan Bhagidari Prathmikta Campaign'*** during the period from 25th April to 1st May 2022 as a Jan Bhagidari movement under **'Azadi Ka Amrit Mahotsav'.**

'Fasal Bima Pathshala' coordinated by CSC from 1 lakh locations across the country.

WORLD EARTH DAY 2022

Earth Day is celebrate every year across the world on the **22nd of April.**
And its focus is on natural processes, emerging green technologies and innovative thinking that can restore the world's ecosystems.
The theme of World Earth Day this year is
"Invest In our Planet"

COVER STORY

APICULTURE

An Income Elevation

Honey bees are the marvelous insects known to the mankind since the prehistoric times. They always fascinated the humanity since the dawn of civilization. ***Honey bee colony has fascination of its own; many are admired them for their industriousness, unity, self-sacrifice, calmness of spirit, toleration, equitable division of labor in their colonies and a spirit of social service***.

It plays an important role as ***natural pollinators*** of crops and propagation of many plants growing in nature thereby maintaining the stability of ecosystem, environmental quality and biodiversity. Also beekeeping is crucially important for agriculture wellbeing. It also helps rural populations to become self-reliant. It favors diversification to the local economy. So, beekeeping recognized as a ***low input and high output activity***, suitable for rural, tribal and other weaker section of population. Totally honey bees contribute immensely to the welfare and economy of

History

Bees are said to have evolved from hunting wasps that developed a taste for honey and decided to go vegetarian. Bees presumably appeared on the earth at the same time as flowering plants in the Cretaceous period, 146 to 74 million years ago, according to fossil evidence.

***Trigona prisca*, the oldest known fossil bee, was discovered in the Upper Cretaceous of New Jersey, USA, and dated from 96 to 74 million years ago.** Fossils of the authentic Apis type were first unearthed in Western Germany during the Lower Miocene (22 to 25 million years ago).

Honey bees are eusocial flying insects belonging to the Apis genus of the bee clade, all of which are **native to Eurasia**. They're well-known for their construction of perennial colonial nests from wax.

In 2021, the Indian honey market was worth **INR 21.1 billion**. Looking ahead, IMARC Group forecasts that the markets will reach ***INR 3803 billion by 2027*, growing at a CAGR of 10.31% from 2022 to 2027.** There are just eight extant honey bee species, with a total of 43 subspecies, despite the fact that traditionally 7 to 11 species were recognized.

Statistical data on honey bee

As per the latest data from the National Bee Board, the **country's total honey production reported in 2019 - 2020 was 1.05 lakh metric tonnes (MTs).** With international demand for honey growing, **India exports 50 per cent of the commodity** and, in the last 12 years, exports have increased by 207 per cent.

Punjab is the major state in beekeeping in the nation, with around **35,000 beekeepers** delivering around 15,000 metric tonnes of honey. This is more than 39% of the nation's total honey production. Next to that, Karnataka has produced 1200 tonnes of honey approximately as updated of 2019.

West Bengal, Uttar Pradesh, Punjab, Jammu and Kashmir and Bihar, contribute about 61% of India's total honey production. As per the reports, Uttarakhand managed to produce 1400 MT honey last year and this was quite a great number to achieve. About 5566 beekeepers were engrossed in this activity to achieve the target. Jammu and Kashmir is also a noticeable name in honey production of India. Kashmir has a potential to invite 120,000 bee colonies for honey production.

01

Total honey production in 2019-20 was 1.05 lakh metric tonnes (mts).

02

India exports 50 per cent of the commodity

03

Punjab is the major state in beekeeping in the nation

04

Indian Honey Market INR 21.1 billion

01

The markets will reach INR 3803 billion by 2027

Importance of Honey Bee

01 In India, the total cultivated area is about 129 million hectares and at least one third of the area is under entomophilous crops which require insect pollination.

02 Insect pollination is extremely important as only 5.0 per cent of flowers are self-pollinated and 95.0 per cent cross pollinated

03 Pollination by honeybees significantly increased yield quantity and quality on average up to 62%. The value of bee pollination in crop production in USA has been estimated at US $ 20 billion per year.

04 Situations where absence of insect pollination has resulted in drastic reduction of many soil holding and soil enriching plants

05 Insect pollination is an essential link in our ecological global chain

Crop dependent on bees for pollination

Category of crops	Name of the crop
Vegetables	All gourd vegetables, carrot, radish, cabbage, cauliflower, onion, soybean, knolkhol
Oilseeds	Sunflower, niger, seasame, safflower, linseed
Pulses	Tur, urad, mung, beans, guar, pea, cowpea
Forage legumes	Lucerene, berseem, clovers
Fruit crops	Oranges, pear, apples, guava, peach, plum, cherry, strawberry, guava, pomegranate, jamun, fig, grapes, blackberry, lemon, raspberry
Plants of forest important	Toon, shisham, soapnut, wild cherry, Trifolium sp, Eupatorium sp, Azadirachta sp, maple chesnut, eucalyptus and magnolia etc

Claims of Human Dependency

Western honey bees are frequently portrayed as critical to human food production, leading to concerns that humanity would starve or perish if they were not pollinated.

"If bees vanished from the face of the earth, man would only have four years left to live"

Albert Einstein is commonly misquoted as saying.

Beekeepers keep, feed, and transport honey bees that have been domesticated. Modern hives also allow beekeepers to transport bees from field to field as crops require pollination, allowing the beekeeper to charge for the pollination services provided, rewriting the historical role of the self-employed beekeeper and preferring large-scale commercial operations.

Bee Products

1. Honey
2. Bees wax
3. Bee bread
4. Propolis
5. Royal jelly
6. Bee venom

Bee Products

Honey: Honey is a complicated substance produced by bees who consume nectar, digest it, and store it in honey combs. Indigenous peoples have collected honey from all live Apis species for food. Only two species, *A. mellifera* and *A. cerana*, have had their honey extracted for commercial reasons.

Bees Wax: The wax is used to create the comb's walls and crowns. Humans collect beeswax for a variety of reasons, including candle making, waterproofing, soap and cosmetics production, medications, art, furniture polish, and more.

Royal Jelly: Royal jelly is a honey bee fluid that is used to feed the larvae of honey bees. It's advertised for its ostensibly beneficial health claims that aren't backed up by evidence. On the other hand, it has the potential to induce severe allergic reactions in some people.

Bee Products

Propolis: Propolis is a resinous mixture collected by honey bees from tree buds, sap flows, and other botanical sources and utilised as a sealant in the hive to cover off undesired open spots. Although propolis is said to have health benefits (propolis tincture is used as a cold and flu cure), it can trigger severe allergic responses in certain people.

Bee Venom: Honey bee venom is being studied in the lab and in clinical trials for its potential qualities and uses in lowering the risk of bee venom therapy-related side events, rheumatoid arthritis and as an immunotherapy for protection against insect sting allergies.

Bee Bread: Pollen baskets are used by bees to harvest pollen and transport it back to the colony. Pollen, honey, and glandular fluids are combined by worker bees and fermented in the comb to form bee bread. The item is intended to be used as a health supplement.

Beekeeping has a tremendous scope for development of ancillary industries. The untapped potential of beekeeping yet remains to be explored for increasing opportunities for gainful employment and income in rural areas.

It provided humanity with very basis of civilization because of their highly evolved social activities and contribute immensely to the welfare and economy of mankind. To be a successful beekeeper one must learn about honeybees and beekeeping by continuous practicing.

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Honey Bee Species and Their Castes System

The genus *Apis* comprises seven recognized species of honey bees four of which are major species and the other three are considered as minor.

The major species include two domesticated/hive bees, *Apis mellifera* Linn. And *Apis cerana* F. and two well-known wild species, *Apis dorsata* F. and *Apis florea* F.

India is a country where all the four major species are present. Three majors species were present in India and the fourth *A. mellifera* was introduced from European countries. The other honey bee species are *A. koschevnikovi, A*. andreniformis and *A. laboriosa*.

1. **The rock bee,** *Apis dorsata*
2. **The Indian bee** *Apis cerana indica*
3. **The little bee** *Apis florea*
4. **The European bee,** *Apis mellifera*

Rock bee *(Apis dorsata)*

- They are giant bees.
- Found all over India in sub-mountainous regions.
- They construct single comb.
- They shift the place of the colony often.
- Ferocious and difficult to rear.

Little bee (*Apis florae)*

- Smallest honey bees species
- They build single vertical combs.
- The bees are very prone to swarming.
- Poor honey yielder (0.5Kg /comb/year)

Indian bee (*Apis cerana*)

- They are the domesticated species, construct multiple parallel combs
- They are native of India/Asia.
- They are more prone to swarming and absconding.
- Low honey yielder (5-10 Kg of honey/comb/year.)

European bee (*Apis mellifera*)

- They are also similar in habits to Indian bees, which build parallel combs.
- They are bigger than all other honeybees except *Apis dorsata*.
- Yield per colony is 25-40 kg.

Apis koschenikovi

- It is very similar to *A. cerana*.
- It also nests in natural cavities and builds multiple parallel combs.
- It has been reported from only some parts of Indonesia.

Apis andreniformis

- It considered as a sister species of *A. florea.*
- More defensive than *A. florea*

Different Castes of Honey Bees

Honey bees are highly social insect which live in a well-organized colony. A colony of honey bees is composed of three castes: a single queen, a few hundred drones and several thousand worker castes. For all three castes of honeybees, eggs hatch in three days and then develop into larvae that are known as grubs. All grubs are fed royal jelly at first, but only the future queens are continued on the diet. When fully grown, the grubs transform into pupae. Queens emerge in 16 days, workers in about 21 days (on average), and drones in 24 days. After emerging, the queens fight among themselves until only one remains in the hive. Queen is a fertile, functional female, worker is a sterile female and the drone is a male insect. Different castes are dependent upon each other and perform different duties on the basis of division of labour.

Queen: The only individual which lays eggs in a colony and is the mother of all bees. Unfertilized eggs develop into drones, whereas fertilized eggs develop into females, which may be either workers or virgin queens. After hatching, the virgin queens are fed royal jelly. When not fed a diet consisting solely of royal jelly, virgin queens will develop into workers. The average life span of a queen is 3-5 years.

Drones: Male member of the hive whose primary responsibility is to fertilise the queen. They also help in maintenance of hive temperature. They cannot collect nectar/pollen and they do not possess a sting. Drones are responsible for passing the colony's genes on to the next generation by mating with queens from other colonies.

Workers: During first three weeks, the worker bees perform household duty which include building comb, cleaning, ventilating and cooling the hive, feeding of older larvae with bee bread, younger larvae with royal jelly, guarding the hive etc. During guarding, the worker bees, in the act of stinging even die, sacrifices for the defence of the colony. Next three weeks, she perform outdoor duty including collecting the nectar, pollen, propolis and water, ripening of honey etc.

Egg

Fertilized

Queen

Fertile Female

Work- Lays Eggs

Life Span– 3-5 Years

Workers

Sterile Female

Work - Collect Honey

Life Span– 22-40 Days

Unfertilized

Drones

Fertile Male

Work - Fertilise Queen

Life Span– 90 Days

Conclusion

Among the seven recognized species of honey bees, only four species (*Apis dorsata, A. florae, A. mellifera and A. cerana indica*) are present in India. Among these four species, the only domesticated species of honey bee are *A. mellifera* and *A. cerana*, and they are often maintained, fed, transported by beekeepers and domesticated for honey production. There are two honeybee sexes, male and female, and two female castes. The two female castes are known as workers, which are females that do not attain sexual maturity and usually are non-reproductive females and; queens, females that are larger than the workers. The males, or drones, are larger than the workers and are present only in early summer.

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SEASONAL MANAGEMENT OF HONEY BEE

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Seasonal colony management is the set of management practices designed to meet the different needs of a colony over the year. During extremes in climate like summer, winter and monsoon certain specific management tactics are required. Good management includes reducing colony space during periods of dearth of incoming food, preventing swarming of bees, feeding food supplements to offset any shortcomings in winter or to stimulate brood production during critical periods of colony development, keeping young and good-quality queens in colonies, and managing diseases and parasites.

Basic Growth Cycle

Good seasonal management begins with understanding that honey bee colony growth depends on rate of incoming food. Nectar and pollen are the staples of the honey bee's diet. Nectar is converted to honey, which is the primary energy source for individual bees and the colony as a collective group. A priority for most beekeepers is to manage bees in such a way as to encourage them to collect and store more honey than the colonies need to survive. The beekeeper harvests the surplus while ensuring the bees have enough stores for surviving dearth in either the summer or winter.

Need of seasonal management

- To know honey flow season and off- season (Dearth) of honey production.
- To be able to manage honeybee in flow and off season of honey production.
- To maximize honey during the honey flow season and throughout the years.

Honey flow and dearth periods at different altitudes

Area	Honey flow season	Off season (Dearth)
High hills	April, May, June, July, August	September, October, November, December, January, February, March
Mid hills	April, May, September, October, November, February, March	June, July, August, December, January,
Foot hills and plain areas	April, October, November, December, January, February, March	May, June, July, August, September

Summer management

- Prepare and make colony strong.
- Keep the colonies with new prolific queen.
- Place the hive under shade.
- Sprinkle cold water twice over hive on sunny days.
- Provide proper ventilation by removing entrance rods.
- Make provisions of clean water near apiary.
- Provide wind breaks against hot wind.
- Feed bees with artificial diets.
- Supply broods and form strong colonies to weaker colonies.
- Control pest and disease and robbing.

Winter Management

- Close all the opening, cracks and crevices in the bee hive.
- Keep the entrance gate opposite to wind.
- Place the hive in open for sun ray but protect from frost.
- Provide artificial food if necessary.
- Covers beehives with gunny bags and use packing materials inside for insulation.
- Examine colony and keep them strong.

Rainy season and monsoon management

- Avoid dampness in apiary site. Provide proper drainage.
- In rain, when bees are confined to hive, provide sugar syrup feeding.
- Maintain new and prolific queen.
- Place the hive under shade.
- Provide artificial diets as pollen and nectar supplement to bee colony.
- Protect bees from enemies and diseases.
- Examine colony regularly and clean hive time to time.
- Unite weak colony with strong by dummy method or smoke method.

Autumn Management and Overwintering

- In the early autumn, hopelessly weak colonies should be combined to avoid losing hive equipment to pests like the small hive beetle or the greater wax moth.
- However, colonies that are diseased by *Varroa* mites or *Nosema* or any contagious disease should not be placed onto stronger colonies because of the risk of spreading viral, fungal, and bacterial diseases to the stronger unit.
- It is best to simply kill these colonies by placing them in freezers to save the combs from pests.
- Fire ants can be encouraged to clean debris out of the combs once the bees are dead.
- Additionally, combs can be soaked in a dilute bleach

Swarm Management

When colonies are strong and developing rapidly, good weather following a period of bad weather seems to heighten the swarming fever. Other factors that contribute to swarming include poor ventilation, heredity, and an age imbalance in the worker bee population.

Cutting out queen cells seldom prevents swarming. It only delays it, since the bees usually build more cells in a few days. Once the bees cap a queen cell, they are committed to swarming. Equalizing the strength of your colonies also helps prevent swarms and makes management easier the rest of the year. Following are ways you can strengthen weak colonies:

- Change their positions with strong colonies in the same yard.
- Add sealed brood from strong colonies.
- Add queenless booster packages.
- Unite two weak colonies.
- Combine a queenless colony with a queenright colony.
- When exchanging bees and brood between colonies, be sure the frames do not contain the queen and that the colonies are not diseased. When adding adult bees to an existing colony, separate them with a sheet of newspaper to let colony odors mix and to keep fighting to a minimum. Such precautions are not necessary for frames of brood.

PESTS AND DISEASES OF HONEY BEES

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Honey bees are susceptible to different pests and diseases. Indian bee is comparatively free from many infectious diseases except Thai sac brood virus whereas, Italian bee is known to be susceptible to diseases like foul brood, sac brood, acarine diseases etc. Bee enemies are more dangerous taking a heavy toll of life, as a result of which annually many colonies are deserted by the bees. It is important for the beekeepers to be aware about the identification and effective management of pests and diseases of honeybees.

1. Wax moth (Galleria melonella)

Damage caused by wax moth larva

Adults of wax

The larva penetrate the wax layer and feed on wax, pollen and propolis. At serious infestation, the comb is covered with silken webs and numerous black faecal particles of the larva are noticed. They can be controlled by frequent cleaning of hives and excess combs not covered by bees can be removed and stored in air tight containers after fumigation.

Acarapis woodi in Infestation of *V. destructor*

Infestation of *V. jacobsoni*

2. Tracheal mite (*Acarapis woodi*)

The tracheal mite is a parasitic mite which causes Acarine disease of adults. They infect prothoracic trachea and feed on hemolymph by piercing the tracheal walls. They can be managed by fumigating the hive with formic acid (85%) @ 10ml/colony.

3. Parasitic mites (*Varroa destructor, Varroa jacobsoni*)

They are ectoparasitic and attacks the larva and pupa of the honey bees. They feed on the hemolymph of larva and pupa of bees. The parasitized individual may die or develop into deformed adults. This mite infestation can be managed by dusting sulphur on the frames.

4. Wasps (*Vespa cincta, Palarus orientalis, Phyllanthus ramakrishnae*)

These wasps capture the bees both at the hive entrance, field and macerate them for feeding the juice to the young ones. To manage these wasps, their nests can be destroyed by burning them or spraying with strong insecticidal solution.

4. Ants (*Camponotus compressus*, *Dorylus* sp., *Monomorium* sp.)

They attack the weak colonies and carry away the honey, pollen and the brood. These ants can be kept away by providing ant pans around the bases of the stand.

Diseases of honey bees

1. Nosema disease (*Nosema apis*)

This disease is caused by protozoa. Hind gut is inflamed by protozoa and leads to dysentery in adults. It can be controlled by administering fumagillin @ 100mg/colony in 250ml of sugar syrup for 10 days continuously.

2. American foul brood disease (*Paenibacillus larvae*)

This bacterial disease affects the bee larva. The infected brood die at prepupal or late larval stage. The dead brood is dull white in color, but gradually changes to light brown and finally black. It can be controlled by feeding streptomycin in sugar syrup @ 0.05-0.15g/litre.

3. European foul brood disease (*Melissococcus pluton*)

This bacterial disease affects the larva. The tracheal system becomes visible and larva dies in a coiled stage causing foul smell. Most of the affected larva die before capping the cells. This disease can be managed by feeding terramycin dissolved in sugar @ 100mg/litre.

4. **Chalk brood disease (*Ascosphaera apis*)**

This fungal disease occurs only in larvae. The dead larva is covered with white mycelia of the fungus and the larva gets mummified, hard, shrink and appear chalk like. The equipments should be sterilized with formalin or carbolic acid to prevent the growth of fungus.

American foul brood disease

European foul brood disease

Chalk brood disease

5. Thai Sac-brood virus disease (Sac-brood virus)

This virus mostly affects worker larva but can also infest adult honey bees. The diseased larva fails to pupate and remains stretched out on their backs within their cells. The pupae turn into sac-like structures filled with lemon coloured liquid at

Infected larva showing change in colour

Larva affected by sac-brood virus

IMPACT OF PESTICIDES ON HONEY BEES

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Over the recent years, indiscriminate use of agrochemical pesticides pose a huge threat to the lives of honeybees and become problematic in the business of beekeeping. Honey bees are highly susceptible to insecticides. Combination of some fungicides with insecticides have been found more deadly to the bees than the chemical alone. The extensive and prolonged used of herbicides leads to a reduced diversity of flowering plants affect the bees colonies and their productivity. The indiscriminate use of acaricides in apiaries for the control of parasites, such as *Varroa destructor*, has added one more threat for the beekeepers, as these chemicals are also toxic although to a lesser degree to the honey bees. The colony collapse disorder (CCD) has been linked not only to parasites and diseases but also to pesticide usage. In these circumstances, a new management approach is needed for successful beekeeping.

Exposure of Bees to Pesticides

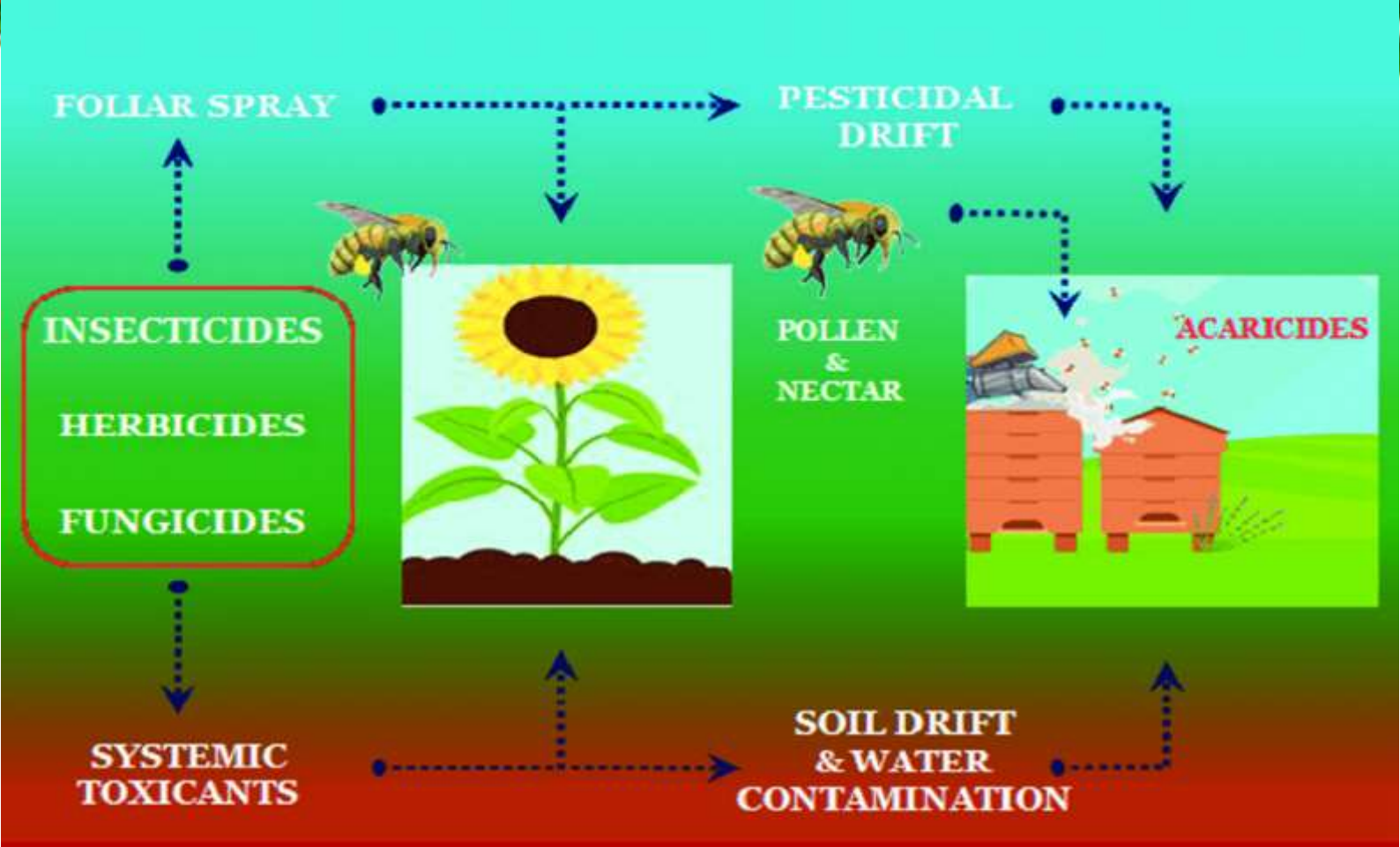
Due to concentrated doses of the chemicals in spray solutions, a single droplet of insecticide may be sufficient to kill a bee. Granular pesticides like herbicides, that are incorporated into soil have no direct exposure to bees. Systemic insecticides are capable of killing honey bees and leaves residues in every parts of plant like pollen, nectar, flower, etc. Most of the time, the exposure of bees to pesticides is through ingestion of residues found in the pollen and nectar of contaminated plants, whether from the crop plants or from the weeds around the fields.

Pesticide residues in pollen and nectar are taken by the forager bees to their colonies and remain in the beebread and honey for quite some time. These residues are then fed to the larvae and the queen, which are affected in similar ways as the forager bees. Some water contamination is also due to drift from spray applications, particularly from insecticides.

Honey bees, bumblebees and wild bees drink from puddles, irrigation ditches, ponds and streams, and if these waters are contaminated with pesticide residues, the forager bees ingest them as well. To date, residues of 173 different compounds have been found in apiaries. It should be realised that through the various routes of exposure to pesticides in the environment.

Toxicity of pesticides to Honey bees

Insecticides and acaricides kill insects and mites by disrupting their neuronal activity, their moulting process or other specific metabolism. acaricides are less toxic to bees than to the target parasites, excessive amounts of their residues in the combs may have unpleasant consequences for the health of the bees.



The persistence of pesticides is evaluated by their half-life ($t1/2$), which is defined as the time required for half the amount of a chemical to disappear from a medium, that is, water, soil, air or biological tissues.

Systemic insecticides, such as neonicotinoids (e.g. imidacloprid) and fipronil, are more toxic and persistent than the majority of organophosphorus (e.g. malathion), carbamates (e.g. carbofuran) and pyrethroids (e.g. cypermethrin). Sublethal exposure to pesticides, including fungicides and some herbicides, often produce stress in animals, because the organisms try to metabolise and get rid of the toxic chemicals quickly using large amounts of energy. All these effects disturb the performance of the individual bees and that of the colony.

Risk of pesticides to bees

The acute toxicity of the chemicals to the bees, which produce their mortality in the short or middle term is the main risk. Sublethal effects may harm the performance of hives and the long-term viability of the colonies. It is another form of risk.

Risks are based on the acute toxicity and the frequency with which a chemical may affect the bees. These include:

1. risks from spraying of pesticides over agricultural fields,
2. risks posed by ingestion of agrochemical residues found in pollen, honey and water, which are collected and ingested by the forager bees and transported to the hive, where they are processed into honey and beebread and fed to the other bees, the larvae and the queen,
3. risks from exposure to combs treated with acaricide products.

Risk assessment through novel approaches

Another way of estimating risks, particularly for oral exposures, is by calculating the time that would take for a bee to reach the LD50 of a given pesticide, based on the daily intake of contaminated food and water. Neonicotinoid insecticides, can cause delayed mortality due to their agonistic mode of action.

Risk from synergistic mixtures of pesticides

Combination of certain chemicals, in particular insecticides and acaricides with fungicides or mixtures of acaricides, is more toxic to bees than the individual compounds on their own.

Management in order to avoid pesticide impacts

Beekeepers should be aware of the landscape environment on which their managed bees forage, a rational approach must look at minimising the risks of such agrochemicals to bees.

Chemical companies are obliged by law to state on the labels whether their products are dangerous to bees or not. If so, they must specify the risks they pose and the specific actions to take, such as "DO NOT spray any plants in flower while they the bees are foraging."

Damage by drift to the hives can be avoided by informing the beekeepers about the spraying operations with sufficient time in advance by the farmers.

Conclusion

In order to minimise the chemical impacts on bees and the productivity of the apiarist industry, harsh chemical insecticides with high persistence should be avoided. Pesticide risk to bees can be reduced by spraying the crops in the evening, when bees are not foraging. Such actions must aim at managing the use of agrochemicals in ways that do not harm other producers of the land. In addition, farmers should minimize the contamination of the surrounding landscapes, including water bodies, with pesticides, because not only honey bees but a large array of pollinator species (e.g. butterflies, bumblebees, hoverflies, etc.) may also be affected.

6 YEARS OF *e*-NAM

Recently, eNAM has successfully completed its **6th year anniversary**, during which it has significantly impacted the marketing of agricultural commodities. It gave hope that transparency could be achieved in the trading of produce.

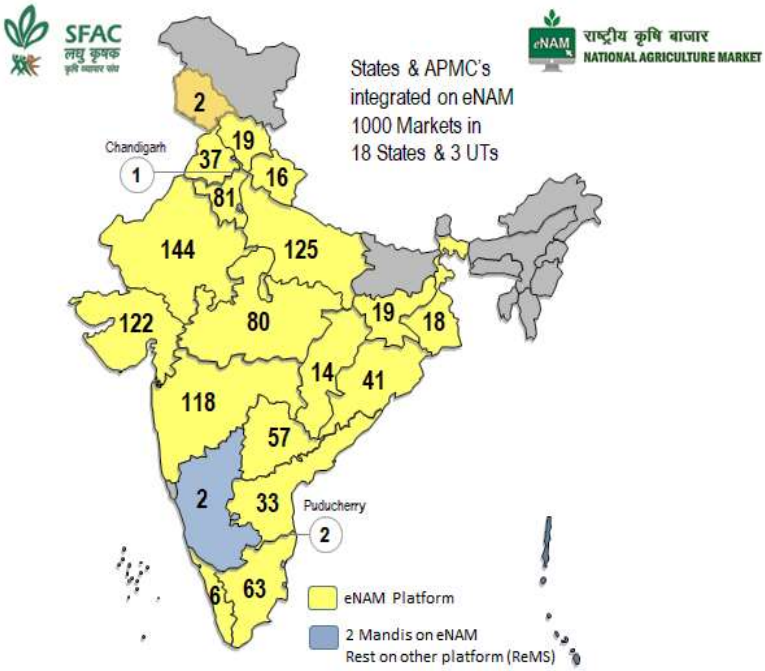
eNAM is a PAN-India online trading portal for agricultural commodities. They are integrating already existing mandis/APMCs (Agricultural Produce Market Committee) onto an online platform for conducting online trades.

Small farmers Agribusiness Consortium (SFAC) is the lead agency mandated by the Ministry of Agriculture and Farmers' Welfare, Department of Agriculture, to implement eNAM. It is managed with the help of technology providers, Nagarjuna Fertilizers and Chemicals Limited (NFCL)'s iKisan division.

eNAM was approved in July of 2015, and it was launched on April 14th, 2016 by the Ministry of Agriculture, GOI. The mobile application was launched in October of 2016.

Initially, it had 21 mandis/APMC's from 8 states, which have been linked with eNAM. At that time, **23 commodities were traded on this platform.**

As of March 2022, 1000 mandis from *18 states and 3 union territories have been linked. Around 1.73 crore farmers, 2.21 lakh traders, and 1 lakh commission agents have registered. Total stake holders in eNAM are*



- **Rajasthan has the most linked mandis.** There are a total of 144 mandis that have been linked.
- They have made the marketing of commodities smoother and less manipulative.

Role:

eNAM is striving to bring more transparency to the trade of agricultural commodities. The software for online trading is provided for free to every mandi. They are helping farmers fetch a better price and prevent distress sale.

The government is providing a grant (around 75 lakhs/mandi/year as of 2020-21 annual report) for developing the infrastructural facilities at each and every mandi. They are aiming to build a competitive marketing channel for agricultural commodities.

They are encouraging farmers to sell their different kinds of produce. Currently, 175 different commodities are being sold on the platform. The breakdown of different commodities is shown below.

Key features of *e*-NAM

- The application is available for both Android and iOS currently. Both the website and the app are available in 12 languages.
- Unified trading licensing system for inter-state
- eNAM shopping cart
- Discount to traders in mandi fee at the time of e-payment
- Bunching of multiple invoices
- Auto sale agreement
- E-learning
- BHIM payment facility
- Logistic information module
- eNAM infrastructure
- Part payment feature for farmers
- Farmers incentive feature for electronic payment
- FPO trading module
- Logistic module
- Kisan Rath
- eNWR module
- ReML-UMP

DOES IT FULLFILL FARMERS NEEDS?

The entire process of trade becoming more transparent and cartelization could be controlled. Since traders from all over India will bid, farmers will fetch a better price for their produce. A commission agent will help the farmer sell his produce. They play a vital role when the traders are reluctant to pay on the same day.

Since the quality of produce is analysed and graded, farmers will be able to fetch a fair price. **Better price discovery** in real time based on actual demand and supply. A legitimate sale bill will be given to farmers, which reduces manipulation of prices and ensures farmers are paid rightly. **Payment** will be made immediately without postponement. Information about market prices and arrivals can be accessed without physically going to the mandi.

WHAT ARE THE CONSTRAINTS?

Sampling in most mandis is done manually, which usually takes 30–40 minutes. In peak seasons, this will become a problem. Sampling of lumpy products like chillies and cotton is not accurate.

Commodities like cereals could be transported without spoilage, but commodities like fruits, which are perishable, might be spoiled by the time they get transported.

There are no proper opening and closing hours for trading, each mandi has been operating at different hours. Even though mandis have been linked with eNAM, they have not been actively participating in the online trade.

Most farmers have a small quantity of produce to sell. In mandis, there is no proper storage infrastructure. Farmers lack trust in online trading. Lack of awareness about eNAM among farmers.

FUTURE PROSPECTS

- More mandis are expected to be linked with eNAM.
- Rural haats/RPMs will be developed into GrAMs (Gramin Agricultural Markets)/Micro mandis and linked with eNAM.
- More equipment will be installed for sampling and assaying of lots.
- More storage infrastructure will be sanctioned.
- More efficient and stable supply chain.
- More transparency in the price discovery.
- Elimination of middle men.

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ICT

NEED AND ROLE IN AGRICULTURE FIELD

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World population is expected to surpass the 9 billion mark by 2050, and agricultural production will need to increase by 60 percent from its 2005/2007 levels to meet this additional food demand. ICT applications can make a significant contribution to meet this future global food needs. Information and Communication Technology can do so by collecting and sharing timely and accurate information on weather, inputs, markets, and prices; by feeding information into research and development initiatives; by disseminating knowledge to farmers; by connecting producers and consumers, and through many other avenues. Some of the broad areas where ICT plays a crucial role in agriculture are shown in Figure 1.

Need of ICT in agriculture:

1. To Accelerate Agricultural Growth

There is an immediate need of vibrant, dynamic and innovative approach to be adopted for agricultural extension in order to achieve targeted growth rate and serve the farms better. Integration of ICT in agricultural extension will provide needed impetus to agricultural sector.

2. To facilitate better information access

Farmers should get information on time so that they can utilise their resources properly. It is expected that convergence of ICTs with traditional extension system will improve the farmer's information access.

3. To make decision making process effective

Effective decision acts as the base towards every development. Sound decision making is dependent upon availability of comprehensive, timely and up-to-date information. There is a need for informed researchers, planners, policy makers, development workers. Information can help to facilitate the development and implementation of food security policies. ICT has an important role in transmit information.

4. To Expand Knowledge Source

ICT has a major role in broadening the knowledge source in different fields. Now a days land and water resources are almost reaching their limits, hence achieving food security heavily relies on "knowledge resource". ICT can complement the traditional extension system for "knowledge resource" delivery to the millions of the farmers.

5. To empower rural community

Today is the era of Information Communication Technology (ICT). Various ICT tools are used to educate and inform the rural people. For generations, rural people have been living in complete isolation without much access to modern media of communication. The development of a society largely depends on the access to information. Even though we live in the modern era, today, in the rural areas, women are suffering from various problems such as less accessibility to modern information sources. ICT helps to empower rural community through education, employability, agriculture, cultural and social aspect, health care natural resource conservation etc.

6. To create employment

The increasingly important role of ICTs in agriculture can help change the face of the sector. In fact, it should form part of the larger thrust to attract more young people to the sector. There's a strong link between ICTs and general youth employment. Agriculture is no exception. ICTs offer employment opportunities in the sector that are both attractive to young people and are in demand.

7. To develop efficient feedback mechanism

The media and ICTs will offer strong potential to improve linkage mechanism. Lack of efficient

feedback mechanism in the research-extension linkage is identified as one of the weaknesses in the existing extension systems. Hence to make communication effective proper feedback mechanism should also be there.

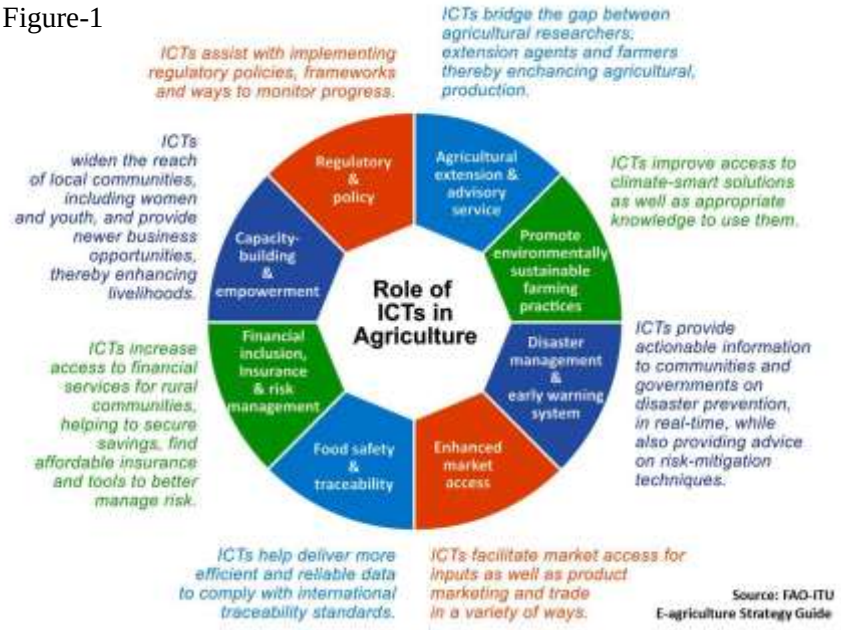
9. To target the small and marginal farmers

In India 77 percent of cultivators are marginal farmers. Land holding declined from 2.28 hectare per family to 1.41 hectare. Therefore the future of sustainable agriculture growth and food security in India depends on the performance of small and marginal farmers. Empowering small and marginal farmers with the right information at the right time and right place is essential for improving efficiency and vitality of small and marginal holdings.

Role of ICT in agriculture field and allied sector

ICT in agriculture offers a wide range of solutions to some agricultural challenges. It focuses on the enhancement of agricultural and rural development through improved information and communication processes. In this context, ICT is used as an umbrella term encompassing all information and communication technologies including devices, networks, mobiles, services and applications; these range from innovative Internet-era technologies and sensors to other pre-existing aids such as fixed telephones, televisions, radios and satellites. E-agriculture continues to evolve in scope as new ICT

Figure-1



applications continue to be harnessed in the agriculture sector. Provisions of standards, norms, methodologies, and tools as well as development of individual and institutional capacities, and policy support are all key components of e-agriculture.

ICTs play an important role in agricultural value chains, with different types of ICT having different strengths and weaknesses when applied to particular interventions. The impacts of ICT are diverse, and they influence market competitiveness in different ways. It is clear the impact of ICT in Agriculture Value Chains is diverse, and influences the market competitiveness in different ways. Given the importance of context and the rapid development technology, it can be difficult to determine whether the appropriate tool now will persist in being the appropriate tool in the future. ICT-based agricultural extension brings incredible opportunities and has the potential of enabling the empowerment of farming communities. With the availability of ICTs, the scheme for an increasing number of extension staff may no longer be exclusively valid. Yet, while use of ICT in extension provides for several key benefits in relation to traditional media, ICT projects also come with a range of challenges including: technological dependence; lack of accessible telecommunication infrastructure in many rural and remote areas; capital cost of technologies, high cost of on-going access and support; inherent need for capacity building; often difficulty in integrating with existing media, and local communication methods and traditions and often lack of involvement of all stakeholders in planning, especially women and youth.

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SPECIES OF HONEY BEE

AND VARIOUS USEFUL PRODUCTS OF HONEY BEE

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Apis spp., or honey bees, are vital to our environment, economy, and health. Honey bees are an excellent model for a variety of biological and physiological studies. The honey bee is a well-known pollinator that helps to increase the quantity and quality of agricultural yield. The honey bee is studied in many areas, including biology, behaviour, ecology, and genetics. The social and beneficial insect honey bee is defined by the presence of groups of individuals with distinct characteristics. The honey bee is the most significant of the five species. The stingless bee in the honey bee family is the dammer bee. *Apis dorsata* is the honey bee species that produces the most honey. The honey bee produces a variety of beneficial goods, the most important of which is honey bee.

INTRODUCTION

Most wild plants and agricultural crops rely on honey bees for pollination. Humans have benefited directly from beekeeping and indirectly through farming, therefore their value extends beyond ecology to include economic considerations. Honey bees are a social insect, which means that they reside in a common nest with a number of individuals with distinct personalities, castes, and duties to complete their life cycle. The most essential pollinator in the food chain is the honey bee, which is a gregarious, beneficial insect.

The workers of honey bees are 15 mm long, fuzzy-bodied insects that aid in pollination. The colour of the employees varies depending on the race, but they are mostly yellow and brown. Pollen and nectar are fed through lapping and chewing mouthparts. Only the workers can sting, hence honey bees are stinging insects.

Honey bees were initially brought in Virginia in 1622, and colonies sprang up all over the colony within a few decades.

SPECIES OF HONEY BEE

Five important species of honey bees are as follows.

1. The rock bee, *Apis dorsata* (Apidae).
2. The Indian hive bee, *Apis cerana indica* (Apidae)
3. The little bee, *Apis florea* (Apidae)
4. The European or Italian bee, *Apis mellifera* (Apidae)
5. Dammer bee or stingless bee, *Melipona irridipennis* (Meliporidae)

1. Rock bee (*Apis dorsata*)

Apis dorsata is also known as the rock bee, gaint honey bee, or cliff bee. The *Apis dorasta* bee is a huge bee with solitary large combs dangling from a limb, cliff face, or building. Each comb produces 36 kilogramme of honey every year.

2. The Indian hive bee (*Apis cerana indica*)

Apis cerana is sometimes known as the Asian hive bee. *Apis cerana* constructs a nest that is made up of a sequence of parallel combs. They produce 6-8 kilogramme of honey per colony per year.

3. The little bee (*Apis florea*)

Apis florea is sometimes known as the miniature honey bee or little honey bee. These bee species build a single comb nest in the open, suspended from a branch or rock surface, usually low down in the bushes. Each hive produces half a kilogramme of honey per year.

4. The European or Italian bee (*Apis mellifera*)

Apis mellifera is also known as the hive bee, European bee, and western hive bee. *Apis mellifera's* nest is made up of a sequence of parallel combs. The average colony produces 25-40 kg of food. They were brought in from European countries (Italy). They have a lower proclivity for swarming and fleeing.

5. Dammer bee or stingless bee (*Melipona irridipennis*)

Melipona and *Trigona*, two species of stingless or dammer bees, are found in our country. The annual honey production per hive is only 100 grammes.

USEFUL PRODUCTS OF HONEY BEES

1. Propolis :

Propolis is a resin material produced by honey bees by combining bee wax and saliva with foraged resin from botanical sources. It is a sticky substance that is also known as "bee glue" and is used to plug undesired hive openings. Propolis has antiviral effects as well.

Resins and balsams make up 55% of the mixture, ethanol and scented oil make up 10%, and pollen makes up 5%.

2. Beeswax:

Wax glands located on the ventral side of immature worker honey bees create beeswax. It is produced by worker honey bees aged 14 to 18 days. When wax comes into touch with air, it solidifies and forms scales, which look as little flakes of wax on the bee's underside.

Beeswax is utilized for honey storage as well as drone raising. Beeswax is also utilized as a medical substance. It's used in cosmetics, the candle business, the preparation of comb foundation sheets, and the preparation of shoe polish, among other things.

3. Venom :

The poison gland of worker honey bees produces venom. Melittin, a polypeptide that accounts for 50% of the dry weight of honey bee venom, is one of the several components found in the venom. In her poison sac, a two-week-old bee contains the maximum amount of venom. A single colony of *Apis mellifera* produces roughly 50 mg of venom.

Apitherapy uses bee venom to treat endoarteriosis, endoarthritis, and neuraglia. It is utilized as a beauty treatment in a variety of creams, serums, and other cosmetics.

4. Honey:

Honey is the honey bee's most significant product. Honey bee workers take flower nectar and digest it, breaking down carbohydrates into simpler sugars. Honey's chemical composition varies depending on the floral resources accessible to honey bees.

Pure honey has a specific gravity of 1.35 to 1.44 gms/cc. Honey is utilized as a food, medicine, or tonic, as well as a cash crop and an export product.

5. Bee pollen/ Bee Bread :

Pollen traps capture it from incoming pollen foragers. Bee bread gives the worker bees the protein they need to make royal jelly.

Bee pollen and bee bread are not only vital nutrients for honey bee survival, but they also play an important part in individual bee immunological function. Bee bread is also utilized as an antibacterial, detoxifying, and apitherapy agent, among other things.

6. Royal jelly :

Royal jelly is a mixture of secretions from the worker bee's hypopharyngeal and mandibular glands that feeds and protects larvae against pathogens. It is also a food source for queen bees, and feeding royal jelly to a single larva initiates development.

Royal jelly is utilized in apitherapy, food supplements, and other applications.

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ROLE OF FISHERS' PRODUCER ORGANIZATION

IN SUPPLEMENTING LIVELIHOOD AND DOUBLING FISHERS' INCOME

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The primary producers *viz*., farmers, milk producers, rural artisans, fishers, fish farmers etc. are forming Producer Organizations (PO) which is based on providing share of benefits/profits among the members. FPO is based on the cooperative principle of collective management in cultivation, processing, value addition and marketing thus leading to remunerative prices and higher sale volume. Farmer collectives are playing a critical role in connecting smallholders with modern markets. Also, the involvement of farmers in Farmer Producer Organizations (FPOs) is reported to have a positive and significant impact on the adoption of technologies and Good Agricultural Practices. However, FPOs of fish farmers or fishers are very less in working. Fishers' Producer Organization is needed to be formed especially in the reservoir fisheries where the large reservoirs are given on lease to the private contractors for fish catch and marketing. To supplement fishers' livelihood and increase their income through fishing, Producer Organizations of Fishers' needs to be formed so that Fishers' Organization can bid the reservoir on lease from the fisheries authority. Formation of Fishers' Producer Organization will provide the marketing right to fishers where they can fetch high prices of their fish catch in contrast to the low wages provided to them by private contractor for fish harvesting. To develop Fishers Producer Organization, a training program for fishers can be organized by Department of Fisheries, where the active and progressive fishers will be identified as fishers friends. These fishers friends will be promoted to fishers' field school. In a typical FFS, 20-25 fishers meets once a week near the reservoir under the guidance of a trained facilitator. The learning by doing approach promotes farm based experimentation in fish seed stocking and harvesting, facilitates group organization and decision making, this increases the chances that fishers will adopt improved fishing practices or aquaculture technologies. At the end of fish harvest, FFS organize a field day to demonstrate the results to local people, peer fishers and officials of Department of Fisheries. After perceiving the results of fishing practices or aquaculture technologies as positive, the officials of Department of Fisheries will promote the Famers field school to FPO. The Pradhan Mantri Matsya Sampada Yojana (PMMSY) of the Ministry of Fisheries, Animal Husbandry and Dairying (MoFAHD) provides financial assistance for setting up of Fish Farmers Producer Organizations (FFPOs) in order to economically empower the fishers and fish farmers.

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ARABICA

AND IT'S POTENTIAL USES

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A. nilotica is an evergreen tree, usually of moderate size varying form 2.5 m to 25 m. Under favourable conditions, it attains a height of 15-25 metre and girth of 2.4-3.0 metres while, under unfavourable conditions, it was found to be stunted, shruby or a straggling tree. It is almost an evergreen tree with a brief short, thick and cylindrical trunk. The tree encompasses a very clear bole and is suitable for timber usage.

The tree has thin, straight, light, grey spines in axillary pairs, usually 3 to 12 pairs, 5 to 7.5 cm long in young plants than mature trees. The spines are stipular, paired, straight (directed downwards) and is often white. Leaves are bipinnately compound with 3-9 pairs of sessile pinnae and leaflets mostly in 12-27 pairs per pinna. Leaflets are 1 to 7 mm long and 0.5 to 1.5 mm wide. It produces bright or golden yellow flowers, in globose heads with sweet scent on axillary peduncles of 1.2 to 4.5 cm length.

English: Indian gum arabic, Black babool

Telugu: Nallatuma

The following sub-species of *Acacia nilotica* are reported to occur in India:

1. *Acacia nilotica* sub-sp indica
2. *Acacia nilotica* sub-sp adstringens
3. *Acacia nilotica* sub-species cupressiformis
4. *Acacia nilotica* sub-species subalata

OCCURRENCE

The species is common to Telangana region especially within the districts of Warangal, Khammam, Hyderabad and other adjoining districts. It occurs commonly in the farmlands, wastelands, pastures, roadside, etc. This species has also been introduced in other parts of India under various schemes of social forestry.

PHYSICAL PROPERTIES OF THE WOOD

Almost every part of the babul tree is utilized for some purpose. The sap wood of babul is sharply demarcated from the heart wood and is white, turning pale yellow on exposure. The heart wood is pinkish brown and turns reddish brown on ageing. The wood is strong and sturdy. The wood is very heavy, strong, tough and extremely hard. The average weight is about 785 kg/m^3 at 12 per cent moisture content. It's somewhat dull coarse-textured with interlocked grains and has no characteristic odour or taste.

TIMBER USAGE

The wood is widely used for construction as posts, rafters, beams and in door frames. It's one amongst the foremost favoured timbers for every kind of agricultural

implements like ploughs, harrows, crushers and rice pounders, and is extensively used in card building, for yokes, shafts, wheels and body work. Babul wood is additionally recommended for certain kinds of sports and athletic goods like clubs, wall bars, parallel bars, etc.

FUEL WOOD

It is an excellent material when used as a fuel wood. Further, it is also made into charcoal and is considered to be of superior quality over the other tree species charcoal.

PULP AND PAPER

The wood from Acacias is good for paper and pulp making. It was reported that, the rayon and paper pulp properties of *A. nilotica* was favourably comparative to *Dendrocalamus strictus* and *Eucalyptus* hybrid. However, the babul wood is highly valued for agricultural implements and house construction, hence; it is rarely available for pulp making.

TANNING MATERIAL

Bark: The bark is obtained mainly as a by-product when trees are felled for timber or fuel. It is separated by beating the logs with wooden mallets and the strips obtained are dried in the open. Then, chipped into smaller pieces and sent to tanneries without grading. The proportion of bark to wood is roughly 1: 5 by weight. A 15 year old plantation of about 620 trees per hectare may yield about 5 tonnes of bark per hectare.

Pods: The whole pod of babul contains about 12-19 per cent tannin and the seeds yield 18-27 per cent tannin.

Gum: The gum obtained from *A. nilotica* is known as "Indian Gum Arabic". It is generally considered inferior to the true Gum Arabic obtained from *A. senegal* in medicinal properties.

MEDICINAL USES

The leaves, bark, pods and gum of *A. nilotica* are used for medicinal purpose. The tender growing tops and leaves are used as a douche in cases of gonorrhoea, dropsy and leucorrhea. Pulp of leaves, decoction of bark and the gum are prescribed for diarrhoea, dysentery and diabetes. A paste made of the burnt leaves with coconut oil makes a very efficacious ointment to treat skin irritations. The leaves and the gum are used for gargling which relaxes the sore throat and spongy gums. Decoction of leaves is also used as wash for bleeding ulcers and wounds.

FOOD

The seed of babul are eaten roasted or raw in times of acute scarcity in Rajasthan. Air dry seeds contain moisture 8.83%; crude protein 26.4%; crude fibre 2.7%; and total ash 4.7%. The other elements in seed are Calcium: 673, Phosphorus: 420, Iron: 4.9, Niacin: 3.17, Ascorbic acid: 4.51, Thiamin: 0.24 mg/100 g of seed.

DYE STUFFS

Dye stuffs from *A. nilotica* is prepared by boiling the pods, leaves, bark in varying proportion and occasional additions of wood extract. Variety of colours from yellow, to black through brown can be obtained by varying proportion of leaves, pods, bark and wood extract.

FENCING MATERIAL

Thorny branches of babul act as a useful fencing material. The spines are also used as fishing hooks and as a substitute for pin. The trees are also planted closely along the field boundary as live fence.

AVENUE TREE

Babul is useful as a hardy avenue tree, where selection of species is difficult. It is also used as a live-hedge fence round circular trenches for planting other important avenue trees.

Perhaps, there is no single Indian tree as useful to the largest proportion of rural population in multifarious ways. Due to its sparse crown it casts a very light shade and is not detrimental to crops grown under it. It is also a known nitrogen fixer. This is the reason why in dry hot parts of India, it is grown on the embankments of fields. It has an important role to play in social forestry of future.

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CORDYCEPS

AN ECONOMICALLY IMPORTANT MEDICINAL MUSHROOM

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Cordyceps is a genus of Ascomycetes fungi which grow on insects and have a symbiotic relationship with their host. *Cordyceps* have a large variety of medicinal effects and Chinese practitioners have used them as medicine for hundreds of years. Of the more than 400 species of *Cordyceps* discovered, two have become the focus of health research i.e. *Cordyceps sinensis* & *Cordyceps militaris*. The medicinal properties are attributed to Cordycepin and some polysaccharides. *Cordyceps sinensis* is mainly found in higher reaches of Himalaya and Tibet. In India it is found in Pithoragarh region of Uttarakhand. In contrast, *Cordyceps militaris* is cultivated under lab conditions. Cultivation is done in jars kept on racks. It is cultivated at 16-24℃ and requires 800-1000 lux light for its fruiting. 70-80% relative humidity is required during its cultivation.

IN VITRO CULTIVATION METHODS

a) Media preparation and inoculation

- Potato Dextrose Agar (PDA) medium is used for maintaining and multiplication of the culture. Pure culture of this mushroom can be made from fruitbody using tissue culture method.
- The culture can also be multiplied in petri plates for its use for preparation of liquid culture. For preparation of liquid spawn liquid medium is prepared using 30 g glucose, 10 g peptone, 5 g yeast extract, 1 g KH_2PO_4 and 0.5 g $MgSO_4$ per litre of distilled water. The medium is poured in flasks, autoclaved, cooled and culture from the test tubes is transferred to sterilized liquid medium and kept on shaker for 4-5 days for preparation of liquid spawn.
- 20-25 g rice or other grains are added per jar followed by about 40 ml nutrient solution to it and cover the jar with autoclavable cap or polypropylene bag and autoclave at 15 psi for 40-50 minutes. A small hole is made in the cap and it is plugged with cotton. This is sufficient for aeration required during growth.

b) Incubation

- After inoculation with liquid spawn the jars are kept in dark for 8-10 days at 20- 22°C, RH 65-70%.
- Jars can be covered with dark polythene or cloth to create dark conditions. Mycelium spreads in the medium and because of its growth in dark, it is of white colour.
- After complete colonization of the substrate, the jars are kept in light for a week when the colour of mycelium turns orange.
- When distinct pinheads are formed light intensity should be reduced to 8-12 hours and it may take another 5-6 week till mushrooms attain harvestable size of 4-6 cm.

c) Harvesting

- It can take up to 72 days after we expose the colonize substrate and the total time required for one crop from inoculation to harvest can be up to 3 months.
- Fresh air may be needed at regular intervals to avoid high carbon dioxide build up in the incubation room. When head of

Fig: *In vitro Cordyceps militaris* cultivation

mushroom turns club shaped, it is ready for harvest. The mushrooms are plucked out of jars and dried.

MEDICINAL VALUE OF CORDYCEPS

- Its polysaccharide content supports gut health and help to modulate immune system.
- It increases the availability of oxygen in the blood and helps to improve cardiac function and respiratory health.
- Cordycepin in *Cordyceps sinensis* and *Cordyceps militaris* has acted as potent anticancer components.
- Control diabetes.
- Helps to treat kidney disease.
- Improves liver function.
- Potential cure for Asthma.

CONCLUSION

Cordyceps militaris is considered as the oldest source of some useful chemical constituents. Besides their popular applications for tonic medicine by the all stairs of the community, the constituents of *Cordyceps. militaris* are now used extensively in modern systems of medicine. A number of culture techniques for this mushroom have been noticed, for example, storage/stock culture, pre-culture, popular/indigenous culture (spawn culture, husked rice culture and saw dust culture) and, special/laboratory culture (shaking culture, submerged culture, surface liquid culture and continuous/repeated batch culture). The prospects for herbal biotechnology regarding drug discovery using *C. militaris* delivering what it has promised are high, as the technology is now extremely more powerful than before.

Fig: Cordyceps militaris

Fig: Cordyceps sinensis

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BIODYNAMIC FARMING

HISTORY, PRINCIPLE AND ADVANTAGES

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Biodynamic farming is one of the most ancient organic methods, dating back to the early twentieth century. Despite scepticism, biodynamic agriculture has increased in popularity over the years and is now seen as having the capacity to address a wide range of environmental, social, and economic issues. The advent of genetically modified (GM) crops is the most recent threat to not only the Earth's balance and well-being, but also to our own. The soil is essentially a living network of interconnections and linkages. The soil's structure must be crumbly, friable, appropriately aerated, and deep in order to be productive. Understanding and working with the influences is essential in biodynamic farming.

INTRODUCTION

In 1924, Dr. Rudolf Steiner gave eight lectures to a large group of farmers in Germany on a new form of agriculture, which gave birth to biodynamic agriculture. Rudolf Steiner was an Austrian philosopher and physicist whose ideas were heavily influenced by eastern philosophy, particularly Buddhism, Hinduism, and the Vedic scriptures. Anthroposophy, or human wisdom (knowledge), sprang from this influence and his own research.

Main effects of using biodynamic agriculture

- To increase the nutritional value of food,
- to regenerate natural resources like as soil (by restoring organic matter in the soil), seeds, and water,
- to develop a personal contact with the world in which we live, with nature, and to learn to work together and
- most importantly, to be of service to the earth and its beings by assisting nature where it is weakened as a result of continual use.

HISTORY

Agriculture is the foundation of human life. We need to grow food just to eat every day, as well as to support our bodies, brains, souls, and spirits! Throughout human history, our music, art, songs, crafts, and tools have all evolved through our interactions with the land. But, during the last hundred years, and especially in the last few decades, we have lost touch with our source of life. Chemical farming arose as a result of the World Wars, when leftover chemicals used in weapons and warfare were discovered to be effective for pest control and fertilization. Agricultural chemicals are derived from fossil fuels found on Earth, which are not sustainable and will be depleted very soon.

The Green Revolution of the 1960s and 1970s also brought hybrid seeds, which are unable to create their own seeds once grown, making farmers dependent on hybrid seed corporations. These hybrid seeds also yield considerably weaker plants that require larger pesticide and fertilizer doses. The recent introduction of genetically modified (GM) crops (which collaborates with certain herbicides, insecticides, and fertilizers) is the most current threat to the balance and well-being of not only the Earth, but also of us humans. There are significant commercial interests linked to GM seeds, which regrettably exerts strong pressure on developing

countries to embrace and legalize their use.

PRINCIPLE AND ADVANTAGES

Substance and energy

Life is made up of more than simply chemicals; it is based on the interaction of matter and energy. Plants, for example, require light and warmth, as well as soil and water, to thrive. A balanced system is formed by the interaction of matter and energy. We live not only from substance, but also from energy, so we need to eat food to get that energy. Only plants that have developed in a balanced soil can provide us with both energy and substance (through trace minerals, enzymes, and growth hormones).

Soil

To grow healthy, vital plants, one must first focus on the soil's structure and life: the nutrients, trace elements, bacteria, worms, and other animals that live there. However, the soil is basically a living system of connections and relationships. If the soil's life energies are balanced, the plants that grow in it will be stronger, healthier, and of higher quality. There are no chemicals required. To be productive, the soil's structure should be crumbly, friable, properly aerated, and deep.

Organic matter

The skillful use of organic materials is essential to generate this balanced, living soil. This is accomplished by constructing compost heaps and employing Biodynamic compost preparations.

Humus

This enigmatic, miraculous fluid sustains life and transports all the plants require to grow. It holds the soil's fertility and keeps water in a steady manner. Humus is fully digested crude organic stuff that is rich, black, and moist with a pleasant odour.

Cow manure

This is a very special substance provided to us by the holy animal Cow that is necessary for healthy soil life. Cow dung is unique due to the extensive digesting process of the cow, which adds a large amount of helpful bacteria to the substance

Cosmic forces

Recognizing and working with the influences of astronomical objects on plant growth through the use of preparations and the sowing schedule.

ADVANTAGES

- Production of high-quality fruits and vegetables with great flavours and high nutrient levels (protein and vitamin content).
- Yields that are always above the average level, higher on average than those produced by organic farming, and consistently high over time, as opposed to chemical farming's dropping yields as the soil mineralizes and pest populations become unbalanced and a problem.
- There is less concern about livestock and plant illnesses.
- There is no spread of insect pests and no significant economic loss as a result of their presence: The issue of insect pests is one of balance and control, which can be restored by effective management such as planting shrubs and trees to house natural predators.

CONCLUSION

It is possible to conclude that biodynamic farming rapidly benefit soil physical, chemical, and microbiological biomass, hence transforming soil into a living system. Biodynamic agriculture promotes high soil fertility, resulting in the greatest and highest quality food for humans. Aside from increased earthworm number, enzymatic activity, and microbial population in the soil, a combination of biodynamic and organic farming approaches results in increased output. Thus, biodynamic agriculture mitigated the degenerative effects of intensive agricultural practices, while also increasing and sustaining soil productivity, as well as plant, animal, and human health.

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ORGANIC WASTE RECYCLING THROUGH VERMI-COMPOSTING

A SOURCE OF INCOME GENERATION FOR THE RURAL FARMERS OF INDIAN AGRICULTURE

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Vermi-composting is an eco-friendly method of recycles organic waste into valuable compost with the use of earthworms. Earthworms feed on the organic waste materials and produce castings through their digestive system and excrete a digested form which is rich in nutrients, minerals, hormones, enzymes and micro-organisms and can improves biological, chemical, and physical properties of the soil. According to a study conducted by Bordoloi (2021) at Ri-Bhoi District of Meghalaya that the nutrient content of vermicompost was very high as compared to simple compost & a good benefit cost ratio was achieved in vermicomposting (2.56) as compared to simple composting (1.99).

Vermi-composting is a very important component of organic farming of India. Organic farming is a holistic approach for protecting the environment primarily the soil and water quality while boosting up the crop productivity by avoiding hazards to environment. It relies on chemical-free farming and its concept is builds on the idea of efficient use of locally available resources as well as the use of adopted technologies like soil fertility management, closing of nutrient cycles as far as possible, control of pest and diseases through management and natural antagonists. Vermi-composting technology can be effectively used for increase the productivity of crops; manage soil health and moreover earthworms affect soil formation and development. Various studies conducted in India shows the increased yield of crops by using vermi-compost along with lime and low rate of chemical fertilizers for reduction of use of chemicals to the crop field.

BENEFITS OF VERMI-COMPOSTING

- Vermicomposting is a potential source of income generation for the farmers and for the rural youth. Large scale vermi-composting can be done at commercial scale by recycling large quantities of organic waste. On the other hand, small-scale vermi-composting may be done to meet the personal requirements for the farmers and for the gardeners.
- It is helpful for reducing the environmental pollution as earthworms are capable of transforming huge amount of waste to valuable compost, which is otherwise a growing concern to our society. It decreases the use of chemical fertilizers and pesticides for crop cultivation.
- It contains readily available macro and micronutrients, it can enhance plant growth and development, can helps in roots development and germination, suppresses disease in plants and parasitic nematodes, improves water holding capacity, porosity and prevents soil erosion.
- Vermi-compost is useful for growth of aerobic microorganisms. These microorganisms perform several important functions like nitrogen fixation, production of enzymes, antibiotics, growth hormones, etc.
- The worm population can double in 2 to 3 months, so, sale of worms can give a return in a relatively short time.

PROCESS OF VERMICOMPOST PRODUCTION

- Generally, a cemented tank is required for vermi-compost

Fig. 1: Cemented tank vermi-composting unit

production. The size of the tank should be 10 feet length or more depending upon the availability of land and raw materials, breadth 3 feet and height should be 2.5 feet.

- A small canal is required in the surrounding of the tank. It should be filled with water to protect the earthworm from outside insects. A hole in the bottom side of the tank is required for drain out excess amount of water from the tank. Suitable plastic structure or bamboo beam/ tank with polythene lining also can be used for vermi-compost production.

Fig. 2: Bamboo beam Vermi-composting Unit

- A thatch roof or any type of shade should be constructed to protect the vermi-compost from direct rain and sunlight.
- For filling the tank, first of all a layer of soil or sand (2 to 3 inch) at the bottom of the tank should be placed.
- Then second layer is by biodegradable waste. Any types of biodegradable wastes can be used for vermi-compost

Fig. 3: chopping the bio-waste in to pieces, drying and sieving of vermicompost

production like waste from crop field (straw, husk, leaves, stalks and weed biomass), kitchen waste, waste from animal farm, organic fraction of MSW etc. The Bio-waste should be chopped into small pieces if required. This was followed by addition of third layer by animal dung.

- The addition of both the chopped bio-waste and animal dung layer-

Fig. 4: Earthworm and Cocoon from vermi-composting Unit

wise should be done into the tank till it is filled. The materials should be allowed for partial decomposition for around 30 days. Mixing should be done every week for quick decomposition and for stabilize the temperature.

- Then inoculation of around 1 kg earthworms per quintal of biomass is required at the surface of the tank. The suitable earthworm species are *Eisenia foetida*, *Eudrillus engineac* and *Amyanthes diffrigens*. It should be done at partial decomposition, almost after one month.
- Covering of the composting mixture with dry straw or jute bags (gunny bags) for maintaining the suitable moisture and temperature conditions is required for quick decomposition. Moreover, net made up of bamboo can be placed over the tank to protect the worms from birds.
- Sprinkle water on regular basis should be done to maintain the moisture content of the compost at 60 % to 70% throughout the decomposition period. Sprinkling of water should be stopped when around 90 % of bio-wastes are decomposed.
- After 2 to 3 months the granular structure will be seen at the surface of the tank. This is the indication of compost becomes ready for harvest.
- Then harvesting should be done from the top and a heap should be prepared by gathering all the compost. This will help in separation of earthworms and cocoon from the compost for reuse.
- For drying the harvested compost, it should be spread under shade. Sieving is required for marketing purpose as it separates the undecomposed materials from the vermi-compost. It is also helpful

for separating the earthworms and cocoons for reuse.

NUTRIENT CONTENT OF VERMICOMPOST

The level of nutrients in vermi-compost is depends upon the types of the raw materials used for preparation of compost. It contains around 1.5 – 2.5 % of nitrogen, 0.5 – 1.0 % of Calcium, 0.9 – 1.7 % of phosphorus, 0.2 – 0.3 % of magnesium, 1.5 – 2.4 % of potassium, 4 - 0.5 % of sulphur and other micronutrients with vitamins, enzymes and hormones are also present in vermicompost.

DOSES OF VERMICOMPOST IN DIFFERENT CROP

- ✓ **Rice-** 1 tonne per acre after transplanting.
- ✓ **Maize-** 1 tonne per acre at last ploughing.
- ✓ **Turmeric/ Ginger-** 1 tonne per acre at last ploughing.
- ✓ **Chilli-** 1 tonne per acre at last ploughing.
- ✓ **Groundnut-** 1/2 tonne per acre at last ploughing.
- ✓ **Citrus-** 2 kg per tree at planting time and before flowering in 1–2-year-old trees.
- ✓ **Mango, coconut etc.-** 2 kg per tree at planting time, 5 kg per tree at 1–5 year-old trees, 10 kg per tree for 6–9 years old trees, 20 kg per tree for older than 10 years tree.
- ✓ **Onion, garlic, tomato, potato, ladies' fingers, brinjal, cabbage, cauliflower:** 1 tonne per acre at last ploughing.
- ✓ **Pots:** 100-200 g per pots.

CONCLUSION

Organic waste recycling through vermi-composting is a profitable venture for rural unemployed youth as it can turn the garbage in to money. It is a method of making organic compost where earthworms eat organic biomass arise from agriculture as well as from non-agricultural activities and excrete the biomass as digested form. It is rapidly becoming a growth industry for the agricultural sector for income generation as it is accepted by all types of cultivation. In India a huge amount of waste is generated from agricultural system as well as an enormous amount of biomass and other organic waste are generated from forest and other non-cropped area every year, which can be utilized successfully for vermi-compost preparation. Moreover, the application of vermi-compost in the crop field increases the crop yield in a desired level and also increases the physical, chemical and biological properties of soil. Vermi-compost technology can balance the resource use efficiency and environmental performance, which are important for resource sufficiency perspective of sustainability and for increase the Farmers' income to a desired level.

Fig. 5: Use of Vermicompost

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SMART FARMING
NEED OF FUTURE

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The term smart agriculture refers to the usage of technologies like Internet of Things, sensors, location systems, robots and artificial intelligence on your farm. The ultimate goal is increasing the quality and quantity of the crops while optimizing the human labor used. Smart Farming is focussed on the use of data acquired through various sources (historical, geographical and instrumental) in the management of farm activities. Technologically advanced doesn't essentially mean that it is a smart system. Smart systems differentiate themselves through their ability to record the data and make sense out of it. Smart farming employs hardware (IoT) and software (SaaS) to capture the data and give actionable insights to manage all the operations on the farm, both pre and post-harvest.

Examples of technologies used in smart agriculture are:

- Precision irrigation and precise plant nutrition
- Climate management and control in greenhouses
- Sensors – for the soil, water, light, moisture, for temperature management.
- Software platforms.
- Location systems– GPS, satellite, etc.
- Communication systems – based on mobile connection, LoraWan, etc.
- Robots.
- Analytics and optimization platforms.

Innovative Technologies to Enhance Smart Farming

Indian people are slightly an orthodox type. They believe that those methods or ancient practices used from ancient times are the best for agriculture. But with the growing population and advanced times that methods should change too. For that, Indian farmers have to adopt innovative technologies to enhance smart farming. Following we are showing some technologies which should be enhanced.

Product innovations

There is a requirement for innovation in products. Those products which are growing from olden times that need to be updated. For that, new technologies introduced in the market which are designing fully new kinds of foods. Those products which are impossible to grow are tested in lab-grown.

Digital marketplaces

The government of India started an eNAM facility for the farmers of India. The eNAM (National Agriculture Market) is an electronic trading portal which creates networks between the existing APMC mandis for the farmers all over India. Its main aim is to promote equality in the agriculture market. From this plan smoothness between the buyers and sellers created and it promotes real time price too and digital marketplace permits farmers to lease equipment, connect to local customers, or pool together for superior insurance.

Operations software

It will help farmers to make better and operation decisions, save

money, track resources or productivity.

Skills-building tools

In Indian farming, there is a need for skill building. Farmers produce which they learnt from their parents or ancestors. They don't know how to use these newly introduced technologies. For that skill building tools should be introduced in the market for the farmers and introduce them with latest farming techniques. It includes hotline voice services, videos, mobile apps and others. These tools help farmers to share experiences and learn new and innovative things. In France, AgriFind is a social networking place to ask questions and advice for the farmers.

Benefits of smart farming in India

Increase Efficiency

By smart farming, farmers can increase their efficiency. With advanced technologies farmers, now farmers can produce more products in a limited time period. They get inspected fast, forecast matters before they happen and make important decisions on keeping them away.

Expansion

With the use of smart farming technologies, expansion in farming takes place. All the agriculture activities take place on time and are of good quality. The short food chain completes on time for these technologies, and everyone in the country gets proper food at an affordable price.

Proper use of resources

By smart farming technologies resources used fully and properly. Resources that include energy, water, and land. By the IoT farming data collected from the sensors which help to allocate an optimum amount of resources to the plants.

Cleaner process

It is a cleaner process that can save energy, water and make framing greener. These technologies evaluate the use of fertilizer and pesticides. These processes provide organic and cleaner products in comparison to traditional farming methods.

Agility

Uncertain weather changes, air quality, humidity, soil in the fields, and health of crops monitored by the smart farming technologies. That provides real time monitoring that can predict the condition of the crop. This provides professional advice in extreme weather changes that can save the crops.

Improved product quality

These help to improve product quality by using crop sensors, farm mapping, and aerial drones. Smart farming technologies create the best conditions to boost the value of nutritional products.

These are all about smart farming in India. I hope you get all the detailed information regarding innovation in farming and advanced technologies that make your farms more productive. For further details, stay tuned with Tractor Junction.

Conclusion

Innovative solutions will pave the way helping to feed the global population. At the same time, consumers can become more aware of the overall agri-food chain that will help them to make informed decision when selecting specific produce. This can enable the opportunity to present consumers the full benefit of premium, organic and upcoming sustainable production methods as well as offer possibilities of better handling fair trade for farmers, hence facilitating their informed decisions. Finally, new and disruptive business models are in reach that will make use of the data-driven agri-food chain. However, the sustainability of IoT based businesses, both for the supply (providers of IOT technology) and demand (agri-food users) stakeholders must be specifically in the Context of large-scale deployments for being able to mobilize a critical mass of end-users and validate the related benefits.

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THE IMPORTANCE OF PLANT HEALTH IN TODAY'S WORLD

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The IYPH is not only a once-in-a-lifetime opportunity to raise global awareness on how protecting plant health can end hunger, reduce poverty, protect the environment, and boost economic development, but also to demonstrate that everyone has a specific role to play in this global action.

Protecting Plants is Protecting Life: Between 2000 and 2016, international agricultural trade increased more than three-fold in value. With increasing trade, opportunities for plant pests and diseases to move around the world have grown exponentially. International travel and the movement of people have also fundamentally increased over the past decades, bringing fresh pathways for pest and disease introduction and spread. New pests and diseases appear now in territories where they had never before been encountered, with negative consequences on local ecosystems, agriculture and food security. Pests and diseases are responsible for losses of between 20% and 40% of global food production and for trade losses in agricultural products exceeding USD220 billion every year.

Plant Health and One Health: Health debates have dominated since COVID-19 became a pandemic. It is seldom that one thinks about the health of plants or that of the environment except in their relation to human health. Plants may appear healthy to untrained eyes, yet plants also get sick. While applying sanitary precautions, procedures, and treatments to tackle the threat of COVID-19 are paramount, we should nevertheless remember that our own health depends on plants while the health of plants depends on us. Therefore, we need to lower the risk of transmitting plant pests and diseases through our actions. This is why the prevention advocated by international regulations, such as the ISPMs (International Standard for Phytosanitary Measures) of the IPPC (International Plant Protection Convention), approved through participatory methods and based on scientific evidence, becomes even more essential.

What is Plant Health? - Plant health is an overarching term for emerging risks including pests, diseases and weeds, integrated pest management and innovation in plant protection. It has the potential to contribute to the wider goal of ensuring the sustainability of primary production on an economic, ecological and social level. I define plant health management as the science and practice of understanding and overcoming a succession of factors limiting to plants achieving their full genetic potential as crops, ornamentals, timber trees, or for other uses.

The Big Four in Plant Health Management: The gains but also many if not most of the setbacks in plant health management over the past 100 years have occurred simultaneously on four fronts. These are:

1. The use of clean, high-quality seed and other planting material.
2. Planted into sanitized and optimally fertilized soil.
3. Irrigated with clean, high-quality water.
4. Protect the crop against the hazards imposed through the air.

1. Clean Planting Material: Probably the greatest collection of success stories for plant health management in the twentieth century is the number of diseases managed or all-but-eliminated by cleaning up the planting material. Technologies such meristem culture, heat therapy, seed indexing, ELISA, and now the modern molecular tools for detection of pathogens in seeds or clonal material have been applied in one form or another to nearly every crop worldwide, with spectacular results. The ornamental, potato, and tree-fruit industries, in particular, have been (for some regions) saved from economic devastation or even extinction because of the technology to produce pathogen-free clonal material.

2. Clean Soil and Root Health Management: Questions such as whether the crop rotation effect or the increased growth response of plants to soil fumigation results from improvements in soil fertility or health and density of roots available to take up nutrients are still being debated, in spite of the overwhelming evidence pointing repeatedly to improved root health because of the elimination of root pathogens. Indeed, soil fumigation became a substitute for crop rotation during the twentieth century, making it possible to replant high-value horticultural crops such as strawberries year after year in the same fields without yield decline.

3. Clean, High-Quality Irrigation Water: For irrigated crops, the "big four" for plant health management includes not only clean, high-quality seed or other planting material planted into sanitized and optimally fertilized soil but also then irrigated with clean, high-quality water. The two major deterrents to meeting this requirement are pathogens and salts.

4. Protection from the Hazards That Arrive by Air: without doubt, the greatest scientific and technical advances for plant health management in the twentieth century, and to some extent the greatest successes, have come from the work aimed at management of the pathogens, pests, and other hazards that arrive by air. Research aimed at the management of foliar pathogens is also the basis for modern theory on epidemiology, aerobiology, and disease prediction and decision-support systems. The potential for crop destruction by an aerial pathogen or insect pest has provided most of the economic incentive for industry to develop and for growers to buy fungicides and insecticides.

Perhaps the greatest single series of technological achievements in this aspect of plant health management are the advances in breeding crops for resistance to pathogens and insect pests.

Conclusion

The proclamation of the IYPH-2020 (International Year of Plant Health) itself marks a key global achievement. It has finally brought to light how protecting plant health can help achieve food security and solve other global challenges. The IYPH is not only a once-in-a-lifetime opportunity to raise global awareness on how protecting plant health can end hunger, reduce poverty, protect the environment, and boost economic development, but also to demonstrate that everyone has a specific role to play in this global action. The private sector, governments, farmers and agribusiness, the scientific community, travelers and citizens can all contribute to this important global goal by taking specific actions.

Recently, UN has taken a decision to establish an annual International Day of Plant Health to be held every 12 May. The Day is a key legacy of the International Year of Plant Health, which was marked in 2020-2021.

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EFFECT OF PESTICIDES USE
IN AGRICULTURE ON ENVIRONMENT AND HEALTH

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In the past three-four decades, excessive and indiscriminate use of pesticides in agriculture have been increased tremendously. It not only degraded the environment and agriculture but also have entered in food chain thereby adversely affecting health and development. The synthetic chemicals in agriculture were introduced with the aim to manage the insect-pests and diseases to mitigate the problem of food safety and food security. But due to excessive and unjudicious use of these chemicals have worsened the problem. The magnitude of this problem would grow further due to insecticide resistance, pest resurgence and outbreak of secondary pest outbreak. In highly populated countries like India and China farming system is market oriented due to land scaracity for agriculture production. To meet the demand of population growth, the situation will be aggravated in the years to come. It is to be noted that in India the annual pesticide business is estimated at around Rs. 5000 crores and in coming years, this would grow faster and soon becomes a major player in the world. The different formulations of the pesticides when applied, move through the air and end up in the environment (soil and water). These pesticides don't degrade into non-toxic chemicals into the environment and enters in the food chain and also affects the non-target plants and animals. To combat this problem, there is a need for sustainable agriculture development. Alternative methods like low external input sustainable farming, ecological farming, application of non-toxic eco-friendly formulations are need to be quantified.

Organic or ecological farming can be a better solution to combat pest for maintaining environment security. It is estimated that in our country around 3000 plants have pest-repellent properties. These plants need to be identified and scientifically studied and utilized for sustainable agriculture development. It is found that most of the agricultural commodities have pesticides residues more than maximum residue limit (MRL). Even the packaged drinking water is contaminated with the pesticide residues. Agricultural chemicals were introduced during mid-sixties to boost the green revolution with the aim to manage the insect-pests and diseases in field crops. Initially, the use of chemicals in agriculture managed the problem of weeds, insect-pests and diseases but in long-term it adversely affected the environment and soil health and ultimately production. Despite the indiscriminate use of synthetic chemicals, agricultural production is stagnant. Knowingly or unknowingly farmers are bound to use these chemicals which are making the situation bad to worse all over the world. Despite of chemical usage approximately Rs. 6000 crores crop loss is done due to pests. Among these pests weeds are the major cause of the crop loss. Initially the use of pesticides was limited to the cereal crops but now-a-days these chemicals are used on most of the crops. The residues of these pesticides have been detected in most of the fruits and vegetables specially green vegetables. The main cause of the pesticide residues in agricultural commodities is that farmers are not aware about the waiting period. Due to detection of pesticide contaminants in agricultural commodities, the consignments have been rejected by the European countries. Even the dry chillies have been detected with pesticides residue. Hence, this problem is very serious and needs attention and quick attention for sustainable development of the society. The use of chemicals in agriculture can't be stopped instantly but these are many alternative methods to control these problems. The sole reliance on the chemicals is not the solution of the agricultural problems. Integrated approach needs to be adopted. The concepts of INM, IWN, IPM, IDM needs to be more emphasized for sustainable development. Nature itself has given enough checks and balances to minimize the pests and diseases if not eradicate them in total. The farmers need to be educated about the role of micro-organisms in improving soil health and increasing production, natural enemies and beneficial insects and other micro-organisms in management of insect-pests and diseases. Adoption of crop rotation adjustment of sowing/ transplanting dates, trap cropping, pruning of infected plant parts. More than 3000 plants in India are reported to have pest control properties like repellency, growth regulators, chitin synthesis inhibitors, juvenile hormones, moulting hormones needs to be promoted because these have target

specific action and no residue problem is faced in use of these.

Use of semiochemicals, Pheromones etc. are need to be more detailed studies in use of pest control. Use of mulching helps in less water evaporation and proliferation of beneficial earthworms ultimately making the soil more porous and increase water holding capacity. Weather based pest forcasting modules should be developed for timely management of insect-pests and disease. The farming techniques needs to be carried out based on indigenous knowledge system gained over years of experience and if needed should be patented for a local region. Developing and utilizing alternatives like plant based solutions also create employment opportunities to local laborers. Growing of flowering plants near borders of the field, providing shelters to conserve the natural enemies. Spraying of chemicals should be done at ETL. All the non-chemical practices should be done after their use. Proper dose of pesticides and fertilizers should be used on need basis only. The empty container should be deep buried in the soil. Application of environment friendly plant based solutions has found to control pest slowly but the impact will be sustainable.

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ADVANCED APPLICATIONS OF REMOTE SENSING

IN AGRICULTURAL CROPS AND NATURAL VEGETATION

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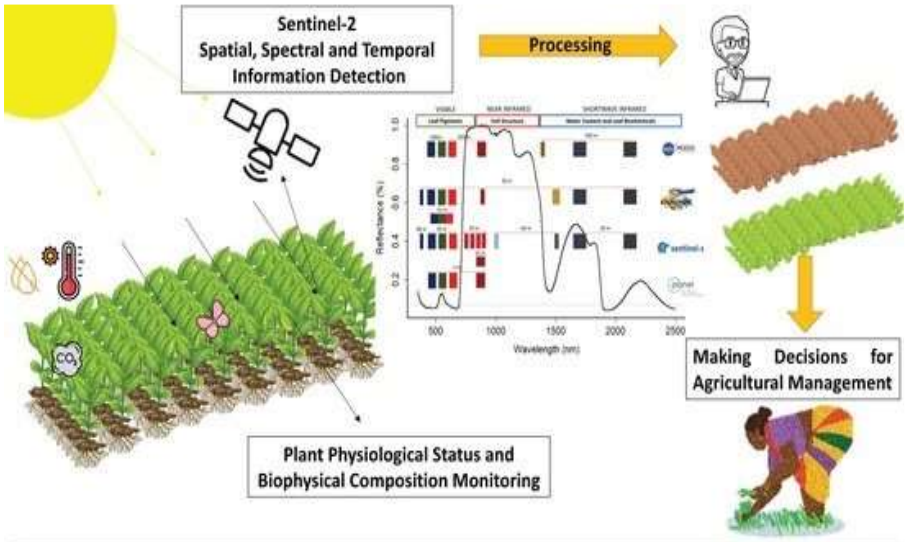
Remote sensing is the technique in which acquisition of information about an object or phenomenon from distance. This involves an instrument or a sensor mounted on a platform, such as a satellite, an aircraft, an UAV/UGV, or a probe. The sensor typically measures the electromagnetic spectral reflectance that is either reflected or emitted by the target. The type of information accessible from remote sensing depends on the specific properties of the instrument and its platform. Agricultural stakeholders (e.g., farmers, agricultural cooperatives, local, national or international authorities) have to meet multiple goals: conducting activities that are economically viable, ensuring agricultural productions to feed a current population, and reducing or even reversing the negative environmental impacts by minimizing the resource depletion or by climate mitigation. As remote sensing is a nondestructive way of spatially and temporally monitoring vegetation, it appears as an inevitable tool to help achieving these goals.

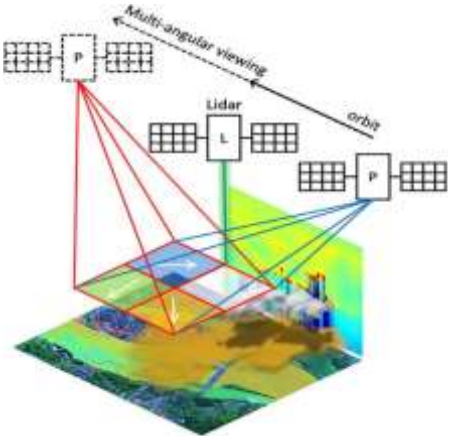
It can contribute to the identification of new varieties that better fit challenging contexts to the monitoring of agricultural land use, to the forecasting of crop production with in crop season, to optimization of short-term production and help to understand supply chain demand of country for specific crop variety, and to the provision of ecosystem services related to soil or water resources as well as to animal or plant biodiversity. In this section, we address recent research developments that permit to strengthen applicative capabilities in remote sensing for the aforementioned thematic.



Remote sensing for agriculture monitoring: Sentinel-2 features and precision agriculture

Crop condition assessment

Remote sensing can play a significant role in agriculture by providing timely spectral information which can be used for assessing the various indicators of plant health. Crop monitoring at specified intervals during crop growth is necessary to take appropriate measures and also to know the probable loss of production due to any stress factor. The crop growth stages and its development are affected by a variety of factors such as available soil moisture, date



of planting, air temperature, day length, and soil condition. Corn crop yields can be negatively impacted if temperatures are extremely high at the time of pollination. For this reason, knowing the temperature at the time of corn pollination could help forecasters to predict corn yields.

Agricultural land use monitoring

One of the most straight forward uses of remote sensing for agricultural is that to purposes to make maps of the agro-ecological landscape. It may be useful to

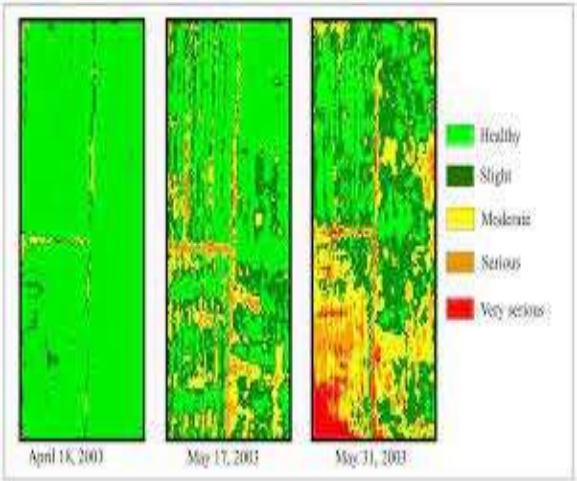
remember that the distinction between land cover, which relates to the physical properties of a land surface, and land use, which corresponds to the activities or functions for which humans utilize the land. Remote sensing will have an increasingly important role for monitoring agricultural land use as the agro-ecosystems change their spatial configurations under the various pressure drivers. Such drivers include climate change, which is expected to modify the patterns of crop suitability. The ability of hyper spectral sensing data to significantly improve the characterization, discrimination, modeling, and mapping of crops and vegetation, when compared with broadband multispectral remote sensing, is well known.

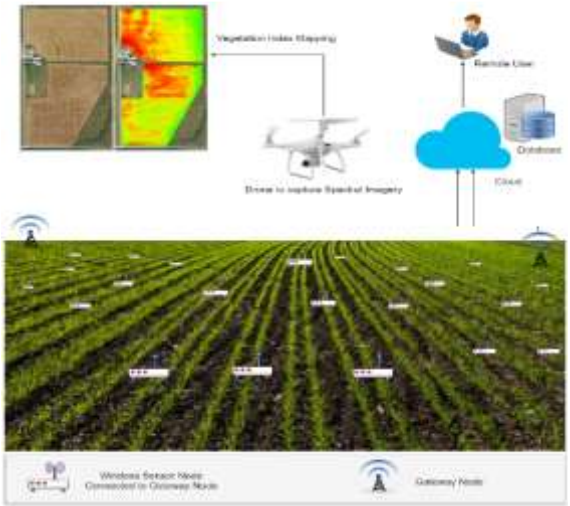
Monitoring crops for yield optimization: precision farming

Remote sensing has been very important technology to forecast crop yields primarily based upon statistical– empirical relationships between yield and vegetation indices. Information on production of crops before the harvest is important for national food policy planning. The crop yield is dependent on various factors such as crop variety, water and nutrient status of field, influence by weeds, pest and disease infestation, weather parameters. The spectral response curve of any study object is dependent on these factors. Remote sensing technology is a key component now a day for precision farming and is being used by an increasing number of scientists, engineers and large-scale crop growers.

Pest and disease infestation

Remote sensing has become a versatile technology for monitoring and quantifying crop stress due to biotic and abiotic factors. Remote sensing methodologies need to be perfected for identification of insect breeding grounds for developing strategies to prevent their spread and taking effective control measures.

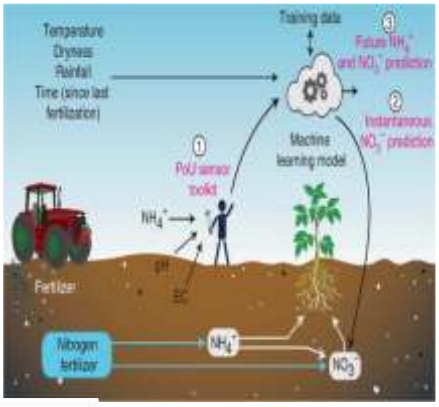




The range of remote sensing applications has included detecting and mapping defoliation, characterization of pattern disturbances etc. and providing data to pest management decision support system. Remote sensing techniques also used to detect specific insect pests and to distinguish between insect and disease damage on oat. High resolution multispectral remote sensing data hold the potential for monitoring of fungal wheat diseases.

Nutrient and water status

The most important fields where we can effectively use remote sensing and GIS for the application of precision farming are nutrient and water stress management. Detecting nutrient stresses with the help of remote sensing and GIS useful in site



specific nutrient management through which we can reduce the cost of cultivation as well as increase the fertilizer use efficiency for the crops.

For example, drip irrigation coupled with information from remotely sensed data such as canopy air temperature difference can be used to increase the water use efficiency by reducing the runoff and percolation losses. The spectral reflectance in the visible region was higher in water stressed crop than the non-stressed. With the increase in the development of hyper spectral bands in the thermal region, remote sensing has been playing a major role in understanding the crop soil characteristics.

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LEMON

A FRUIT OF MULTIPLE USE

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Citrus limon (L.) Burm. f. is a tree with evergreen leaves and yellow edible fruits from the family Rutaceae. In some languages, *C. limon* is known as lemon (English), Zitrone (German), le citron (French), limón (Spanish), and ningmeng, (Chinese). The main raw material of *C. limon* is the fruit, particularly the essential oil and juice obtained from it. The *C. limon* fruit stands out as having well-known nutritional properties, but it is worth remarking that its valuable biological activities are underestimated in modern phytotherapy and cosmetology.

A brief history

It is not very clear where the lemon has its origin. Citrus fruits have been cultivated in southern China and Southeast Asia for approximately 4000 years (apparently a lemon-shaped earring was found in the Indus-valley dating back to 2500 BC). Between 400 and 600 BC the lemon (the scientific name of the tree is *Citrus lemon*) was introduced into the Middle East, one can find old oriental stories where this fruit is mentioned. It were Arab traders in Asia who brought then around AD100 and 700 citrus fruits into Eastern Africa and the Middle East, after that they planted lemons in the Sahara, Andalusia and Sicily, bringing the lemon to Southern Europe.

Nutrition facts

Lemons contain very little fat and protein. They consist mainly of carbs (10%) and water (88–89%). A medium lemon provides only about 20 calories.

One lemon weighing 58 grams (g)

- Energy: 16.8 calories (kcal)
- Carbohydrates: 5.41 g, of which 1.45 g are sugars
- Calcium- 15.1 milligrams (mg)
- Iron- 0.35 mg
- Magnesium- 4.6 mg
- Phosphorus- 9.3 mg
- Potassium- 80 mg
- Selenium- 0.2 micrograms (mcg)
- Vitamin C- 30.7 mg
- Folate- 6.4 mcg
- Choline- 3.0 mg
- Vitamin A- 0.6 mcg
- Lutein + Zeaxanthin- 6.4 mcg

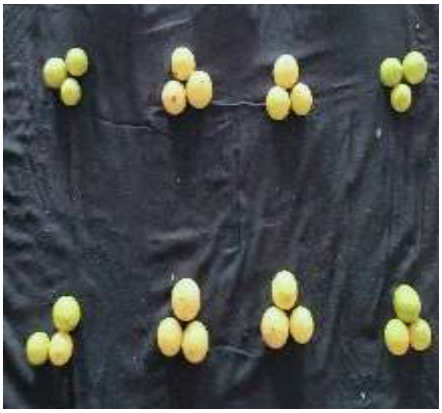
Benefits of lemon

1) Lowering stroke risk

According to a study, the flavonoids in citrus fruits may help lower the risk of ischemic stroke in women. Ischemic stroke is the most common type of stroke. It can happen when a blood clot blocks the flow of blood to the brain. Long term, regular consumption of foods that contain flavonoids might help protect against cancer and cardiovascular disease.

2) Blood pressure

Person who consumed lemon every day had lower blood pressure than those who did not. More research is needed to identify the role of lemon in this improvement and to discover whether consuming lemon can help reduce blood



pressure since walking daily can also lower blood pressure.

3) Cancer prevention

Lemons and lemon juice are an excellent source of the antioxidant vitamin C and Antioxidants which may help prevent free radicals from causing cell damage that can lead to cancer.

5) Preventing asthma

People with asthma who consume higher amounts of vitamin C and other nutrients when they have a cold may experience fewer asthma attacks. It has been observed that vitamin C also benefitted people with bronchial hypersensitivity when they also had a common cold.

6) Increasing iron absorption

Iron deficiency is a leading cause of anaemia and pairing foods that are high in vitamin C with iron-rich foods maximizes the body's ability to absorb iron. However, a high intake of vitamin C can trigger gastrointestinal problems in people who are taking iron supplements. For this reason, it is best to obtain iron from dietary sources, such as beef liver, lentils, raisins, dried beans, animal meats, and spinach. Squeezing a little lemon juice onto a salad containing baby spinach leaves can help maximize the intake of both iron and vitamin C.

7) Boosting the immune system

Foods that are high in vitamin C and other antioxidants may help strengthen the immune system against the germs that cause the common cold and the flu. One review found that, while vitamin C supplements do not appear to reduce the incidence of colds in a population, they may help reduce the length of time a cold lasts. Vitamin C may also help boost immunity in people who are undergoing extreme physical activity.

8) Vitamin C

Vitamin C is an essential nutrient and an antioxidant. Scurvy if a person does not consume enough vitamin C, they will develop a deficiency, which is known as scurvy. It is rare in the United States, but it can affect people who do not have a varied diet. Lemons contain about 50 mg of pure Vitamin C in only 100g of lemon.

Conclusions

C. limon contains a good amount of nutrients for and have multiple health benefits in spite of use in other commercial industries. The *C. limon* fruit provides raw material that can be used in different forms, e.g., extracts, juice and essential oil. The rich chemical composition of this species determines a wide range of its biological activity and its being recommended for use in phytopharmacology. Extracts from *C. limon* fruits are rich in flavonoids such as naringenin and hesperetin. Current pharmacological studies have confirmed the health-promoting activities of *C. limon*, especially its anti-cancer and antioxidant properties. *C. limon* also finds increasing application in cosmetology and food production.

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BENEFITS AND CHALLENGES OF VERTICAL FARMING

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The Food and Agriculture Organization (FAO) of the global organization projects that global agricultural production will have to increase by 50 percent so as to fulfill the food requirements of a projected world population of just about 10 billion by the year 2050. Yet, the available land suitable for farming and other agricultural activities is finite and has actually declined in recent decades, from nearly 40 percent of the world's area in 1991 to only 37 percent in 2015.

Fortunately, innovative agricultural techniques like controlled environment agriculture (also sometimes brought up as vertical farming) hold significant promise as a mechanism to extend overall agricultural production to deal with local or regional food needs and to assist bring fresher and more nutritious food to billions of individuals, all while reducing the environmental impact related to conventional farming techniques. But the successful deployment and operation of vertical farms depend on the effective use of several key technologies, including state-of-the-art lighting systems and products, moreover as regional acceptance and suitable regulations.

What is vertical farming?

The term "vertical farming" was coined in 1999 by Dickson Despommier, professor of Public and Environmental Health at Columbia University. Although often used interchangeably with the more generic term "indoor farming," the term "vertical farming" generally refers to a farming technique in which plants are grown in vertically-stacked planting beds stored in a controlled, indoor environment.

In general, vertical farms rely on soil-based or hydroponic solutions, which can use a customized combination of minerals and other natural nutrients consistent with the requirements of a given plant. Other solutions with the potential to further enhance resource efficiency are aeroponic techniques, in which a nutrient solution is sprayed on free-hanging plant roots, or aquaponic grow systems which combine a plant growth system with a fish cultivating system.

Key factors in vertical farms

The technique of growing the crops on a vertical farm involves the following elements

- Temperature control
- Humidity control
- Artificial lighting
- Control and monitoring of nutrients and fertilizer

Photosynthesis is the process by which plants convert light energy into chemical energy. Artificial light sources designed to influence plant development are often referred to as plant light, grow light, or horticulture light. Unlike LED lighting systems used for industrial or commercial applications, LED luminaires used for plant growth must satisfactorily address a variety of performance and safety factors to help ensure that vertical farms achieve their optimal agricultural output without harming the surrounding environment or workers operating the installation.

Benefits

Vertical farming allows us to grow crops with a fraction of the space, sun, soil, and water traditional farming uses. It can benefit

businesses and communities, providing access to fresh produce. Vertical farming decentralizes the food system and democratizes the food supply because it increases supply, lowers prices, and provides food access to all sections of the population. Some of the advantages and benefits of vertical farming are the following:

- Offers a plan to handle future food demands
- Allows crops to grow year-round
- Uses significantly less water
- Increases food accessibility.
- Weather doesn't affect the crops
- More organic crops can be grown
- There is less exposure to chemicals and disease
- Saves space by freeing up traditional agricultural areas
- Harvest throughout the year
- Independent and flexible
- Low transportation and storage costs
- Saves water due to closed cycles
- No maintenance or external lubrication is required
- No contamination
- Resistance to dirt, dust, and corrosion
- Fast ROI due to cost-effective automation components
- FDA compliance
- Can grow more crops with less land and less water than conventional farming

Challenges

Vertical farming has both pros and cons. Vertical farming technologies face economic challenges with large start-up costs. The disadvantages and challenges of vertical farming include the following:

- Very costly to build and economic feasibility studies have not yet been completed
- Pollination would be very difficult and costly
- Involves higher labor costs
- Relies too much on technology and one day of power loss would be devastating
- Vertical farming technologies are relatively new
- The power cost of maintaining a controlled environment 24/7 is high, only a few vertical farming companies currently operate profitably.

Vertical farming is the most sophisticated and technologically advanced way to grow crops. Vertical farms alone cannot meet the food needed by the global population. To make vertical farming more efficient and productive will take the integration of new technologies such as robotics and artificial intelligence, the Internet of things, and big data analytics.

Conclusion

Vertical farming is a world-changing idea whose time has come. It is a young, vibrant, and ever-changing sector that is expected to grow in the next decade. It is a highly promising and sustainable solution to the growing need for healthy, local foods. It is poised to be the farming of the future.

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NEW INDIA
DIGITAL AGRICULTURE

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Recently, the Ministry of Agriculture and Farmers Welfare signed 5 Memorandums of Understanding (MOUs) with private companies for taking forward Digital Agriculture. These pilot projects are part of the Digital Agriculture Mission and will draw on the National Farmers Database which already includes 5.5 crore farmers identified using existing national scheme.

Digital Agriculture

Digital Agriculture is "ICT (Information and Communication Technologies) and data ecosystems to support the development and delivery of timely, targeted information and services to make farming profitable and sustainable while delivering safe nutritious and affordable food for all."

Examples

Agricultural biotechnology is a range of tools, including traditional breeding techniques that alter living organisms, or parts of organisms, to make or modify products; improve plants or animals; or develop microorganisms for specific agricultural uses. And in other Precision agriculture (PA) is an approach where inputs are utilized in precise amounts to get increased average yields, compared to traditional cultivation techniques such as agro-forestry, intercropping, crop rotation, etc. It is based on using ICTs. Digital and wireless technologies for data measure-ment, Weather monitoring, Robotics/ drone technology, etc.

Benefits

Prevents soil degradation so than after increases agriculture productivity. When farmer gets actual knowledge about need of chemical fertilize than reduces chemical application in crop production and use actual quantity, efficient quantity of use water resource in agriculture. Disseminate modern farm practices to improve the quality, quantity and reduced cost of production. Change the socio-economic status of farmers.

Challenges

(1) High Capital Costs:

It discourages the farmers to adopt digital methods of farming.

(2) Small Land Holdings:

Indian farms are very small in size and 1-2 acres farm plots are the most common. Also, agricultural land leasing under various arrangements is widely prevalent in India.

(3) Renting and Sharing Practices:

Due to both limited financial resources and small farm plots, renting and sharing platforms rather than outright purchase for equipment and machinery like tractors, harvesters etc.

(4) Illiteracy in Rural Area:

The lack of basic computer literacy hinders the fast development of e-Agriculture.

Related Government Initiat-ives

- **Agri-Stack**:

The Ministry of Agriculture and Farmers Welfare has planned creating 'Agri-Stack'- a collection of technology-based interventions in agriculture. It will create a unified platform for farmers to provide them end to end services across the agriculture food value chain.

- **Digital Agriculture Mission**

This has been initiated for 2021 -2025 by the government for projects based on new technologies like artificial intelligence, block chain, remote sensing and GIS technology, use of drones and robots etc.

- **Unified Farmer Service Platform (UFSP)**

UFSP is a combination of Core Infrastructure, Data, Applicat-ions and Tools that enable seamless interoperability of various public and private IT systems in the agriculture ecosystem across the country. UFSP is envisaged to play the

following role: Act as a central agency in the Agri ecosystem (like UPI in the e Payments) and enables registration of the service providers (public and private) and the Farmer Services. Enforces various rules and validations required during the service delivery process. Acts as a Repository of all the applicable standards, API's (Application Programming Interface) and formats. Act as a medium of data exchange amongst various schemes and services to enable comprehensive delivery of services to the farmer.

National e-Governance Plan in Agriculture (NeGP-A):

A Centrally Sponsored Scheme, it was initially launched in 2010-11 in 7 pilot States, which aims to achieve rapid development in India through use of ICT for timely access to agriculture related information to the farmers. In 2014-15, the scheme was further extended for all the remaining States and 2 UTs and other digital initiatives: Kisan Call Centers, Kisan Suvidha App, Agri Market App, Soil Health Card (SHC) Portal, etc.

Way Forward:

The use of technology has defined the 21st century. As the world moves toward quantum computing, AI, big data, and other new technologies, India has a tremendous opportunity to reap the advantage of being an IT giant and revolutionize the farming sector. While the green revolution led to an increase in agricultural production, the IT revolution in Indian farming must be the next big step. There for is a need to build a robust digital infrastructure in the country consisting of satellite imaging, soil health information, land record, cropping pattern and frequency, market data, and others. And Data efficiency can be increased through - Digital Elevation Model (DEM), Digital Topography, Land Use & Land Cover, Soil Map, etc.

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AEROPONICS

FARMING IN THE AIR

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Aeroponics means "growing in the air". It is a medium of system in which the roots of plants are free hanging inside on open root zones atmosphere. It is the method in which nutrient water and air are supplies to the growing chamber.

By this technique many herbs are grown such as chives, oregano, basil, sage, rosemary. The global aeroponics market size was valued at 578.70 million in 2018 and projected to reach 3.53 billion by 2026.

Types of Aeroponics

a. **LPA:** Low Pressure Aeroponics
b. **HPA:** High Pressure Aeroponics

a. Low Pressure Aeroponics (LPA)

Low pressure aeroponics supply the mist to plant roots at a low pressure with large droplets. In this plant roots are kept over a nutritional solutions or inside a channel connected to reservoir in low pressure aeroponics gardens. It is more efficient and it required low initial cost.

b. High Pressure Aeropo-nics (HPA)

This type of aeroponics is most advanced and expensive to set up because it requires specialized equipment.

High pressure to reduce water into tiny droplets of 50 micron or less. High pressure aeroponics produce fine droplet size that create more oxygen for the root zone and it is efficient too.

Nutrients used in Aeroponics

In aeroponics, water and nutrients are required less because plant roots are sprayed in intervals by using a droplet size and provide nourishment to the plant. Water may contain different elements with some primary nutrient such as nitrogen, phosphorus, potassium and secondary nutrient such as calcium, magnesium and sulphur. Nutrients are taken by roots in water positively charged cations or negatively charged anions. Cation charged include ammonium NH^{++} and anion nitrate NO^{3-} and both are important source for plants. The optimum pH required in aeroponics is between 5.8 and 6.3.

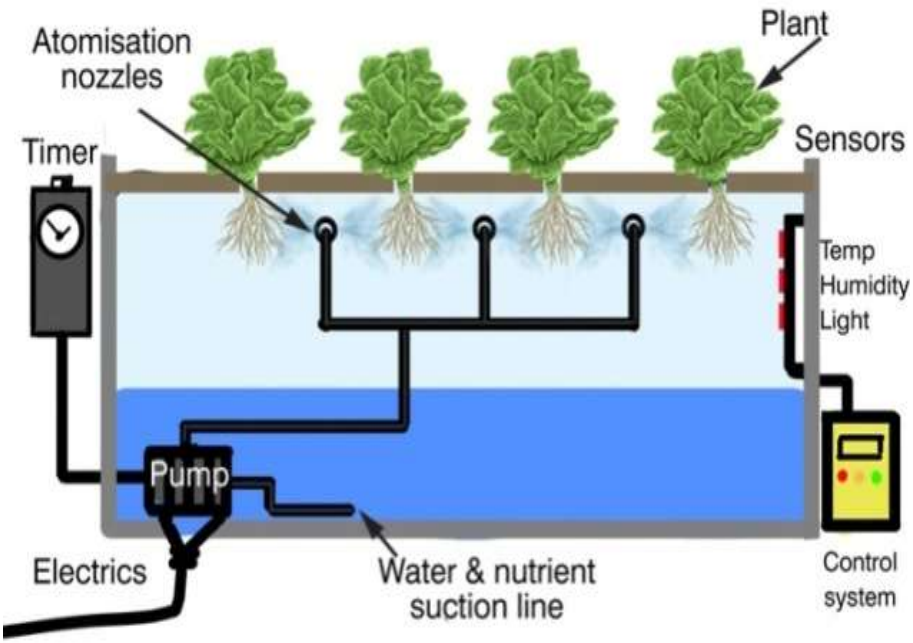
Table No. 1- Concentration of diffe-rent nutrients in Aeroponics

S. No.	Nutrients	Concentration (gm/lit.)
1.	$N\text{-}NH_4$	0.54
2.	$N\text{-}NO_3$	0.35
3.	P	0.40
4.	K	0.35
5.	Ca	0.17
6.	Zn	0.03

Source – *Chemical Science Review and Letters* 2017, 6(22), 838-849

Principles of Aeroponics

The principles of aeroponics is based on cultivating vegetables whose roots are not inserted in soil but roots are kept in container filled



with water and nutrients and thus it provide good moisture and oxygenation to the plants. Nutrient are flow down through the growth columns young plants are placed at highest level of the growth column. Plant nutrition is supplied in closed circuit, so it is nonstop production cycle and reduces the agriculture labour.

Components of Aeroponics System

a. Spray Mister

Atomization is reach by pumping water through nozzle at high pressure water through nozzle at high pressure. Chance of clogging is reduced by large nozzle and opening but it need pressure to operate and have high flow rates. In spray mister droplets size vary from submicron to thousands of microns.

b. Droplet Size

The ideal size of droplet for most plant species is 20-100 microns. The large droplets of size 30-100 microns make contact with the roots. Less than 30 microns size of droplets remain in the air as a fog and droplet having size more than 100 microns fall out of the air before containing any root.

c. High Pressure Water Pump

It is used to pressure the water to produce the ideal droplet size of 20-50 microns. The pumps require in high pressure water pump is generally diaphragm pump or reverse osmosis booster pump.

d. Light and Temperature

The optimum temperature for all plant is 15°C - 25°C. Sunlight is very essential but it is replaced by fluorescent tube of intensity 15000-20000 lux for vegetative growth 35000-40000 lux for flowering and fruiting.

e. Misting Frequency and Nutrient Reservoir

Aeroponics system mist the root system continuously misting cycle of 1-2 minutes of misting followed by 5 minutes. It will ensure the root system does not dry out under most conditions.

Crop Production using Aeroponics

The main crop produce using aeroponics are potato, lettuce and leafy vegetables. It is likely to be profitable producing high value crops.

Table No. 2 – pH and electrical conductivity of different crops grown as aeroponics.

SN	Crops	pH	Electrical Conductivity (mS/cm)
1.	Cucumber	5.8 - 6.0	1.7 – 2.2
2.	Onion	6.0 - 7.0	1.4 – 1.8
3.	Potato	5.0 - 6.0	2.0 – 2.5
4.	Tomato	5.5 - 6.5	2.0 – 5.0

Source – *Chemical Science Review and Letters* 2017, 6(22), 838-849

Conclusion

The main benefits of aeroponics system are the massive plants growth and higher yields as compared to other systems. We see that the price to set up the system is quite expensive and as it require the well expertise with advanced knowledge (about pH and nutrient density ratio). It is the best system in which crops are grow without pesticides and disease free and crops grows in natural healthy manner by conserving water, land and nutrients.

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HYDROPONICS
IN VEGETABLE CROPS

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Hydroponics is the cultivation of plants without the use of soil. As a result, it is apparent that plants in hydroponics are grown without soil and receive nutrients from fertilizer solutions mixed into the water. Hydroponics is a method of growing plants in nutrient solutions (water with fertilizers) with or without the use of a mechanical support medium (sand, gravel, vermiculite, rock wool, perlite, peat moss, coir, or sawdust). Hydroponics is a method of growing plants without soil by immersing their roots in nutritional solution.

Advantages of hydroponics

- Crops can be cultivated in areas where there is no adequate soil for crop production or if the soil is infected with diseases.
- Various intercultural operations such as tilling, cultivating, fumigating, watering, and other practices have been largely eliminated.
- Maximum yield may be obtained thereby making the system economically feasible in high-density and expensive land locations.
- This approach makes good utilization of water and nutrients. As a result, there is a lower risk of valuable chemicals being lost, resulting in less pollution of land and streams.
- By implementing this system, soil-borne plant diseases can be effectively eradicated.
- The system (i.e., timely nutrient feeding, irrigation, and root environment) and various greenhouse type operations allow for more complete control of the environment. Light, temperature, humidity, and air composition can all be easily manipulated.
- Production of 'off-season' vegetable is possible when market prices are highest.

Disadvantages of hydroponics

- The cost of constructing a hydroponics unit per unit area is really high.
- Before beginning hydroponically cultivated vegetable crop cultivation, proper instruction or knowhow is required. It is critical to understand how plants grow and the principles of feeding.
- There is a risk of imported soil-borne illnesses and nematodes quickly spreading to all beds on the same nutrient tank in a closed system.
- The majority of existing plant varieties that are adapted to regulated growth conditions must go through extensive research and development.

Hydroponics uses soilless growing material.

The growing media for a hydroponics system should have the following characteristics:

a. It must act as a nutrient source for appropriate plant growth and development.

b. It ought to be able to hold a lot of water.

c. It must concurrently deliver water and gases to the plant.

d. It must give adequate plant support.

Materials used in hydroponics

1. Coco Coir: Has an excellent air to water ratio with great water retention.

2. Rockwool:
- A fibrous material made from melted rock.
- Not biodegradable.
- Hazardous to health.
- Must be pH balanced.
- Excellent water retention.

3. Expanded clay Pellets:
- Most popular media.
- Drain quickly & pH neutral.
- Reusable.
- Used in ebb & flow, water culture.
- 50/50 mix of clay and coco creates a breathable medium.
- Heavy.

4. Potting soil (Perlite)
- Perlite + Coco Coir + Vermiculite.
- Synthetic materials are puffed/ heated to produce light and porous material.

Hydroponics structures and their classification

Wick method, ebb and flow method, Deep water culture (DWC) method, and drip method are some of the techniques used in hydroponics systems.

Wick method

This is the most basic hydroponic system, as it does not require electricity, a pump, or aerators. Plants are planted in a growth medium such as coco coir, vermiculite, or perlite, with a nylon wick extending from the plant roots into a nutritional solution reservoir. Capillary action is used to deliver water to plants. This technique is not suitable for crops that require a lot of water.

Ebb and flow method

The flood and drain principle are used in this system. In this technique, nutrient solution is pumped from a reservoir into the growth medium, flooding it for a brief time, and then the nutrient solution is allowed to flow back into the reservoir through the rooting medium. Air is drawn into the rooted bed by the outflow of nutrient solution from the growing media, providing a supply of O_2. Plants can obtain water and nutrient elements from the moist rooting medium. Again, the roots are exposed to a changing environment with such a nutrient solution delivery system, which may not be ideal for optimal plant growth and development, however plant performance is usually good with this hydroponic technique. Root rot, algae, and mould are all common problems with this system, hence a modified system with a filter unit is required.

Deep water culture method

Plant roots are suspended in nutrient-rich water, and air is delivered directly to the roots via an air stone. The hydroponics bucket system is a classic example of this type of approach. Because there is a risk of rapid growth of algae and moulds in the reservoir, oxygen, nutrient concentrations, salinity, and pH should be monitored often and very carefully in this system. Cucumber and tomato are two examples of vegetables that can be produced effectively using this strategy.

Drip method

This approach is commonly used by both home and commercial hydroponic farmers. With the help of a pump, water or nutrient solution from the reservoir is delivered to individual plant roots in an appropriate proportion. Plants are often grown in a medium that is fairly absorbent, which is why the fertilizer solution drops slowly. This strategy can be used to raise a variety of vegetable crops. Aside from the strategies described above, there are a few others that can be grouped together based on how water is circulated. These are briefly listed and detailed below.

Circulating methods

NFT (Nutrient Film Technique)

Dr. Allen Cooper, an English scientist, devised this procedure in the mid-1960s. A thin coating of nutritional solution flows continually via channels, soaking bare roots. Nutrient solution is collected at the lower end of the channels and flowed back to the nutrient solution tank. If the right cultivars and solution temperature are chosen, spinach can be cultivated all year in a greenhouse using NFT.

DFT (Deep flow technique)

Nutrient solution flows 2-3cm deep through PVC pipes with a diameter of 10 cm in DFT. Planting materials are contained in plastic pots, and the bottom portion of the pots touches the nutrient solution flowing via the pipes. Plants in pots are arranged in a single plane or in a zigzag pattern.

Non circulating method

Root Dipping methods

Plants are cultivated in small pots filled with a small number of growing media in the root dipping technique. Submerge the bottom 2-3cm of the pots in the fertilizer solution. While some roots are dipped in the solution, others are suspended in mid-air.

Capillary action technique

Capillary action transports the nutrient solution to the inert media. Ornamentals, flowers, and indoor plants can all benefit from this strategy.

Nutrient solutions

- For vegetative and reproductive growth, plants require 17 essential components. Carbon, hydrogen, and oxygen are the first three elements.
- The remaining 14 nutrients are macronutrients such as nitrogen, phosphorus, potassium, calcium, magnesium, and Sulphur, the first three of which are categorized as primary nutrients and the remaining three as secondary nutrients.
- Iron, manganese, copper, zinc, boron, chlorine, molybdenum, and nickel are examples of microelements.
- Nutrient control is simple in

hydroponics.

- Nitrogen is generally beneficial to plant vegetative growth.
- Phosphorus and potassium aid the plant's flowering and reproductive growth.

System requirements

The following criteria must be considered for successful hydroponically grown vegetable crops.

- The pH of the solution should be between 5.8 and 6.4, indicating that it is slightly acidic to neutral.
- The solution's electrical conductivity should be between 1.2 and 3.5 Mho.
- The entire system temperature should be kept between 65- and 78-degrees ^{o}F.

Conclusion

Hydroponic culture is the most intensive form of crop production in today's agriculture business, and it is mostly employed in industrialized and developing countries to produce food in small spaces. It is very productive, conserves water, is environmentally friendly, and can be carried out on a limited amount of land and space. Hydroponics helps plants to develop up to 50% quicker than soil by delivering constant and easily available nourishment. It also yields more than the traditional way. In a short period of time, the frame of hydroponics has expanded substantially, leading to a surge in experimentation and research in the area of indoor and outdoor hydroponic agriculture.

Table 1: Vegetable crops suitable for hydroponics system

Leafy vegetables	Lettuce, Parsley, Leafy type Chinese cabbage/ Pakchoi etc.
Other than Leafy vegetables	Tomato, Chilli, Brinjal, Green bean, Beet, Wingedbean, sweet pepper, Cabbage, Cauliflower, Cucumbers, Melons, Radish, Onion etc.

Table 2: Vegetable production under hydroponics in India

Vegetables	Production (g/ sqm/ day)
Carrot	56.5
Cucumber	226
Garlic	57
Ginger	57
Leek	57
Green bean	113
Lettuce	226
Onion	56.5
Pea	113
Potato	56.5
Salad greens	226
Tomato	113

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DRAGON FRUIT PHENOLOGY (*Hylocereus spp.*)

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Dragon fruit (*Hylocereus spp.*) is a hemiepiphytic climbing cactus that blooms at night and has a high fruit value and market potential. However, there is a scarcity of data on its phenology. Because important cultivation practises are based on plant phenophases, systematic documentation of phenological stages is required to achieve higher productivity and better fruit quality.

Introduction

Dragon fruit belongs to the order Caryophyllales and the family Cactaceae, which includes approximately 125–130 genera and 1400–1500 species. While the majority of the species are known for their ornamental qualities, nearly 250 are known for their fruit value. The genus *Hylocereus* contains 14 species, the most cultivated of which are *H. undatus*, *H. monacanthus* (previously known as *H. polyrhizus*), *H. costaricencis*, and *H. megalanthus* (previously known as *Selenicereus megalanthus*). *Hylocereus* species are distinguished primarily by their fruit morphology, pulp colour, areole characteristics, and the number and shape of their spines. In this genus *Hylocereus*, there are distinct morphological differences in stem, flower, and fruit characters.

Botanical characteristics of dragon fruit

Dragon fruit is a member of the botanical family Cactaceae, genus *Hylocereus*. *Hylocereus* is a genus of climbing plants with aerial roots that produce a glabrous berry with massive scales. It is diploid (2n = 22) in nature.

At the moment, the world market contributes four types of dragon fruit:

1. Red skin, white flesh (*Hylocereus undatus*), primarily from Vietnam and Thailand.
2. *Hylocereus polyrhizus* (red skin, red flesh), primarily from Israel and Malaysia.
3. *Hylocereus costaricencis* (red skin, purple flesh), primarily from Guatemala, Nicaragua, Ecuador, and Israel.
4. *Hylocereus (Selenicerus) megalanthus* (yellow skin, white flesh), primarily from Colombia and Ecuador.
5. The world market shares of red–skin with white flesh, red–skin with red flesh, red–skin with purple flesh, and yellow–skin with white flesh are approximately 94, 4.0, 1.5, and 0.5 percent, respectively

H. undatus has long, green stems that are horny at the age margins. Flowers are very long (up to 29 cm), with green (or yellow-green) outer perianth segments and pure white inner perianth segments. Its rosy-red fruit (length: 15–22 cm; weight: 300–800 g) is oblong and covered in large and long scales that are red and green at the tips; it has a white flesh with many small black seeds, a pleasant flesh texture, and a good taste.

Fig 1: Four different types of dragon fruit in world market

H. polyrhizus has very long (25–30 cm) flowers with margins, outer reddish perianth segments, especially at the tips, and stigma lobes that are rather short and yellowish. Its scarlet fruit (length: 10–12 cm; weight: 130–350 g) is oblong and covered in varying size scales.

H. costaricencis has dynamic vines, conceivably the boldest of the genus. Its crimson fruit (diameter: 10–15 cm; weight: 250–600 g) is ovoid and enclosed with scales that vary in size; it has a red purple flesh with many small black seeds, pleasant flesh texture, and honourable taste.

Fig 2: Flowering in dragon fruit

Flowering and fruiting

Flowering occurs from April to November and lasts until December. The flower of dragon fruit is creamy white in colour. Their fragrance attracts pollinators. During the early morning hours, honey bees are effective at pollinating dragon fruit. Flowering occurs in four to six flushes, and frequently in seven flushes, in dragon fruit. It's been a long day for the plant. Flowers are normally open from 6.30 p.m. and close at 10 p.m. the same day. If they are not pollinated, they will remain open until 12.00 noon the following day. Dragon fruit flowers are 25-30 cm long and 15-17 cm wide. They are fragrant, nocturnal, and hermaphrodite in nature; however, some cultivars are self-compatible. The dragon fruits are non-climatic and highly sensitive.

Conclusion

Phenology is the most important aspect of any crop study. Crop yield is always predicted by the crop's phenological status and performance. Dragon fruit flowering is extremely sensitive to rain, as rain during fruit development results in the production of malformed fruits that are typically undersized and of poor quality. Such fruits are not common in the market. Agriculture researchers face a significant challenge as a result of this sensitivity. Because dragon fruit is a relatively new crop to the world, studies on this aspect must be conducted on a regular and well-planned basis in order to achieve higher and better yields.

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CROP REGULATION

IN FRUIT CROPS

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Crop regulation provides the foundation for a consistent and high-quality harvest. Fruit growth and, eventually, fruit size at harvest are influenced by crop density, which is a measure of fruit crop density. It is highly reliant on flowering and fruit production. Crop regulation employs a variety of ways to boost productivity while improving fruit quality. Manual thinning, chemical thinning, selective harvesting, training, summer and winter trimming, and the avoidance of pre-harvest fruit loss are all options. Some fruit crops bloom all year long, with no rest period in between, and produce two or three crops (bahar) per year, however yield and quality are not as good in all crop harvests. It is essential to consider crop flowering and fruiting behaviour, as well as which bahar will produce a productive crop when all aspects linked with that bahar are taken into account.

Need of crop regulation

Many crops that bloom more than once a year do not produce a consistent yield or fruit quality throughout the year. The bahar determines the yield and quality. For example, in the rainy season, guava fruits are fairly bland and watery, and do not keep well. The winter crop is usually preferred because it is not only larger in size but also of higher quality. Winter crops (mrig bahar), which ripen from the second fortnight of October to the first fortnight of January, are of greater quality, devoid of illnesses and pests, and yield a higher profit.

Principle of crop regulation

Crop regulation's basic principle is to regulate the fruit plant's natural flowering in the appropriate season to maximize fruit output, quality, and profitability. The majority of crops only bear blooms on young, succulent, vigorously emerging vegetative growths, which supports this theory. These fresh growth flushes might appear as new lateral bud emergences on older stems or as expansions of already established terminals of varying size and vigour.

Objectives of crop regulation

Crop regulation's major goal is to force the tree to rest and produce abundant blossoms and fruits during one of the two or three flushes. To ensure that fruits are of consistent and high quality, as well as to maximize production and profit for the grower. Because continuous continuous flowering would generate light crops throughout the year and necessitate a large cost for monitoring and marketing, the cost of cultivation must be reduced.

The selection of bahar at a location is mainly determined by

- Availability of the irrigation water
- Quality of products
- Occurrence and extend of the damage by the disease and pests
- Market demands Climate of the area
- Availability of fruit in the market
- Comparable yields

Methods of crop regulation

In order to get only appropriate season crop it is necessary to manipulate the flowering. The following practices can be adopted:

- Deblossoming or thinning
- Withholding of irrigation
- Root exposure and root pruning
- Shoot Pruning
- Chemical/PGRs application
- Nutrients application
- Shoot bending in guava

Deblossoming or thinning

Different chemicals led the rainy season crop to deblossom, which resulted in an increase in the winter season harvest. Rathore (1975) observed 96% deblossoming in guava with 100 ppm NAA. Pandey *et al*. (1980) reported total deblossoming using 400 ppm NAA in guava. Under various agroclimatic conditions, growth regulators and

certain chemicals have been found to be very effective in thinning flowers and manipulating the cropping season.

Withholding of irrigation

Withholding irrigation after harvesting the winter crop of guava in the northern plains causes the tree to shed its blooms and go dormant. June sees the application of well-balanced manure and fertilizer, as well as irrigation. The tree bloomed profusely after around 20-25 days, and the fruit matured throughout the winter. Water stress can be induced by withholding irrigation from December to June or until the start of the monsoon, depending on the weather circumstances.

Root exposure and root pruning

The plant's roots are exposed to the sun by removing up to 7-10 cm of dirt from a 40-60 cm radius around the tree trunk. Before blossoming, the water is withheld for a month or two. Leaves wilt and fall to the ground as a result of water stress. Roots are covered with a mixture of soil and FYM and irrigated right before one month of targeted bahar blossoming begins. Irrigations are administered at appropriate intervals after that. As a result, plants produce fresh vegetative growth, as well as abundant flowering and fruiting. In light sandy and shallow soils, however, root exposure should be avoided, and withering and debilitation of trees can be achieved by simply withholding water for 2-3 weeks. The roots are exposed and minute roots are cut away and irrigation is withheld so as to allow the leaves to shed in guava.

Shoot pruning

To avoid Ambe bahar, only the terminal area of the guava up to 20 or 30 cm in length should be clipped in April, and excessive pruning should be avoided at all times. It was suggested that the present season's growth of spring flush be pruned to avoid the rainy season harvest. In the northern areas of the country, pruning the current season's growth of spring flush to avoid rainy season crop has been urged. It was discovered that trimming 25-50 percent of shoots on 20 April, 10 May, or 30 May prevented flowering in the wet season and encouraged Sardar guava flowering in the winter. During the wet season, pruning vulnerable shoots by 4 to 5 inches from their tips reduced flower loss percentage in guava trees.

Chemical/pgrs application

Desai *et al*., (1982) from Rahuri, Maharashtra, India discovered that cycocel sprayed at 1000 ppm twice on August 16th and September 16th, followed by a spray of 2, 4, 5-T at 10 ppm on September 30th, produced 58.2 percent blooms compared to 16.3 percent in the control. With each increase in the chemical's concentration, the number of flowers and fruits increased as well.

Nutrition application

To enhance the amount of winter crop, the fertilizer schedule should be adjusted from April-May to May-June, which will result in greater vegetative growth, which will increase the amount of winter cropping.

Bending of shoot

In the off-season of guava, shoot bending is one of the methods for producing higher-quality fruits. When a branch bends, the wood tension of the branch increases and phloem production decreases. As a result, photosynthetic products travel more slowly from bending branch shoots to other sections of the plant, preserving a higher C:N ratio and causing greater flowering and fruit set. Bending stimulated the development of latent reproductive buds. Compared to the bent branch, the upright branch produces fewer flowers and fruits.

Conlusion

Various approaches including the use of various chemicals and the bending technique have been adopted by various research professionals all over the world. Different investigations by researchers have largely advised that using a variety of cultural and chemical strategies to regulate summer flowering and yield fruits in the winter was beneficial. The results of various studies reported by scientists in guava has revealed that the fruits of the winter season were significantly superior in every respect, including attractive size, weight, and better internal bio-quality parameters, than the fruits of the rainy season, which helped to fetch remunerative price for growers as well as affordable price for consumers.

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BIO-AESTHETIC PLANNING

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The aesthetic branch of horticulture known as bio-aesthetic planning deals with the placement of ornamental plants to generate a beautiful appearance. Lancelot Hogben coined the phrase "bio-aesthetic planning." Egypt was the first country to implement this type of urban planning in their cities. M.S. Randhava was the pioneer of bio-aesthetic planning in India.

India is one of the world's twelve mega-biodiversity countries, with 46,000 plant and 81,000 animal species documented so far, covering 70% of the entire geographical area studied. Bengaluru is a bio-aesthetic planned city in South India, and Chandigarh is a bio-aesthetic planned city in North India.

Scope

Environmental, ecological, and socioeconomic benefits enable a wider range of bio-aesthetic planning. Plants' pollution-fighting potential has not been fully used thus far. In bio-aesthetics, efforts should be focused on preserving natural landscapes that seem healthy, harmonious, diversified, and distinctive for the next century. As a result, bio-aesthetic planning may help to improve the environment of urban and industrial regions while also beautifying them.

Concept

Man has an aesthetic sense and strives for order and beauty. The majority of human art is influenced by natural forms, colours, and textures. Bio-aesthetic planning is the notion of meeting leisure requirements with attractive flora and wild animals. Locations that are suited for bio-aesthetic planning.

Benefits

1. Environmental benefits

- It is used to reduce the amount of heat in a room.
- Used to reduce the temperature of the air.
- Assists in the reduction of air pollution.
- Cleans the air by catching and slowing dust particles.
- Improves infiltration, decreases runoff, and lowers soil erosion.
- Isolate yourself from traffic noise.
- Act as a carbon sink and continue to be the most cost-effective and efficient source of extra CO_2.
- Effectively control snowdrift.
- The vertical and horizontal concentration of leaves alters the airflow pattern.

2. Social and economic benefits

- Supply wood, fruits, mulch, and composting materials and firewood.
- Contributes to the economic stability of the community.
- Offers public possibilities for active and leisure recreation.

3. Ecological benefits

Preserves ecological equilibrium and allows evolutionary processes to continue.

4. Aesthetic benefits

- Used to block off unwanted and distracting sight lines.
- The dynamic behaviour of the plants adds to the appeal of the surroundings.
- Make the concrete structure less harsh.
- Use architectural lines that complement one another.
- Give buildings background surroundings.
- Add monotonous cities to the skyline.
- Variety in shape, colour, and texture is added.

Places suitable for bio-aesthetic planning:

Industrial areas	Urban areas			Village	Highway
	Private	Public		Panchayat Ghar	
		Town roads		Religious places	
		Parks			
		Railway station, bus stand, airport			
		Around water bodies			
		Public building			
		Modern Building	Historical Building		
		Government offices			
		Hospitals			
		Educational institutes			
		Courts			
		Dak bungalow			
		Commercial buildings			
		Bank and post offices			

WEED RESISTANCE TO HERBICIDES

A SERIOUS THREAT TO GLOBAL FOOD PRODUCTION AND IT'S MANAGEMENT

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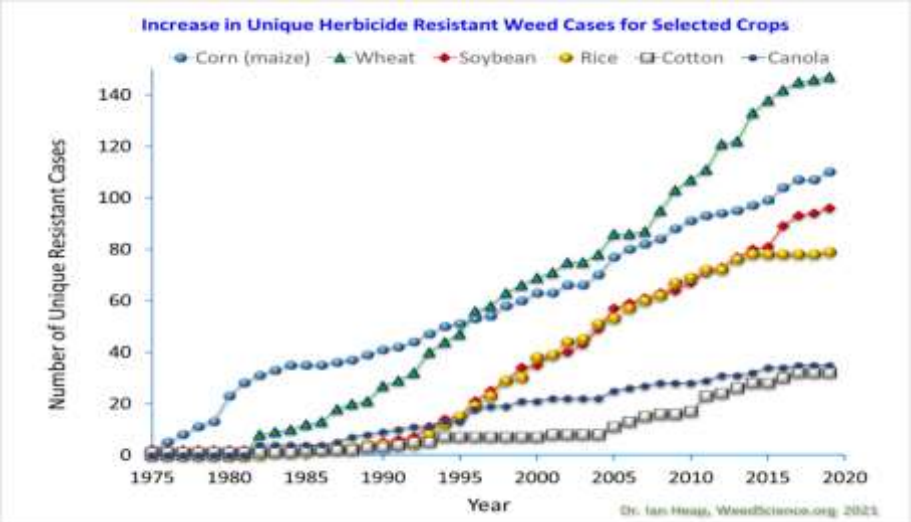
As of 2020, herbicide resistance had been reported in 263 species (152 dicots and 111 monocots) in the fields worldwide. Weeds have evolved resistance to 21 of the 31 known herbicide sites of action and to 164 different herbicides. Herbicide resistant weeds have been reported in 94 crops in 71 countries. In some species, for example *Alopecurus myosuroides* in the UK, resistance is so widespread that it is now described as being endemic. As long as herbicides form a part of a weed management programme, then resistance will remain a problem, although integration of herbicide usage with non-chemical management practices can vastly reduce this risk.

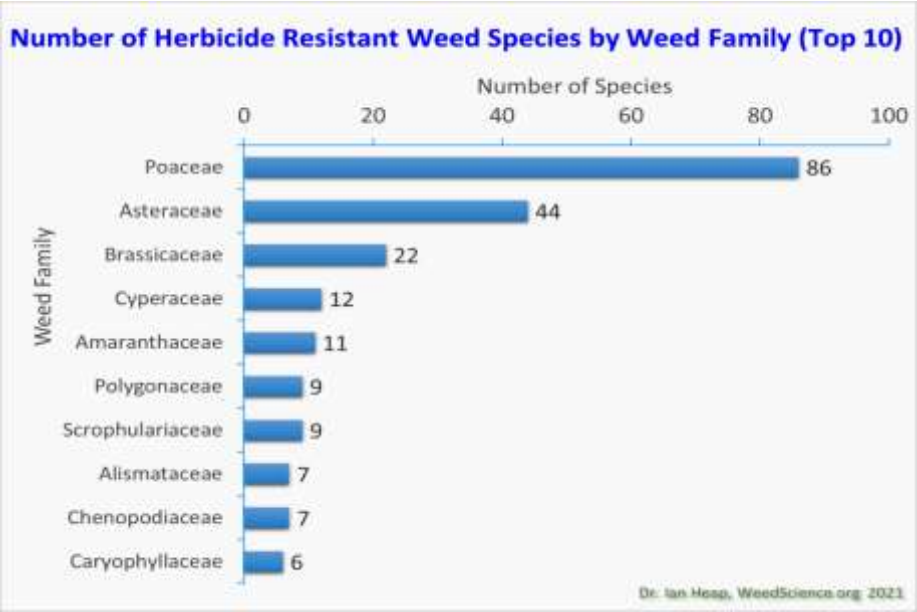
DEFINITION

Herbicide-Resistant Plants Committee proposed the following definition of herbicide resistance, "Herbicide resistance is the inherited ability of a plant/biotype to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type". About 250 weed species have been confirmed to be resistant to at least one herbicide mode or site of action around the world. In a growing number of situations herbicide-resistant weeds limit crop production.

RESISTANCE AFFECTS EVERY SECTOR OF THE AGRICULTURE INDUSTRY

The growing incidents of weeds developing resistance to herbicides is a critically important issue for all stakeholders of the field crop agriculture sector including farmers, crop production advisors, researchers, pesticide product regulatory authorities, the crop





protection and seed industry members. Once in a field, herbicide resistance can remain at a relatively high frequency because it declines at a slower rate than it evolves. Herbicide resistance is one of the primary issues threatening sustainable agricultural systems globally. Herbicide resistance increases the complexity and often the cost of weed management programs. Herbicides provide effective, reliable and economical weed control for broad-acre agriculture and their utility and longevity must be preserved. The fear that farmers may end up with few or no herbicides that control weeds resistant to multiple herbicide modes or sites of action is becoming a reality.

HERBICIDE RESISTANCE BEST MANAGEMENT PRACTICES

Increasing the diversity of chemical and non-chemical weed management practices used in crop management programs will slow herbicide resistance development and reduce the adverse impacts of herbicide resistance on crop production systems. The prevention of resistance occurring is an easier and cheaper option than managing a confirmed resistance situation. Simply changing herbicides is not enough to overcome resistance, integrated system needs to be developed like Integrated Weed Management. The following are the three key areas of weed management.

Rotation of Crops

The principle of crop rotation as a resistance management tool is to avoid successive crops in the same field which require herbicides with the same site of action for control of the same weed species. Crop rotation allows rotation of herbicides having a different site of action. The growth season of the weed can be avoided or disrupted by sowing crops at differing sowing times and different seedbed preparation and they also differ in their inherent competitiveness against weeds.

Cultural techniques

Cultural (or non-chemical) weed control methods do not exert a chemical selection pressure and assist greatly in reducing the soil seed bank. Some of the cultural measures include ploughing prior to sowing to control emerged plants, delaying planting, using certified crop seed free of weed, post-harvest grazing and stubble burning.

Herbicide rotation and herbicide mixtures

When planning a weed control program, products should be chosen from different site of action groups to control the same weed either in successive applications or in mixtures. Avoid continued use of the same herbicides having the same site of action, limit the number of applications of a single herbicide having the same site of action, use mixtures or sequential treatments of herbicides having a different site of action and use non-selective herbicides to control early flushes of weeds

The Use of Chemical Mixtures to Prevent Resistance

Mixtures can be a useful tool in managing or preventing the establishment of resistant weeds. For chemical mixtures to be effective, they should include active ingredients which both give high levels of control of the target weed and include active ingredients from different site of action

CONCLUSION

For future, the entire agri-industry is to develop frameworks that enable early detection of resistance on farms and to develop and implement alternative strategies that extend the useful life of herbicides and enable farm profitability to be maintained.

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DYNAMICS OF BLACK GRAM CULTIVATION

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Black gram [*Vigna mungo* (L.) Hepper] is a widely grown short duration grain legume assuming considerable importance from the point of food and nutritional security in the world. Among the various pulse crops grown in India, black gram [*Vigna mungo* (L.) Hepper] holds the third most important position right after chickpea and pigeon pea. It is popularly known as urdbean and mashbean in different tracts of the country. It belongs to the family fabaceae and sub family papilionaceae under which it has been categorized to the genus *Vigna* with chromosomes number 2n=24. The farmers of Eastern India mostly keep their lands fallow after the harvest of summer rice during spring-summer. Inclusion of summer pulse crops like green gram and black gram in this cropping sequence may be a fantastic way out to sustain the fertility status of the soil along with some economic harvests at the end of the season. Endowed with a unique capability of symbiotic nitrogen fixation, the crop has an excellent capacity to maintain soil fertility. Black gram seeds are excellent source of protein, carbohydrate, fat, fibre, vitamin and minerals. In 2020-21, black gram crop was cultivated in 24.5 lakh ha area with a production of 4.6 million tonnes and productivity of 533 kg ha^{-1} respectively in our country.

STATUS OF BLACKGRAM CULTIVATION IN INDIA

Black gram is an annual legume, native to India and is grown preferably during kharif season under rainfed situation. It is also cultivated in rabi and spring-summer as well. In fact, the crop has an accomplishment of higher yield potential particularly during spring-summer season. In general, black gram is a crop of warm weather preferably grown under an optimum temperature range lying between 25-32°C with an annual rainfall amounting about 600 to 1000 mm. Black gram has been reported to contribute around 13% in total pulse growing area and about 11% in total production of pulse crops cultivated in India. Its cultivation is normally practised in the states including Andhra Pradesh, Madhya Pradesh, Karnataka, Bihar, West Bengal, Maharashtra, Uttar Pradesh, Punjab and Haryana.

NUTRITIONAL ASPECTS

Black gram is very much popular for its use as seed for culinary purposes in human diet by virtue of the higher nutritive values and excellent digestibility since ancient times. Because of this fact, black gram has been regarded as one of the highly remunerated pulse crops. Black gram seeds are almost three times richer in quality protein than that of cereals, containing about 26.2% crude protein. Besides, the seeds are also consisted of 56.6 % carbohydrate, 1.2 % fat, 185 mg Ca (per 100 g seeds), 8.7 mg Fe (per 100 g seeds), 345 mg P (per 100 g seeds) and vitamins in terms of retinol (A), thiamine (B_1), riboflavin (B_2), niacin (B_3), ascorbic acid (C) etc with higher calorific values to the tune of 347 calories per 100 g of seeds. Dry seeds are one of the good sources of phosphorus. About 78% to 80% nitrogen in black gram seed has been found as albumin and globulin.

Black gram is extensively used in different culinary preparations. Green pods of black gram are considered as a highly nutritious vegetable. Seeds can be consumed after boiling or after frying. They are also used as dal after splitting the cotyledons. Crushed seeds are used as flour to prepare curries, porridge, sweets, snacks or bread and biscuits in bakeries. Popular south Indian food items like dosa and idly are prepared by mixing the flours from rice grains and black gram seeds. Notably, the black gram seeds

possess several types of medicinal properties regarding curing diabetes, nervous disorders, digestive system disfunctions, rheumatic afflictions and hair related disorders. Also, both the hull (outer covering of seed) and stover are used as nutritive feed for cattle.

PRODUCTION CONSTRAINTS

However, black gram production has been found to be adversely affected by a number of environmental factors, especially abiotic stresses like excess soil moisture in autumn season, lack of soil moisture during spring-summer and winter seasons, heat stress during pod filling stage etc. leading to a huge yield-gap. Besides, black gram cultivation is generally carried out in soils of marginal and submarginal lands with poor crop management practices under rainfed situation. Because of this fact, a stagnant yield potential of black gram crop has been observed. Besides, this crop suffers with several physiological drawbacks like inappropriate canopy structure, photo-thermo sensitivity, imbalanced partitioning of photo-assimilates and lower photosynthesizing capacity, premature flower and pod abscission, poor pod set etc. On the top of this, various diseases and pest infestations give rise to drastic loss of seed yield of black gram.

STRATEGIES TO MAGNIFY PRODUCTION

To boost up black gram production by means of overcoming its physiological setbacks as well as agroclimatic barriers, a number of agronomic innovations may be adopted. They are-

- Implementation of appropriate sowing techniques like line sowing and drilling method.
- Provision of need based irrigation (one pre-sowing and atleast one to three more during stand establishment if possible).
- Proper weed managements in the initial stages.
- Adoption of seed priming to improve seed germination characteristics.
- *Rhizobium* seed inoculation for better biological nitrogen fixation.
- Application of phosphorus solubilizing bacteria (PSB) for proper phosphorus nutrition due to higher requirements of P in case of black gram as being a legume crop.
- Provision of balanced nutrition through soil application of recommended dose of fertilizer.
- Implementation of foliar feeding to improve the physiological efficiency including the photosynthetic ability regardless of the soil conditions.
- Integrated nutrient management by amalgamating organic and inorganic nutrition.
- Precision nutrient management based on soil test crop response (STCR) approaches enhance productivity with substantial economization of the inputs used.
- Adoption of integrated pest management.

CONCLUSION AND WAY FORWARD

Black gram crop holds a very promising position to substantially contribute to the global food security in the 21st century as a nutritional resource particularly in the tropics and subtropics. Sowing of black gram crop in optimum time may be of prime importance for proper harmony between its vegetative and reproductive phases, eventually determining the optimum yield potential of the crop. Additionally, modern agronomic interventions like micronutrients seed priming and foliar nutrition in collaboration with recommended dose of fertilizers may be fantastic way outs to improvise physiological efficiency of legume crops like black gram including the photosynthetic ability irrespective of soil conditions leading to productivity enhancement.

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HIGHER RETURNS

THROUGH SUMMER CULTIVATION OF SESAME VARIETY (JCS 1020)

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Sesamum crop is grown as summer crop in Turmeric, Paddy and cotton fallows in Northern Telangana Region. Short duration, less cost of cultivation, less pest incidence and suitability to most of the types of soils and remunerative market price are the factors favoring the farmers to cultivate the Sesamum crop in larger area.

The farmer is earning an additional income of Rs. 17, 600/- through the cultivation of sesame variety JCS 1020 compared to local variety.

Apart from these farmers get more yield with organic cultivation of sesame. In this context, various awareness programmes, seed distribution, exposure visits, demonstrations and field days have been conducted on popularization of HYV Sesame variety JCS 1020 in the adopted village, Veldurthi of the Regional Agricultural Research Station, Polasa, Jagtial. As a result the farmers cultivated the variety JCS 1020 in an area of 40 acres in summer, 2021. Later, after achieving an yield improvement of 1 to 1.5 q/acre i.e before introduction of the variety the farmers got an yield of 3.5 to 4 q., after the introduction of the variety JCS 1020, farmers got an yield of 5 to 5.5 q. with less cost of cultivation, by this way the farmer obtained yield of 5.5q/acre, with a gross return of 66,000/- and net income of 56, 300/-. Later the farmers have undertaken large scale cultivation of Sesame High yielding, white seeded, variety JCS 1020 in 80 acres in turmeric fallows and getting higher yields at adopted village, Veldurthi of RARS, Jagtial.

The farmers of adopted village visited cold pressed oil extraction unit at Regional Agricultural Research Station, Jagtial and motivated by the sesame oil extraction. Apart from increased returns, the farmers are now consuming the healthy and nutritious sesame oil by value addition. In this context, there was large scale varietal shift with higher returns to the farmer was noticed with sesame variety JCS 1020 cultivated in turmeric fallows in the village.

Challenges addressed

Farmers are facing the problem of low yields and pest and disease infestation with local varieties. Hence, the new HYV sesame variety JCS 1020 was introduced to addresses the problem.

Features of the Sesame variety JCS 1020:

- White seeded.
- Moderately Resistant to powdery mildew and Alternaria leaf spot.
- Suitable for late sown conditions.
- Duration is 90-95 days.
- Recommended for summer season.

- Seed yield of 947 to 1032 kg/ha.
- Oil content is 46-49%.

Benefit and Impact

The farmer, Sri Ramakishan, adopted village, Veldurthi is cultivating Sesame variety JCS 1020 in turmeric fallows. The farmer has sown the variety in second fortnight of January. He used seed rate of 3 kg/acre and broadcasted the seed after mixing in sand. As the farmer applied more fertilizer to Turmeric, he cultivated sesame without application of fertilizer. He only applied urea @ 20 kg at the time of flowering. The crop is also free from pest and diseases. For control of sucking pest, he has sprayed Acephate1.5g/L of water. He had Irrigated the crop 10 times upto the end of the crop. By this way the farmer obtained yield of 5.5q/acre, with a gross return of 66,000/- and net income of 56, 300/-.

The farmer is earning an additional income of Rs.17, 600/- through the cultivation of sesame variety JCS 1020 compared to local variety.

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Cost of cultivation and returns as per the farmer

S.No	Operation	Cost incurred /acre (Rs.)	
		JCS 1020	**Local variety**
	The farmer cultivated JCS 1020 in summer, 2021		
1	Land preparation	3000	3000
2	Seed cost	600	0.00
3	Weeding	1600	1600
4	Plant Protection	600	800
5	Fertilizers	300	300
6	Harvesting	2400	2400
7	Threshing	800	800
8	Transport	400	400
9	Cost of cultivation	9700	9300
10	**Yield (Q)**	**5.5**	**4.0**
11	Market price (per q.)	12,000	12,000
12	Gross returns	66,000	48,000
13	**Net returns**	**56,300**	**38,700**

CONSERVATION TILLAGE TECHNOLOGIES FOR SUSTAINABLE AGRICULTURE

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Conservation agriculture (CA) defined as minimal soil disturbance (no-till) and permanent soil cover (mulch) combined with rotations, as a more sustainable cultivation system for the future. It's agricultural management system that is gaining popularity in many parts of the world. Cultivation and tillage play an important role in agriculture. CA is a more sustainable and environmentally friendly management system for cultivating crops.

Or

Conservation tillage is a system that optimally utilized agroecosystems to achieve food security and enhance productivity while at the same time maintaining and improving the environment and natural resource base. Conservation tillage (CT) is also defined as the process of mulching for land preparation before planting increase the coarseness of the topsoil. Conservation Tillage is any tillage and planting system that covers 30 % or more of the soil surface with crop residue, after planting, to prevent water erosion. Conservation tillage technologies are useful for erosion control, soil health, farm efficiency, crop productivity, and profitability.

"Conservation tillage as the gateway to sustainable development"

Key Points

- Conservation tillage technologies have been increasingly adopted by growers to reduce soil erosion, maintain soil fertility and soil organic matter (SOM), and improve sustainability of dryland cropping systems.
- Adoption of conservation tillage systems is dependent on considerations such as agroecological class, soil fertility management, crop rotations, residue management, equipment, support systems, and economics.

Types of conservation tillage

There are several types of conservation tillage:

- **No Tillage:** No tillage is a land management system in which the only disturbance done to the soil cover which is done during seed planting. The topsoil is not affected by this tillage system because only minimal disturbance is allowed. It involves letting crop residues to cover the topsoil and mulch to boost soil productivity.
- **Reduced Tillage / Minimum Tillage:** Reduced tillage involves the use of primary tillage equipment such as ploughs.
- **Mulch Tillage:** Mulch tillage is a crop residue-covering system that allows crop residues to cover a large portion of the land assigned to crop production.
- **Ridge Tillage:** The soil is left undisturbed from harvest to planting, except for nutrient injection. Sweeps, disc openers, coulters, and row cleaners are used to prepare a seedbed on ridges for planting. Residue is left on the surface between ridges. Weed control is accomplished with herbicides, cultivation, or both. During cultivation ridges are rebuilt.
- **Conventional Tillage:** Tillage types that leave less than 15% residue cover after planting critical wind erosion period includes plowing or other intensive tillage

Table 1. Conservation Tillage (CT) for various parameters and issues

Parameters / Issues	Conservation Tillage (CT)
Tillage operation	Minimum soil disturbance
Crop residue	Leaves more than 30% on surface
Soil Temperature	Surface soil temperature- Intermediate in variability
Soil organic matter	Build-up or Increase SOM sequestration possible in surface soil layers
Greenhouse gas emission	Reduce greenhouse gas emission ex: CO_2
Erosion	Reduce soil loss from wind, water and soil erosion
Soil physical health compaction	Improved reduced tillage is used to reduce compaction
Soil biological health	Moderately better soil health
Soil water storage	Increase infiltration and reduce evaporation
Water body pollution	Minimum water body pollution with sediment load and field-applied chemicals
Water infiltration	Good water infiltration
Aggregate stability	Increase soil aggregate stability
Labour, fuel, costs of production and timeliness	Low labour cost, low fuel use and intermediate cost of production and timeliness of operations
Tillage equipment	Direct seed drills costlier than conventional drills
Weed control	Reduced tillage controls weeds and reliance on herbicide during fallow
Crop management	evolving new crop management strategies
Germination	Slower germination potential
Fertilizer	May initially require more nitrogen
Yield	Can be lower where planting delayed

operations. Herbicides, cultivation, or both are used to control weeds.

Conclusions

The conservation tillage technologies that use specific technical equipment to provide scientific proof of the benefits of soil and water conservation, to reduces run-off, to minimize or prevent soil degradation and disturbance, to restore the soil productivity, encourages build-up of organic matter promoting greater aggregate stability which restricts soil erosion, improved chemical, physical and biological soil conditions, increases biodiversity, to produce more food on less land by making more efficient use of natural resources and with minimal impact on the environment, to stabilize crop yield level, reduced labor and tractor hours, lower machinery costs, and higher economic returns can guarantee a steady growth of conservation tillage. Conservative tillage technologies with direct sowing or minimal tillage, using equipment with working bodies adapted to the climatic and soil conditions specific to the regions with heavy, medium and light soils.

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BUZZ POLLINATION

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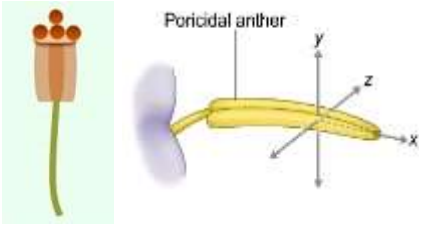
Buzz pollination is the pollination service in which bees especially bumble bees gather pollen grains from flower anthers by vibrating their bodies and transferring them to the stigma in the process allowing fertilization even in some incompatible flowers. Due to the characteristic sound produced during the vibrations, this buzzing behaviour of some bees to harvest pollen has been termed "Floral Sonication." Flowers with buzz-specialized morphology can be found in over 20,000 species of flowering plants, including commercially important crops like tomato, potato, kiwi and many more. Flower buzzing by pollinators has been reported in 74 genera, accounting for around 58 percent of bee species. The attributes of both bee flora (floral structures) and fauna (insect anatomy, physiology and behavior) become vital in determining the ecological and evolutionary consequences of this relationship between flowers and their visiting pollinators when interacting closely.

How does bees produce floral vibrations?

When buzzing a flower, a bee grabs the anthers or other floral structures and uses its thoracic muscles to produce vibrations while keeping its wings in neopterous condition. These vibrations deposit pollens on the bee's body, which it grooms into place before returning to the nest. Bees employ their flight muscles to produce floral vibrations, notably the dorsal longitudinal and dorso-ventral muscles, which are attached to interior of the thorax and give flight strength. The rate at which these muscles contract differs from the rate at which they receive brain impulses, indicating that they are asynchronous. Brain impulses can be used by some insects with stretch-activated muscles to adjust the overall power generated. The self-perpetuating cycle of muscular contractions in buzz pollination, on the other hand, allows for a far greater frequency of vibrations than would be possible without stretch activation of muscles. The frequency of floral vibrations can exceed 300 Hz (hertz-cycles per second), with some species even reaching 400 Hz. The vibrations produced by buzz pollination differ slightly from those produced by flight. The features of floral vibrations are thus influenced by both the bees' neurological system and the body's biomechanics.

Plants pollinated by buzz pollination

Bees buzz around flowers with a variety of floral morphologies. Pollen is hidden inside anthers that open only through microscopic pores or slits at their tip (called as poricidal anthers) in the vast majority of buzz pollinated flowers. These species' anthers are enormous vividly colored, and clearly shown to



approaching visitors. Since their anthers are large and cannot be transferred by regular pollinators, the power of buzz pollination has been employed by the nature to pollinate such flowers. The petals often reflex away from the anthers, which create a cone at the center of the flower in some cases.

The following plants are pollinated more efficiently by buzz pollination especially under greenhouse conditions:

- All *Dodecatheon* (shooting stars)
- *Heliamphora*
- Many members of Solanaceae family (e.g., tomato and eggplant)
- *Hibbertia*
- *Dianella* (flax lilies)
- Many members of Ericaceae
- *Arctostaphylos*
- Some Fabaceae plants like *Senna*
- Some members of genus *Rhododendron*, *Vaccinium* (blueberries, cranberries)

***Senna*'s** poricidal anthers

Buzz pollinating bee species

Only around half of the bee species, including huge carpenter bees and tiny sweat bees, can buzz pollinate flowers. Bumble bees and carpenter bees can emit buzzes with enough acceleration to release pollen

from poricidal anthers, while honeybees (*Apis mellifera)* are unable to do so.

Some buzz pollinating species are as follows -

- *Bombus terrestris*
- *Xylocopa frontalis*
- *Euglossa sp.*
- *Melipona sp.*
- *Protandrena sp.* etc.

Bumble bee buzz pollination

Types of bee vibrations

In the end, all vibrations created by bees can be traced back to the contraction of the energy-draining indirect flight muscles. Bee buzzes are divided into three categories:

(i) thermogenic activity, which produces heat with little or no thoracic oscillations

(ii) thoracic oscillations, which drive wingbeat and enable bees' flight

(iii) non-flight vibrations, which produce air- or substrate-borne vibrations and are associated with communication, defence, and vibratile pollen collection.

Effect of buzz properties on pollen release

The frequency, pitch, length and amplitude of floral vibrations are all different. These characteristics influence the amount of pollen released during buzz pollination. High velocity and high acceleration buzzes favor more pollen discharge during floral vibrations. Buff-tailed bumble bees, *Bombus terrestris* create floral vibrations with higher velocities and accelerations than vibrations produced during flight or defence. Furthermore, the amount of pollen released by a particular buzz can vary over time. When buzzed at frequencies similar to those employed by bees (less than 400 Hz), older virgin *Primula conjugens* (Primulaceae) blooms produce more pollen than younger virgin blossoms. Buzz pollination is a hot subject to explore the mechanical ecology of plant insect interaction because of the ecological connection between plants and bees through their biomechanics and behavior.

Conclusion

Buzz pollination refers to the emergence of specific flower morphologies and pollinator behaviour in which bees use vibrations to harvest pollen (floral buzzes). Thousands of flowering plants, including agriculturally important crops like tomatoes and potatoes, have evolved buzz pollination. The dependency of many plant species on buzz-pollinating bees makes the current drop in the bees' populations around the world alarming. Buzz pollination offers an amazing field for exploring how biomechanical, physiological, behavioral, and ecological aspects of both bee flora and fauna combine to produce an evolutionarily widespread and ecologically significant mutual relationship between flowers and pollinators.

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GENOME EDITING

TOOLS IN PLANT DISEASE MANAGEMENT

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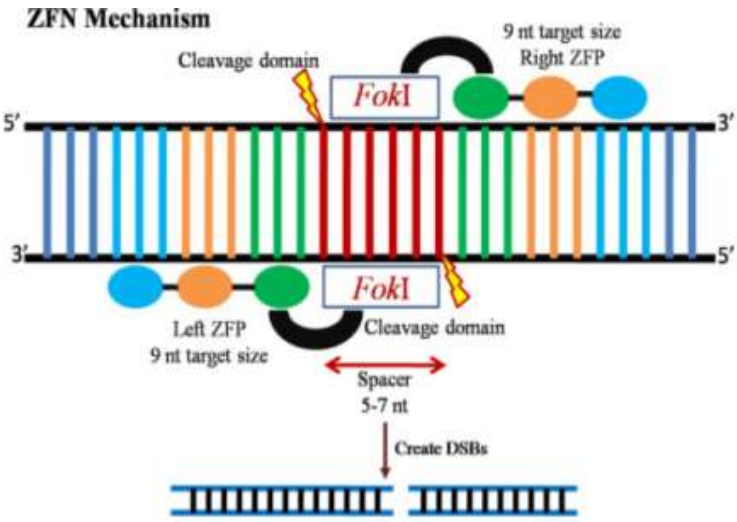
Plant diseases are a threat to world agriculture and general food security. Significant yield losses due to the attack of pathogen occur in most of the agricultural and horticultural crop species. Several biotechnological tools and approaches have been employed to overcome the hazardous effects of disease and pest in crop plants. Genome editing is a group of technologies that has the ability to change the DNA of an organism. These techniques allow genetic material to be added, removed, or altered at particular locations in the genome of the organism and thus alter DNA sequences and modify gene function. Genome modification of different types can be achieved through TALEN, CRISPR and ZFN. Through these, several modifications can be created such as new gene insertion in specific locations, substitution of gene fragments, point mutations and deletion of large regions of the nucleotide sequences.

Genome editing technologies

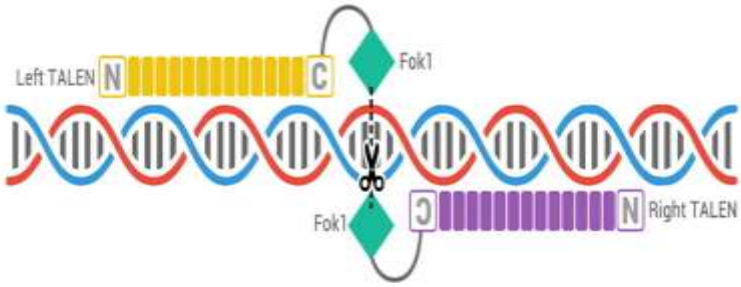
1. Zinc Finger Nucleases (ZFN)

These are the fusion proteins consisting of zinc finger domains obtained from transcription factors attached to the endonuclease domain from the bacterial Fok I restriction enzyme. The Zinc finger domains target the specific desired DNA sequences which enables the ZFNs to target unique sequences within a complex genomes. Each zinc finger domain recognizes a 3- base pair DNA sequence, and tandem domains can potentially bind to an extended nucleotide sequence that is unique to a genome. Three ZF motifs are believed to be the minimum for effective cleavage in genome and to achieve the adequate specificity and affinity.



2. Transcription activator like effector nucleases (TALENs)

It was developed in 2010 by Dr. Voytas. It comprise of a non-specific Fok I nuclease domain fused to a customizable DNA-binding domain. The DNA-binding domain is composed of highly conserved repeats derived from transcription activator-like effectors (TALEs), which are proteins secreted by *Xanthomonas* bacteria to alter transcription of genes in host plant cells. The bacteria were found to secrete effector proteins (TALEs) to the cytoplasm of plant cells, then they enter the nucleus, bind to effector-specific promoter sequences, and activate the expression of individual plant genes, which can either benefit the bacterium or trigger host defences.



3. CRISPR/ Cas 9 System

CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) is a family of DNA sequences found in the genome of the prokaryotes. Cas9 is an enzyme that uses CRISPR sequences as a guide to recognize and cleave specific strands of DNA that are complementary to the CRISPR sequence. CRISPR-Cas9 was adapted from a naturally occurring genome editing system in bacteria. The bacteria capture snippets of DNA from invading viruses and use them to create DNA segments known as CRISPR arrays. The CRISPR arrays allow the bacteria to remember the viruses (or closely related ones). If the viruses attack again, the bacteria produce RNA segments from the CRISPR arrays to target the DNA of viruses. The bacteria then use Cas9 or a similar enzyme to cut the DNA apart, which disables the virus.

Examples of genome editing technologies in plant disease management

Plant	Nuclease type	Targeted gene	Pathogen
Tobacco	ZFN	Rep gene	*Tobacco curly shoot virus, Tomato yellow leaf curl china virus*
Barley	TALEN	Mlo	*Blumeria graminis* f. sp. *tritici*
Tomato	CRISPR	SIDMR6-1/S1JAZ2	*Pseudomonas syringe and P. capasci*
Wheat	CRISPR/Cas 9	Taedr1	*Blumeria graminis* f. sp. *tritici*
Arabidopsis	CRISPR	EDR1	*Erysiphe cichoracearum*

Conclusion

An increasing consciousness about environmental pollution and health hazards due to fungicides and development of disease resistance in pathogen population has challenged the plant pathologists to search eco-friendly tools which are economical, eco-friendly and requires less time in development compared to conventional breeding techniques. Genome editing technology has proven itself as viable technology for disease management.

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PHALSA FRUIT BREEDING

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Phalsa is a bushy plant that may thrive in a variety of soil and climatic conditions. This plant can withstand temperatures as low as 45ºC for a few days. It bears a large number of little reddish brown fruits. Gujarat, Haryana, Punjab, Rajasthan, Uttar Pradesh, Madhya Pradesh, Maharashtra, Bihar, West Bengal, and Andhra Pradesh are among the states where it is commercially grown. The phalsa is found throughout large parts of India and Southeast Asia. Phalsa is a native of India, most probably in the Gujarat city of Vadodara.

Composition and uses

The air dried phalsa seed contains 7.2 % oil, rich in linoleic acid (51.7 % w/w) and also contains small amounts of heptadecanoic, palmitoleic, arachidic acids and linolenic. Sucrose and fructose was present in both tall and dwarf types, whereas glucose was present only in the fruits of tall type.

The phalsa fruit has a cooling effect. The unripe phalsa fruits are used to treat inflammation as well as respiratory, cardiac, and blood diseases. The leaves are used to treat skin outbreaks and contain antibacterial properties. Ropes are made from the bark of the phalsa tree. Its wood is utilized for archer's bows, shingles, spear handles, and poles because it is fine grained, robust, and flexible. Its stems are used to make both garden poles and baskets. Juices and candies can be made from fruit. In India, ripe phalsa fruits are eaten fresh in sweets or processed into delightful fruit and soft beverages throughout the summer.

Centers of origin

Phalsa is native to India, probably Vadodara in Gujarat. It is widely cultivated, in tropical and subtropical India. It is mostly propagated through seed therefore, a lot of variability of phalsa exist in central India, Rajasthan, Bihar, and drier parts of South India.

Floral biology

Plants are small trees with alternating, simple and serrated leaves and inflorescence is cymose. Flowers are bisexual, actinomorphic, and have a hypogynous ovary. The sepals are five, cornate, and velvety at the base. Petals are five in number and range in colour from light yellow to greenish yellow. The stamens are numerous, free, and the anthers are two-celled, with longitudinal dehiscence. Bicarpillary, syncarpus, and superior ovary. Insects are responsible for pollination. Anthesis begins around 6 a.m. and lasts until 15 a.m., with a peak at 10 a.m. The formation of a crack in the sepals at the base of the bud is the first sign of anthesis. The dehiscence of anthers occurs before the flowers are fully open. Pollen of Phalsa has a high viability. When compared to self-pollinated plants (23.00 per cent), open pollinated plants had a greater fruit set (61.60 per cent). The tall phalsa with open pollination produced the most fruit (66.70 per cent). *Apis florea*, *A. dorsata*, *Megachile bicolor*, *Apis mellifera* and *Chalicodoma cephalotes* were among the insect pollinators observed feeding on both nectar and pollen, whereas others foraged on nectar only.

Fig. 2 Phalsa flower

Fig. 1 Phalsa Fruits

Breeding objective

- To develop high yielding varieties with good blend of acid and sugar.
- To develop the cultivars with uniform ripening and good keeping quality.
- To develop biotic and abiotic stresses resistant cultivars.

Problems in breeding

Because of self-pollination, there is little variation within the species. In phalsa only two varieties reported: tall and dwarf. The breeding process was also hindered because of small and tiny flowers and unsynchronized flowering.

Different species

Phalsa (*Grewia subinequalis*) belongs to order malvales and family Tiliaceae which includes 18 genera and 350 species. The genera Grewia has about 140 species, out of which 40 species occur in India. However, *Grewia subinequalis* is of commercial importance.

1. *Grewia subinequalis*

The phalsa is a large shrub or small tree that develops to a height of 4.5 m or more. It has long, thin, drooping branches with thickly covered juvenile branchlets. Fruit skin changes colour from green to purplish red to dark purple or nearly black.

2. *Grewia tenax* (Frosk.)

It is known as White Cross berry and Phalsa Cherry is an example of multipurpose plant species which is the source of food, fodder, fiber, fuel wood, timber and a range of traditional medicines that cure various perilous diseases and have mild antibiotic properties. *G. tenax* is a common plant species that grows all year in a semi desert environment and might be useful as a feed source for honeybees. Bees and other insects visit the flowers in search of pollen and nectar, making the plant suitable for apiculture. Other species which are found in drier parts of tropical Africa are *G. flavescens, G. villosa, G.bocolour, G. ferruginea, G. louisii, G. monticola, G. plagiophylla, G. pinnatifida* and *G. microthyrsa*.

Crop improvement methods

1. Introduction

Phalsa germplasm was obtained from all across the country. They include the states of Rajasthan, Haryana, Gujarat, Maharashtra, and Andhra Pradesh. Phalsa germplasm is being maintained at the Jodhpur Field Gene Station. NBPGR in New Delhi has been conducting basic research on seed physiology and storage.

2. Selection

Not much attention has been given for the improvement of phalsa. In Phalsa, there are no unique cultivars are available. Haryana Agriculture University, Hissar, identified two unique varieties, tall and dwarf. Plant height, fruit output, and other morphological factors like as leaf size, fruit size, and fruit weight change between these two varieties. These two types did not show any remarkable variation in their fruit weight, edible portion, seed weight and juice yield.

2.1. Tall type

The fruits produced by the tall growing wild phalsa plants are of poor quality and not enjoyed by most customers. The fruit production per plant is around 5.2 kg. TSS is 14 %, acidity is 4.64 %, juice is 5.4 %, Pulp is 81.5 %, and the fruit weighs 0.478 gm and has a diameter of 2.07 cm. Plant height is 4.5m, with a bright green bottom leaf surface.

2.2. Dwarf type

The low growing dwarf type of phalsa plants which develop a good blend of sugar and acid in the fruit flesh are preferred for cultivation. The fruit production per plant is around 3.5 kg. The dwarf variety is extremely productive and widely cultivated. Dwarf-type fruits have a calorie value of 72/100g and include 60-70 % juice, 23 % citric acid, and 18-20 % TSS, 30-40 mg/100g vitamin C, 700-750IU vitamin A and 0.4-0.6 % minerals. Plant height is 3.4m, with a greenish white bottom leaf surface.

Future thrust

Phalsa fruit has a short shelf life and is considered suitable only for local marketing. So, emphasis may be given on selecting phalsa genotypes for bold fruit type having improved shelf life. Thrust may also be given for synchronous flowering types so that labour cost in fruit pickings could be reduced. It has a limited genetic basis that can be expanded by mutagenesis, interspecific hybridization, and the selection of bud mutants or somaclonal variations. Because phalsa fruits have a high therapeutic value due to their low glycemic index and anticancer capabilities, varieties with better medicinal features should be preferred.

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SPEED BREEDING

A TOOL TO ACCELERATE PLANT BREEDING

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The world population is growing rapidly over the last several years and is expected to reach 9.9 billion by 2050. The demand for food, feed and fibre is also expected to grow by 70 percent. This perspective for 2050 raises questions on global food security. Conventional breeding methods will not be sufficient to meet the demands of future generations, so breeders and cultivators are under constant pressure to improve crop production and develop new varieties of crop that are of higher quality and yield higher yields that should be of superior quality in every respect, such as nutritional values, disease resistance, and climatic changes. So there is a need to advance the crop generation in a short duration of time to achieve the growing demand.

Speed breeding is a combination of techniques that involves manipulating the environmental conditions in which crop genotypes are produced with the goal of speeding up flowering and seed development in order to move on to the next breeding generation as soon as possible. Through quick generation development, the approach saves time and resources in the breeding process. Speed breeding results in ~3 to 9 generations per year as compared to 1 to 2 generations per year achieved with conventional selection approaches. As a result, speed breeding leads to faster production of homozygous and stable genotypes, resulting in accelerated development and release of new varieties. In addition, for multiple trait selection, speed breeding technology works well with MAS and high-throughput phenotyping approaches.

Speed breeding setup

The core recipe for programming an existing growth room to set up speed breeding conditions involves light, photoperiod, temperature and humidity. SB can be used with any light that generates a spectrum that reasonably covers the PAR region (400–700 nm), with a focus on the blue, red, and far-red regions. LEDs, or a combination of LEDs and other lighting sources (e.g., halogen lamps), or, in the case of a glasshouse, simply supplementing the ambient illumination with LEDs or SVLs, can provide an appropriate spectral range. In a 24-hour diurnal cycle, the photoperiod of 22 hours with 2 hours of darkness is required. For each crop, the best temperature regime (maximum and minimum temperatures) should be used. During the photoperiod, a greater temperature should be maintained, however a drop in temperature during the dark period can help with stress recovery. A 12-hour 22°C/17°C temperature cycling regime with 2 hours of darkness within 12 hours of 17°C has proven to be effective. Humidity control is limited in most controlled-environment chambers, but a range of 60-70 percent is optimum. A lower humidity level may be preferable for crops that are more acclimated to dry circumstances.

Applications of SB in research

The development of biparental and more complex mapping populations, pyramiding traits, hastening backcrosses, phenotyping adult plant attributes, mutant studies, and genetic transformation experiments are all examples of SB applications. Recent research has

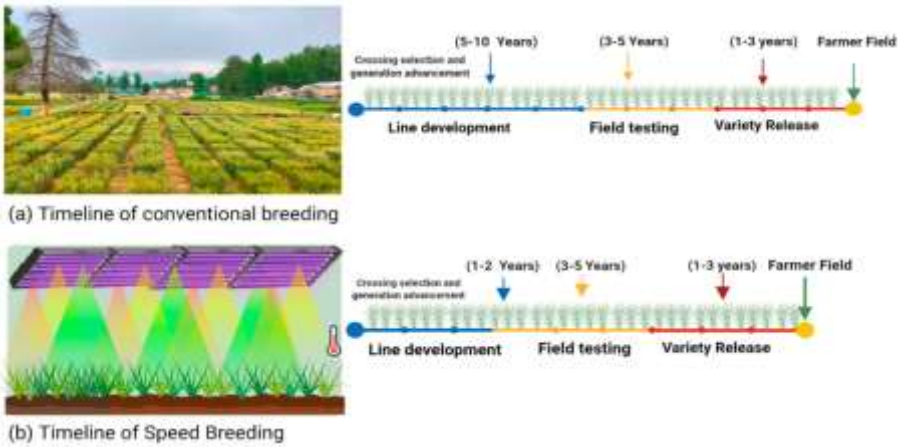

Fig 1. Timelines of varietal development with (a) conventional breeding and (b) speed breeding

demonstrated the value of combining modern techniques with SB for crop improvement, including as gene editing, high-throughput phenotyping and genotyping, genomic selection, and MAS. Genomic selection along with speed breeding is used to achieve more genetic gain per breeding cycle and per year as compared to conventional phenotypic selection. SB aids in the resolution of problems connected with double haploid (DH) technology, such as low germination rates, weak vigour, and even distorted development. Similarly, SSD can advance and evaluate segregating generations in a short period of time under SB conditions, which saves time and money as compared to conventional pedigree breeding method. This method was successful in decreasing the generation period, resulting in a three-fold increase in generation turnover when compared to shuttle breeding (Table1).

Challenges and limitations

Speed breeding techniques are a helpful tool for accelerating conventional breeding programs. But it requires expertise, effective and complementary plant phenomics facilities, suitable infrastructure, and ongoing financial support for research and development. A lack of trained and active plant breeders, and plant breeding technicians in developing countries is a major challenge in adoption of speed breeding. Speed breeding requires sophisticated infrastructure to regulate environmental factors like soil moisture, temperature and photoperiod. Unreliable supplies of water and electricity are a major problem for the management of temperature and photoperiod for speed breeding. Apart from these, different speed breeding protocols are required for every crop which requires more expertise and time. Excessive photoperiod can limit plant growth and may lead to photo-oxidation, high level of starch production, and elevated levels of stress hormones. As well as, harvesting of immature seed may interfere with the phenotyping of seed traits.

Table1. Techniques for rapid generation advancement with corresponding days to flowering, number of generations achieved per year and selection methods used in different crops.

Crop	Techniques	Days to flowering	No. of generation/year	Selection method
Arabidopsis thaliana	Plant hormones, immature seed germination and photoperiod	20-26	10	-
Barley	Photoperiod, temperature, soil fertility, immature seed germination and embryo rescue	24-36	9	SSD
Canola	Photoperiod, light intensity, temperature, immature seed germination and soil moisture	73	4	SSD
Chickpea	Photoperiod and immature seed germination	33	7	SPD
Groundnut	Photoperiod and temperature	25-27	3	SPD
Soybean	Photoperiod, temperature and immature seed germination	23	5	SSD
Wheat	Photoperiod, temperature, soil fertility, immature seed germination and embryo rescue	28-41	7.6	SSD

Conclusion

Speed breeding is considered as the elite breeding strategy for achieving genetic gain targets for food and fodder security in a short period of time. Speed breeding can accelerate the development of high performing varieties with market-preferred traits by reducing the amount of time, space and resources required in the selection and genetic advancement of superior crop varieties. This allows plant breeders to develop improved crop varieties more rapidly. Furthermore, combining speed breeding with conventional, MAS and GE breeding approaches can enhance effective selection of elite genotypes and lines with novel traits. However, the adoption of speed breeding is limited by the lack of trained plant breeders and plant breeding technicians, and a lack of the requisite infrastructure and reliable supplies of water and electricity. There is also a lack of organizational and financial support from the government to launch and sustain speed breeding in public plant breeding programmes. ■

INDIA SOFTENS RULES ON GENE-EDITED CROPS

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On March 30, the Indian government eased restrictions on gene-edited crops. Genome editing technologies allows scientists for the addition, removal, or modification of genetic material at specific points in the genome without introduction of foreign DNA. It exploits the natural repair mechanism in host organisms which gets activated after introduction of double stranded breaks using appropriate GE techniques. Different editing techniques include:

- Meganucleases
- Zing finger nucleases (ZFNs)
- Transcription activator-like effector nucleases (TALENs)
- Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)

Application of genome editing in crop improvement

Genome editing methods offer a broad array of uses in current biotechnology, including the development of novel crop types that are high-yielding, resistant to abiotic and biotic stresses, and have a great nutritive value. In plant breeding, a genome editing method has been utilized for:

1. to introduce point mutations comparable to natural SNPs
2. to make modest changes to gene function
3. for integration of foreign genes,
4. gene pyramiding and knockout,
5. suppression or activation of gene expression
6. epigenetic editing.

Difference between genetically modified and genetically edited crops

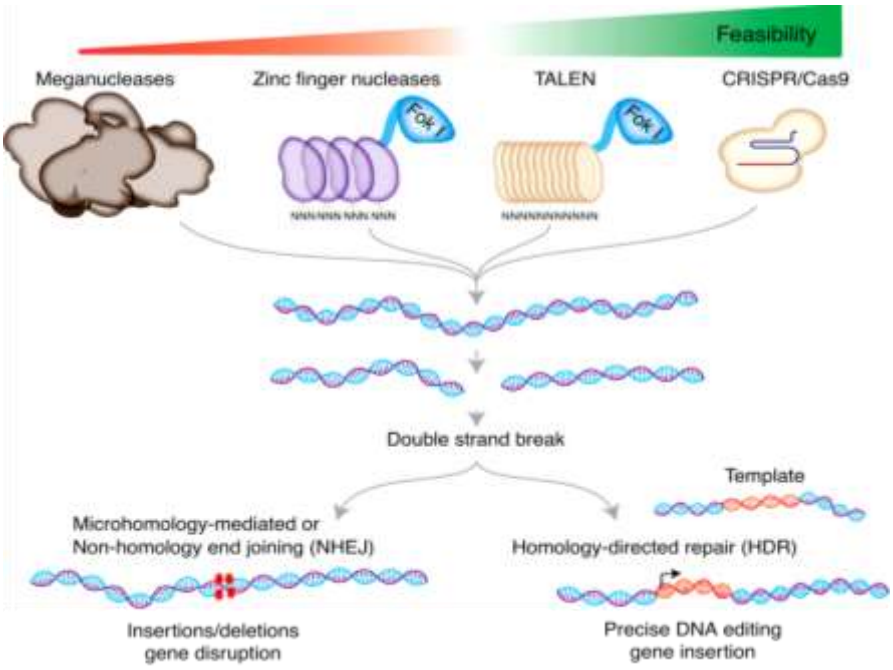
The process is separated into three categories based on the type of edit that is performed. SDN1 makes tiny insertions and deletions in the host genome's DNA without introducing any foreign genetic material. In the instance of SDN 2, the edit entails generating particular alterations with a tiny DNA template. Both of these procedures do not include alien genetic material, and the end outcome is very identical to conventionally developed crop types. The SDN3 process, on the other hand, utilises bigger DNA fragments or full-length foreign genes, making it analogous to the formation of genetically modified organisms (GMOs).

GMOs (genetically modified organisms) include the insertion of alien genetic material into the host's DNA. In the case of cotton, for instance, the introduction of genes cry1Ac and cry2Ab from the soil bacteria *Bacillus Thuringiensis* (BT) allows the native cotton plant to spontaneously produce endotoxins to combat pink bollworm. Genome editing differs from genetic engineering in that genome editing does not entail the insertion of foreign genetic material. Both strategies attempt to create variations that are more productive in agriculture. Such variety enhancement was done before the advent of genetic engineering by selective breeding, which involves carefully crossing plants with certain features to generate the desired trait in the progeny. Not only has genetic engineering improved the accuracy of this work, but it has also given scientists more control over characteristic development.

Regulation under GE in other countries supporting

"USDA does not control or have any intentions to regulate plants that could otherwise have been generated via standard breeding processes as long as they are neither plant pests or developed employing plant pests," said US Secretary of Agriculture Sonny Perdue in March 2018. This contains a collection of novel approaches that plant breeders are increasingly employing to create new plant varieties that are virtually indistinguishable from those generated through traditional breeding procedures.

This underlines that gene editing will not be subject to the same regulatory oversight as genetically modified organisms in the United States. A crucial problem for the USDA is that it is almost hard



Source- wikipedia (The different generations of nucleases used for genome editing and the DNA repair pathways used to modify target DNA)

to tell whether an organism's DNA has been modified or not. Furthermore, the USMCA (United States-Mexico-Canada Agreement), which was signed into law in early 2020, is said to have provisions to facilitate gene editing.

Status of genome editing in world

The commercialization of CRISPR technology highlights how academic institutions are increasingly playing a role in the establishment of new businesses. This shift in entrepreneurial culture suggests that the emergence of academic-based bio businesses will be aided by knowledge-based economies. CRISPR-related technologies will continue to proliferate fast in agriculture and healthcare. While academic institutions in the United States and the European Union continue to debate and contest ownership of CRISPR technology, emerging global players such as China will have a clear path to further CRISPR development and create their own bio ventures in countries where patents are not strictly enforced, such as China.

Furthermore, China, where restrictions are less strict, may take the lead in developing commercial gene-editing uses for people. Although the patent ownership issue around CRISPR technology has prompted some investors to be hesitant, it has not greatly slowed investment growth. Patent monopolisation of gene-editing procedures, which may limit the spectrum of commercial goods, is a worry in market segmentation. Furthermore, the FDA's restrictions on CRISPR technology are uncertain. In the immediate future, gene-edited agricultural goods will have a large market share, but gene-edited human treatments might take decades to reach the market and change healthcare.

Gene-edited CRISPR mushroom escapes US regulation

The white button (*Agaricus bisporus*) mushroom was developed to resist browning by Yinong Yang, a plant pathologist at Pennsylvania State University (Penn State) in University Park. The effect is achieved by targeting the polyphenol oxidase (PPO) gene family, which encodes an enzyme that induces browning. Yang wiped out one of six PPO genes in the mushroom's genome by removing just a few base pairs, lowering the enzyme's activity by 30%. This got into commercialization since gene editing does not include transfer of gene from other organism.

Conclusion

Although, rules have eased for commercialization of genome edited yet there is still huge discussion still going on regarding health and ethical issues.

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HOW THE FARMERS IMPROVE FERTILITY OF SOIL

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Soil fertility can be defined as the capacity of soil to provide physical, chemical and biological needs for the growth of plants for productivity, reproduction and quality, relevant to plant and soil type, land use and climatic conditions. For improve and maintain soil fertility, some agriculture practices and component are very useful for farmers:

Organic matter

Organic matter serves as a reservoir of nutrients and water in the soil, aids in reducing compaction and surface crusting, and increases water infiltration into the soil. Soil organic matter (SOM) is the organic component of soil, consisting of three primary parts including small (fresh) plant residues and small living soil organisms, decomposing (active) organic matter, and stable organic matter (humus).

Mineral & nutrient amendments

Mineral and micro-nutrient amendments can correct soil imbalances. It is a rare soil that is perfectly balanced. Calcium, magnesium, nitrogen, phosphorus, sulfur, and potassium are considered macro-nutrients. Iron, boron, zinc, manganese, copper and others are considered micro-nutrients. Most macro-nutrients can be purchased as naturally mined materials and applied directly to the soil. Micronutrients may be available in a naturally mined form, but also are allowed as an approved synthetic. However, that you can't apply micronutrients without soils test that shows the need for it.

Compost

Applied at least one month before planting your annual garden and worked into the soil, organic matter will decompose and provide nutrients to plants. An even better way to add organic matter is with compost. It helps break up clay particles, allowing water to drain better. In sandy soils, it binds the grains together to retain moisture and fertility. Compost can be applied as mulch to perennial plantings. Compost helps plant growth by balancing soil density. In soils that are too tight, compost helps to loosen the soil; whereas in compost that is too loose, it helps to clump it together. This balancing allows plants to develop healthier roots into the soil contributing to healthier growth.

Green Manures and cover crops

Green Manures and cover crops should be part of every organic farmer's soil fertility toolkit. Cover crops not only protect the soil from erosion and improve soil tilth, but also supply organic matter and fertility when worked into the soil. Legume cover crops like clovers, trefoil and alfalfa also fix nitrogen. It is possible to provide enough organic matter and fertility on good soils through cover cropping alone.

Crop rotation

Crop rotation is the planned order of specific crops sown on the same field for a period of 2 or more years. The succeeding crop may be of different species (e.g., grain crops followed by legumes) or variety from the previous crop. A well-designed crop rotation suppresses weeds and disrupts pest cycles.

Fertility and soil tilth improve when cover crops are included and when combined with manures and/or compost. A lesser-known way to improve soil fertility is to plant different crops in the same field in order to prevent soil erosion and control the spread of soil-borne plant disease. Doing this with legumes will have the benefit of adding nitrate to the soil. Try to use deep rooted vegetables, which will improve soil fertility naturally. ■

BIOCHAR
A BOON FOR SOIL

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Biochar is defined as a carbon-rich material produced during pyrolysis process that is a thermochemical decomposition of biomass with a temperature about ≤700°C in the absence or limited supply of oxygen. It is a carbonised biomass obtained from sustainable sources and sequestered in soils to sustainably enhance their agricultural and environmental value under present and future management. This distinguishes it from charcoal that is used as fuel for heat, as a filter, as a reductant in iron-making or as a colouring agent in industry or art. Biochar, a porous material, can help retain water and nutrients in the soil for the plants to take up as they grow. Due to its adsorption ability, some biochars have the potential to immobilise heavy metals, pesticides, herbicides, and hormones; prevent nitrate leaching and faecal bacteria into waterways; and reduce N_2O and CH_4 emissions from soils.

Sources of biochar

Researchers have concentrated on making biochar from diverse sources of biomass at different production parameters. Crop residues and animal manure, when left in the field play an important role in carbon sequestration, conservation of soil and water, microbial activity, and agricultural productivity. Their use avoids the extra application of synthetic fertilizers and currently are commercialized as compost and soil improvers. Moreover, some crop residues are used to feed livestock. Therefore, crop residues and animal manure represent no waste in agriculture and removal of these ELB from the land to produce biochar should be done carefully, i.e. the optimal amount of feedstock removal should be analysed and the resulting biochar may be reincorporated into the same land where the feedstock originated.

Biochar based novel approaches to increase NUE

Biochar application influences various soil properties including pH, bulk density etc. These changes in soil properties are likely to impact nutrient reactions on soil particles and microbial transformation of nutrients, maintains soil aggregate structure. The central quality of biochar that makes it attractive as a soil amendment is its highly porous structure, potentially responsible for improved water retention and increased soil surface area. In addition, biochar is known to (a) reduce N loss from the soil in terms of N_2O emission and NH_3 volatilization (b) improve nutrient retention capacity and CEC of soils and (c) improve soil physical, chemical and biological properties and thus improve the soil health and plant growth. The sorbed nutrients on biochar gradually release and become available to plants and micro-organisms in the course of time at pyrolysis under low temperatures (200–400°C), biochar is character-rized by having more oxygen-containing functional groups, such as –COOH, –OH, C=O, phenolic –OH and –CHO groups, which stimulate nutrient exchange and, thus, improves soil fertility.

Rate of application

Experiments have found that rates between 5-50t/ha (0.5-5 kg/m^2) have often been used successfully. In the case of piggery and poultry manure biochar, the biochar works both as an organic fertilizer and soil conditioner with agronomic benefits observed at low application rates (10 t/ha).

Constraints

- Inadequate technology.
- Availability of resources.
- Timely production and supplement.
- Availability and feasibility of small scale production units.
- Assessment of effect of biochar addition on controlling inorganic nitrogen losses in agricultural fields is quite difficult.

Conclusion

- More than half the nitrogen used for crop fertilization is currently lost into the environment.
- Biochar application improves the soil physio-chemical conditions (aggregate stability and soil structure, increase porosity, CEC and nutrient contents) that in turn enhance the rate of soil N-mineralization.
- biochar addition can lead to retention of N in the soil and reduced leaching up to 15.2%.
- Application of biochar decreased the cumulative N_2O emission and ammonia volatilization by approximately 70%.
- Application of biochar increase yield and nutrient uptake of crops (15.8%).

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BIOCHAR vs HUMIC SUBSTANCES

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The term biochar(s) means charcoal materials intended to be used for agronomic purposes that are produced in such a way as to sequester carbon. Biochar is a stable carbon-rich product of oxygen-limited combustion (pyrolysis) of carbonaceous biomass, such as crop residues, cull timber and sawmill wastes.

Terra preta, char, and humic substances

It is generally accepted that the stability of carbon in fresh biochar is attributed to the fused ring structures that form during pyrolysis, similar to the ring structures of coal. In contrast, the chemistry of char residues found in the terra preta sites indicates a more oxidized condition. The structure of terra preta char residues consists of groups of fused aromatic rings with substituted negatively charged COO- groups (Fig.1) that are responsible for the high cation exchange capacity (CEC) of the terra preta. These oxidized fused ring groups are similar to the char residues found in Mollisols: high fertility soils that have a history of grassland fires.

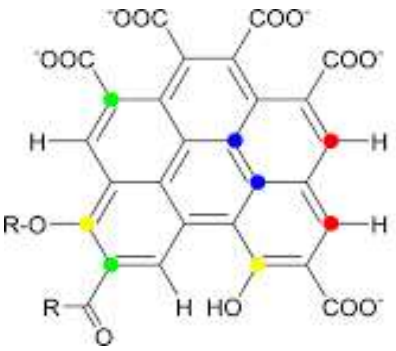

Fig 1. Fused ring structure of char residues

Wildfire chars are thought to contribute to the fertility of some soils by undergoing both biotic and abiotic carboxylation of their fused aromatic ring structures and converting to HS over long periods. The surface chemistry of fresh char materials applied to soils changes over long periods by undergoing natural oxidation, demonstrated by an increase in carboxyl (-COOH) and phenolic (-OH) functional groups and the concomitant evolution of surface charges from positive to more negative. In addition to the surface oxidation of char particles themselves, it is possible that the relatively high CEC could result from the adsorption of highly oxidized organic matter onto the char surfaces over long periods. The amount of time required to convert char into more oxidized materials that contribute to soil fertility suggests that simply adding biochar to soils does not necessarily result in terra preta-like materials during the relatively short time frames of agronomic production. Compared to biochar, HS demonstrates a higher density of carboxyl (-COOH) and phenolic (-OH) functional groups, along with ketone (-C (O) C-) and aldehyde (-CHO) groups distributed across numerous aromatic, cyclic, and aliphatic chains). These functional groups are responsible for numerous interactions with soil components through hydrogen bonding, electron donor-acceptor complexation hydrophobic interactions. Even though there is not a generally accepted structure for HS, molecular analysis suggests that HS are highly dynamic, demonstrating conformational flexibility and self-assembly of complex mixture components.

A primary purpose of biochar is to improve the moisture-holding capacity of soils, which is achieved through the porous physical structure of the char product. HS are amphiphilic, having diverse chemical groups that impart both hydrophobic and hydrophilic character within their proposed structures, allowing them to interact with many soil processes. HS is known to have a high moisture content as well, but they retain moisture both by hydration of polar

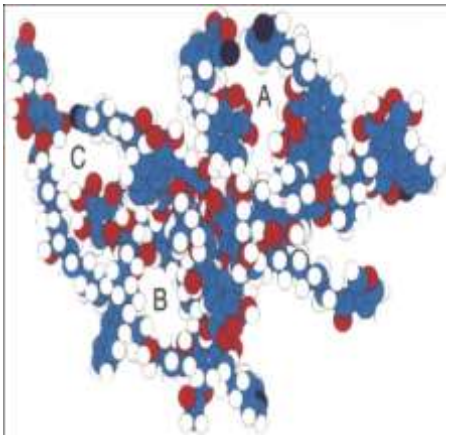

Fig 2. Proposed 3D structure of humic acids

Element colors are: carbon = blue; hydrogen = white; nitrogen = black; and oxygen = red; A, B,C

groups and voids in secondary structures (Fig. 2).

Origin and Properties of Biochar

There are substantial differences in the physical and chemical properties of synthetic biochars depending on the feedstock, time and temperatures used during pyrolysis, and post-production practices. Because of the variable properties of the final products, and as there are no standardized materials, the comparison of experiments is very difficult. Post-production "activation" of chars is accomplished by either cooling rapidly in the atmosphere or with water. Both processes oxidize the surfaces of the materials, altering the character of the surface groups that interact with soil components. The production of biochars is in stark contrast to the genesis of HS. Biochars are produced from cellulosic materials, such as corn stover, switchgrass, or wood, that are subjected to relatively high temperatures over short periods under reducing (oxygen-deprived) conditions. Biochars, therefore have little or no oxygen content. Although the materials used in humic products typically originated as cellulosic materials also, they formed over much longer periods. The process typically begins with microbial decay and subsequent chemical and biochemical reactions that form the materials under more aerobic conditions. Because of that, HS have relatively high concentrations of oxygen-containing phenolic and carboxylic functional groups that account for the high chemical reactivity of HS.

Application of biochars

The application rate is important for tropical soils because they stated that in their opinion, the 11 Mg ha^{-1} rate is roughly equivalent to the amount of carbon sequestered in some types of tropical vegetation that can be converted to biochar, rather than using what they called slash and burn practices. The charcoal content of the current terra preta soils at a depth from 0 to 0.3 meters is estimated to range from 15 to 60 Mg ha^{-1} (7 to 27 tons $acre^{-1}$). Biochar is applied to acid soils to raise the pH of acid soils, but the degree to which wood ash in the char contributes to the increase in pH is unknown. Biochar application is more effective on highly weathered acid soils and hardwood feedstocks can be better at ameliorating acid pH than conifer feedstocks because they are higher in base cations (Ca, Mg, K and Na).

Application of humic substances

Humic and fulvic acids are sometimes classified as biostimulants because they appear to directly affect plant growth and metabolic processes when applied at minute rates relative to typical plant nutrient application rates. The hormone-like activity of HS has been extensively debated because it is difficult to distinguish between indirect positive growth effects caused by improvement of nutrient uptake and the up and downregulation of plant genes involved in metabolic and signaling pathways. The definition of biostimulants is the more complex chemistry and low application rates of humic products set them apart from biochars.

Conclusions

Biochar is primarily promoted as a way to sequester carbon, improve soil water holding capacity, amend acid soils, and increase crop yields when used as a soil amendment. The main benefit of humic products would seem to be as a crop amendment, not as soil amendments. Humic products may increase soil carbon sequestration by promoting bigger root systems and possibly more root exudates.

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CAN INDIAN AGRICULTURE BE SAVED BY BALANCED SOIL NUTRIENT MANAGEMENT ?

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For the first time since independence, India was able to achieve food self-sufficiency due to the Green Revolution in 1965-66. This was accomplished by using advanced technologies such as high-yielding wheat and rice varieties (HYV), tractors, herbicides, irrigation systems, and fertilizers. Before the mid-1960s, fertilizer use was less than one million tonne, but it increased after the introduction of HYV seeds. In 1991-92, it was 12.73 million tonnes, up from 0.78 million tonnes in 1965-66.

It was a golden period for Indian agriculture and politics, but the Green Revolution's dark side has emerged over time, most notably in the form of declining soil health. Soil is appropriately referred to as the "soul of infinite life." However, due to ill-agricultural practises being adapted to feed the ever-increasing populations, its spirit has recently been decrepit.

In Punjab and Haryana, small and marginal farmers still connect urea with fertilisers. In quiet tones, they can be heard muttering "SSP, DAP, MOP" (Single Super Phosphate, Diammonium Phosphate, Muriate of Potash). Farmers have limited knowledge of fertilisers.

Some news channels have boasted of a bumper crop at the end of every Kharif and Rabi season for the past few years. But, if that's the case, how come our country still ranks first in terms of malnutrition? Why is it so difficult for farmers to achieve a profitable output-to-input ratio?

The main reason for this is that our policymakers and farmers pay too much attention to Nitrogen (urea) in their nutrient management. Imbalanced nutrient management is when you don't use the correct fertiliser or don't use it in the right ratio at the right time.

Fertilizers are the most expensive inputs in Indian farming, yet they are also the least understood. Farmers and policymakers must first understand the negative consequences of unbalanced fertilizer application, which ultimately resulted in soil mining or soil sickness, a decline in soil health, reduced crop productivity, crop water and nutrient use efficiencies, deterioration of environmental and human health, and a financial hit to the farmer.

Over the years, an overemphasis on nitrogen, phosphorus, and potassium (N, P, K) nutrients has resulted in secondary (sulphur) and micronutrient (zinc, boron, manganese) deficiency in soils across the country, with the agricultural community and the country paying the price sooner or later. Increase crop production, sustainability, and crop nutrient and water usage efficiency are our best bets. Farmers and policymakers must acknowledge the importance of feed the crop according to its requirements.

The 4R principle defines balanced nutrient management: the right fertilizer, right rate of application, right time, and right place of application. The goal is to put more emphasis on micronutrients, which might be just as essential as basic nutrients. Balanced nutrient management involves the soil's nutrient reserve, crop nutrient removal, target yield, fertilizer economics and profitability, farmers' investment capabilities, agro-techniques, soil moisture regime, soil physical environment, and unfavourable soil conditions such as salinity, alkalinity, and acidity.

The concept is focused on site-specific nutrition management rather than an overall recommendation. Improving soil health, preserving ecological balance, boosting crop reaction to fertilizer application and, most importantly, crop yield, and restoring the soil's skewed N:P:K ratio are all objectives of balanced nutrient management.

A groundbreaking 10-year research by China Agriculture University on millions of smallholder farmers adopting better techniques was published in Nature magazine in 2018. Farm production increased by 11% as a result of a nationwide effort, while nitrogen

fertiliser consumption decreased by 14-18%. Nitrogen fertilisers are important for improving crop yield but may be detrimental to the environment if used excessively.

Even before accounting for the favourable environmental effects, the intervention was profitable at $12.2 billion. Chemical fertilizer deregulation and price increases, a non-renewable source of energy, have caused a severe setback to our country's balanced nutrient management strategy.

A urea subsidy and little awareness of the benefits of balanced nutrient management on our farming community's income and standard of living would also improve. Domestic urea usage increased significantly at a CAGR of 1.3% from 31.9 million tonnes in FY 2016-17 to 33.6 million tonnes in FY 2019-20. Because of the comparatively higher use of urea, as well as the fact that the nutrient-based subsidy (NBS) has resulted in a substantial price disparity between urea and non-urea fertilizers, demand for urea has remained stable.

In the current situation, it appears that farmers and policymakers in Indian agriculture need to be educated about balanced nutrition. They must realise that crops require not just nitrogen, phosphorus, and potassium, but also additional nutrients such as zinc and boron. We cannot move quicker toward adopting a balanced nutrient management strategy given the existing state of India's soil health in terms of nutrient imbalance, physical, chemical, and biological degradation. The ugliness of starvation and farmer suicides in India has highlighted our incorrect farming techniques.

India will always depends on its own farming community and limited land resources to feed its population, regardless of where we end up. Nutrient management that is balanced for our soils and crop production must thus be supported and implemented at all levels. We can't and shouldn't wait for another significant setback to even get back on track. To sustain Indian agriculture, we must be conscious of the requirements of our soils, crops, and farmers' households, and implement the best suitable balanced nutrient management strategy.

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NANO FERTILIZERS

APPLICATIONS IN AGRICULTURE

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To feed ever increasing population on earth, the agricultural scientists are facing a wide spectrum of challenges in crop production system such as crop yield stagnation, declining organic matter, multi- nutrient deficiencies, shrinking primary agricultural resources such as arable land, water and labour resources. According to studies in India, it is reported that the current ratio of NPK fertilizer utilization is at 10: 2.7: 1 against the optimal NPK fertilizer ratio of 4: 2:1. It is very well known that fertilizers gets lost very rapidly in various pathways like decomposition, volatilization and leaching loss which causes ground water pollution thus leads to eutrophication. The percentage of crop loss is increasing every year (25 -30%) due to great extent of multi-nutrient deficiencies. Nano fertilizers are prepared by fortification of nutrients with nano-dimension singly or in combination on to various adsorbent materials. Different kinds of fortification method are: (a) encapsulation of nutrients with nano materials like nanotubes or nanoporous materials, (b) coating of nutrients with a thin protective layer of polymer (c) Formulations which can deliver nutrients as particles or emulsions of nanoscale dimensions.

Nano fertilizers have some unique properties such as high specific surface area (≈ 1150.5 m^2 g^{-1}) due to its small size along with high stability and CEC (cation exchange capacity), which is 10 times more than that of soil, layered with honeycomb like crystal structure. These special properties of nano fertilizer will help in slow and specific release of based on plant nutrient requirement.

Subramanian and Rahale (2012) observed that nano zeolite loaded with zinc sulfate showed the highest sorption 429.5 mg kg^{-1}among native and ball milled zeolite and montmorillonite, halloysite and bentonite. Nano-zeolite showed the release of zinc in three stages *i.e.*, the first stage is upto 220 hours with heavy release of zinc, then second stage is from 300 to 500 hours with release of 2 ppm zinc and The third stage from 500 hours with release of 1.5 ppm of Zn^{2+} and this condition is static even after 1000 hours.

Thirunavukkarasu and Subramanian (2014) conducted a comparative study of the release of sulphate (SO_4^{2-}) from fertilizer-loaded surface modified nano zeolite (SMNZ) and $(NH_4)_2$ SO_4 fertilizers were performed using the percolation reactor. The results showed that the SO_4^{2-} supply from fertilizer- loaded SMNZ was available even after 912 hours of continuous percolation, whereas $SO4^{2-}$ from $(NH_4)_2$ SO_4 was exhausted within 384 hours. These properties suggest that SMNZ has a great potential as the fertilizer carrier for slow release of SO_4^{2-}. Prasad *et al*. (2012) reveled that, nanoscale ZnO (25 nm mean particle size) at 1000 ppm concentration promoted both seed germination and seedling vigor and in turn showed early establishment in soil manifested by early flowering and higher leaf chlorophyll content.

Al-Juthery *et al*. (2018) had observed significantly higher growth and yield (5.996 Mg ha^{-1}) parameters of wheat with spraying of super micro capsule (SMC) nano-fertilizer (which contain 11 essential nutrients) compared to control and traditional (NPK+TE(Fe 260, Cu75, Mn320, Zn230, B100 and Mo10 ppm)) fertilizer treatments respectively. The highest fertilizer productivity was achieved with spraying treatments of nano SMC (1936.0 kg kg^{-1}) compared to traditional fertilizer (569.0 kg kg^{-1}).

Conclusions

The Yield of a crop can be increased upto 60% higher with use of nano fertilizers due to slow release of nutrients for longer period of time (40 to 50 days) unlike conventional fertilizers (4-6 days). And also nano fertilizers with seed treatment results high seed germination per cent (90%) and seed vigour index. The nutrient use efficiency has improved has improved by 3 folds compared to traditional fertilizers, which will results in less soil and water pollution with higher economic returns to the farmers.

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PUSA DECOMPOSERS:

AN ALTERNATIVE APPROACH OF CROP RESIDUE BURNING

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In India over 650 million tonnes of agricultural residues are produced every year and with increased production of rice and wheat, residue generation has also increased substantially. These crops are preferred by farmers since they provide higher economic return, as compared to other crops. Usage of mechanical harvesters leaves at least 15 cm of standing crop of rice in the field along with large amount of straw and this straw bed is not suitable for the establishment of wheat seedlings. The very short between rice crop harvest and sowing of wheat seed vis-à-vis intensive use of mechanical harvester's force farmers to burn crop residues in preparation of the land for sowing of next crop. Burning releases toxic gases like CO, CO_2, $(SO)_x$ and N_2O etc. which further reduced the air quality, and a loss to the soil which otherwise could have ploughed back/recycled into th earth. It has been estimated that burning of one tonne of paddy straw accounts for loss of 400 Kg C, 5.5 Kg N, 2.3 Kg P, 25 Kg K and 1.2 Kg S. Besides nutrient loss, burning creates serious air quality problems affecting human and animal health. The recycling of these wastes is both an ecological necessity and economic compulsion. Bioconversion of the residues to good quality compost/manure through microbial process is an eco-friendly and viable proposition. However, decomposition of paddy straw is a problem because of its lignocellulose content and high C:N ratio (90:1).

Recently, Indian Agricultural Research Institute New Delhi, scientists have developed the bio-decomposing product, namely Pusa decomposers, to convert stubble of crops into compost. The Pusa bio-decomposer is a low-cost microbial bio-agent that can decompose crop residues, including stubble from paddy crops, in a bid to prevent farmers from setting them on fire. It help to farmers for prepare the compost and decompose paddy stubbles very fast. Pusa bio-decomposer reduce the environmental pollution which occurs mainly in Delhi and many other parts of Northern India by preventing the burning of the stubbles in the field. The decomposers are in the form of capsules made by extracting fungi strains that help the paddy straw to decompose at a much faster rate than usual. The fungi help to produce the essential enzymes for the degradation process.

Making Process

The bio-Decomposer is prepared with a mix of seven different fungi, which produce several digestive enzymes, including pectin, cellulose, and lignin. It starts by making a liquid formulation with the help of decomposer capsules which are then fermented over 8 to 10 days. The mixture is then sprayed over fields where the crop stubble is lying to aid in the speedy decomposition. The farmers can prepare 25 liter of liquid mixture with 4 capsules, jaggery and chickpea flour. The 25L liquid so obtained is mixed with 500L water and sprayed on paddy straw in one hectare field.

Time of decomposition

After spraying such mixture over the stubble, it will take over 20 days for the same to degrade completely. In comparison, paddy straw which is shredded and watered, takes a time of at least five days to decompose completely after mixing with soil. Another problem with the conventional method of decomposition of stubble is that farmers do not get enough time to prepare their fields for wheat crops.

Difficulties faced during conventional composting

- High C:N ratio and recalcitrant nature of Agri-residues results in slow decomposition.
- Low P content of plant biomass results in nutrient poor compost.
- Requires long time (120-150 days) to prepare quality compost.
- Plant pathogens and weed seeds often survive during natural composting.

- Incomplete degradation of plant parts results in phytotoxicity when applied.

Methods of composting

The following methods can be employed to prepare nutrient enriched compost by using Pusa compost inoculant.

1. Pit Method
2. Windrow Method

Pit method

For pit method, the site should be selected near the cattle shed and water source. The site should be located at high level so that no rain water can seep in during the monsoon season. The size of the pit should be at least 8 m long, 2 m wide and 1 m deep. Two methods can be used for filling of pit viz: (1) Layer method where the material such as straw, crop residues or any organic waste is spread evenly in 3-4 layers. Then water slurry of FYM/Cow dung/ Poultry droppings and compost inoculant can be sprayed above this layer. A second layer of organic residues can be spread in a similar manner and the process can be repeated until the pit is filled completely. (2) Pit can also be filled directly adding whole material like paddy straw, cow dung, soil and old compost along with the compost inoculant is mixed nicely. Sufficient quantity of water is sprinkled over the material to maintain 90% moisture content. One can check by taking Agri-residues in hand and squeezing it tightly. In ideal situation, water should not drip out of hand. The material should be turned at least 3 times during the whole period of composting- i.e. at an interval of 15 days up to one month and at 30 days during thereafter.

Windrow method

This method is suitable for large scale composting and raw material is laid in windrows of any length in the forms of piles as described in pit method with the help of machines like Pusa loader and tractor operated turner-cum-mixer together with the application of culture and water. The material is turned fortnightly for proper aeration with the help of tractor turner. To prepare nutrient enriched compost FYM/poultry dropping/cow dung can be added along with rock phosphate. If FYM/poultry dropping/cow dung is not available, pyrite or urea can be added into the raw material. The main purpose of supplementation is to narrow down the C:N ratio of raw materials in the desirable range.

Benefits of composting

The bio decomposer helps improve and enhance the fertility levels of the soil. This, in turn, directly helps to enhance the productivity of the soil, which will help produce better yield for the farmers. The farmers can use the stubble left behind to spread manure and compost in their fields over the crops. Consequently, they will need to spend less on a separate fertilizer for their crops. This will mean direct savings for the farmers.

The soil remains rich and productive and is another main benefit that farmers can derive from the bio-decomposers. The practice of stubble burning actively contributes to draining the richness of the soil and destroying all the useful bacteria which are otherwise quite useful for the soil. Additionally, stubble burning also causes depletion of fungi in the soil, which is harmful to the environment. Using a bio decomposer is an efficient, effective, and cheaper alternative to stop the harsh practice of stubble burning. It is quite practical and easily achievable as well. Moreover, it is very ecofriendly and ecologically safer as a technology that can help to eliminate the problem of air pollution in the major metro cities of North India. The practice of using Pusa decomposers is seen as an active effort to achieve the objectives of the Swachh Bharat Mission.

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EFFECT OF SOIL CARBON SEQUESTRATION ON CLIMATE CHANGE MITIGATION

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This is a significant climate change notion. 'C sequestration' may assist lower CO_2 levels and regulating the global C cycle. CO_2 makes for around 60% of GHGs. Endogenous C sequestration is the biological fixation of atmospheric C. A system (like soil) must store C to combat climate change. The "achievable potential" for reducing GHG is 10–20 percent. Agriculture emitted 13 million tonnes of CH4 and 0.227 million tonnes of N_2O. Entry fermentation produced 61% of total CO_2eq emissions, whereas rice production produced 20%. Agricultural soils emitted 16% of total CO_2. 10% comes from agricultural waste and manure management. "C sequestration" now means reducing climate change. CO_2 must be reduced or reversed through C sequestration. Carbon sequestration is the movement of carbon within an ecosystem. CO_2 emissions grew by 3.20.1 Pg C per year owing to fossil fuel combustion, 2.30.8 Pg C per year due to ocean absorption, and 2.31.3 Pg C per year due to a terrestrial sink that is Assumed to 136 55 Pg C from land-use change. Fuel combustion and forest destruction induce CO_2 enrichment-less emphasis on soil organic materials. The loss of SOC was estimated at 40 Pg. In addition to restocking SOC, we may increase agricultural productivity and water quality, minimize sedimentation in reservoirs and rivers, and reduce global warming concerns. CCS captures and stores CO_2 in the soil to increase MRT and limit re-emission sinks. Through carbon offsetting, it seeks to limit net increases in atmospheric CO_2 (400 ppmv in 2013) and the pool (800 PgC).

Soil organic matter (SOM) sequestration is transporting CO_2 from the atmosphere into the soil via plants and other organic substances (humus). Carbon sequestered in soil (the terrestrial pool of the carbon cycle) can be held for short or long periods. Sequestered SOC mechanisms increased new SOC storage. Le Foll suggests 4 per 1000 SOC sequestration to offset anthropogenic emissions at the 2015 UNFCCC-COP21 session in Paris. On average, 5,500–6,000 Mt CO_2-eq per year from soil mitigation represents 90% of global agricultural technology mitigation potential. No or reduced tillage, set-aside land, animal manure application, and intensification are some mitigation techniques. These actions all fall under "soil carbon sequestration." It involves turning CO_2 into inert, long-lasting carbon molecules (U.S. Department of Energy, 2008). Biosequestration slows C active cycling. Putting C-containing molecules and CO_2 into a longer-lasting reservoir.

Sources of the rise in gas concentrations in the atmosphere

The oceans took 3.2 0.1 Pg C/year of CO_2 from fossil fuel combustion, while an unknown terrestrial sink received 2.3 1.3 Pg C/year. Assumed 136, 55 Pg C from land-use has been changed. Jenny (1980) identified CO_2 enrichment sources like fossil fuel burning and deforestation. Focus on soil organic matter. On lost 40 Pg 20th century SOC. Let's restock SOC. Also, it may help increase agricultural output and water quality, as well as prevent sedimentation in reservoirs and rivers.

Potential climate change's impact on soil organic matter and soil quality

Climate change may affect soil moisture and temperature. A 3°C increase in temperature changes the vegetation belts by 500 m. Temperature increases of 1°C correspond to 200 km shifts in vegetation zones. Elements, water availability, and soil temperature can all affect plant growth. Temperature rises enhance mineralization, lowering the SOC pool. This reduces soil aeration and increases runoff.

Soil Carbon Sequestration

Improved soil C sequestration and storage will help reduce GHG accumulation. Carbon is sequestered in terrestrial ecosystems, underground as carbonates, and seas. It depends on the long-term equilibrium of C absorption and release. Climate, soil chemistry, and biological processes affect soil inorganic carbon concentration. SOM levels in natural soils rise significantly at first, then stabilize. But pristine woods collect more SOC than farmed forests. SOM levels diminish as agricultural conversion causes soil inversion and loss of high-grade forest C with higher lignin concentration and more resistant C fractions.

Conservation agriculture- a way to Soil carbon sink

Conservation farming (CA) is often used to describe agricultural practices that reduce land disturbance while boosting crop diversification and soil quality. High above- and belowground biomass (deep-rooted plant species) input cropping systems may benefit CA systems. Using tillage machinery is reduced by 11.2%, reducing overall fossil fuel use in the cropping system. Conservation agriculture allows for more effective water and fertilizer usage by increasing soil biodiversity and microbiological activities. SOC increases agricultural output and reduces variability. Increased SOC buildup reduces CO_2 emissions while improving soil fertility and water retention. This means that healthy soils are crucial in developing climate-resilient agricultural production systems.

Measures for carbon sequestration and climate mitigation

Increase in SOC Content

It may reduce GHG emissions while increasing soil health by enhancing physical, chemical, and biological characteristics. Many mitigating methods, such as reducing soil erosion, conserving soil moisture, and crop diversity, are useful in promoting SOC storage.

Conservation Agriculture

In the past, agricultural management has been found to reduce GHG emissions. No-tillage or minimal soil disturbance improves C sequestration. Soil inputs can be augmented by adding biomass or increasing OM inputs from other ecosystems. These processes promote soil C storage, plant agronomic traits, and soil microbial activity.

Carbon assimilation by Forest lands

Reforestation can increase forest area and hence help reduce atmospheric CO_2 buildup by replacing fossil fuel CO_2 emissions. Longer harvesting cycles and fewer disturbances may improve forest carbon density. On Ethiopian Vertisol soils, alley-cropping with Sesbania increased soil carbon storage.

Cover crop

High biodiversity ecosystems absorb and retain more CO_2 than low or reduced richness ecosystems. Leguminous cover crops promote biodiversity, residue quality, and SOC pool. Using legume-based cropping systems has been found to prevent soil loss of C, and N. Cover crops have boosted SOC levels. No-tilling with hairy vetch may enhance SOC concentration.

Restoring degraded soils

Soil C sequestration may be greatly increased by restoring damaged ecosystems and soils. It is possible to recover most of the SOC in degraded soils by using appropriate land use management strategies. Themean SOC content on plots beneath the grass ley system grew regularly and considerably over the span of 4 years at a rate of 0.78 percent.

Nutrient management

Nutrient management is essential to the sequestration of carbon dioxide (CO_2). Soil organic matter (SOC) is increased through the use of organic manure and compost, but chemical fertilisers are not. Under conditions of high CO_2 concentration, an adequate supply of nitrogen (N) and other important soil nutrients may boost biomass output. Using organic manure-enriched soils considerably enhances the ability of conservation tillage for sequestering SOC.

Conclusion

Changes in land use and agrochemical usage encourage high productivity but damage soil quality and atmospheric conditions. Agriculture produces 28% of GHGs, whereas soils emit 13%. From 280 to 380 ppm of CO_2 in the atmosphere in the last 250 years they create significant global warming that harms agricultural output. These CO_2 losses from soil profiles raise questions regarding carbon sequestration to prevent global warming. Several studies show that using resource land management techniques, such as conversation agriculture, can dramatically boost soil carbon sequestration. Because the soil carbon pool is the largest terrestrial reservoir of up to 3 m depth, it can be either a source or a sink of atmospheric CO_2 (4000 pg). Weather, clay type, textural classes, and water depth affect soc sequestration. Even with soil c sequestration, the atmospheric CO_2 content will continue to rise at a 2.0–2.6 pg c/year. Diverse organic inputs can change the soil carbon pool. Physical, chemical, or biological stabilization of SOC improves carbon storage and thus soil structure, increasing plant-available nutrients. So healthy soils can produce nutritious food while simultaneously acting as a carbon sink, assisting shortly. Although soil carbon sequestration can help reduce atmospheric CO_2 enrichment caused by human activity, we urgently need to create a long-term solution to solve climate change challenges. Regardless, we can't afford to neglect soil C sequestration.■

GREEN APPLE APHID

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Apple (*Malus domestica*) is an important temperate fruit crop which belongs to the family of Rosaceae and originated in Asia minor to Western Himalayas. In India, it is mostly grown in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh, Sikkim and Nagaland. Apple plants are attacked by a number of insect pests. Among these, green apple aphid (*Aphis pomi*) is considered as a important pest causing serious losses in apple nursery and orchards which possess a great problem to the apple growers throughout the country.

Biology of green apple aphid

Green apple aphids overwinter as eggs (1mm long black shiny and oval shaped) on suckers at the base of buds on terminal shoots. Eggs hatch when buds burst and the first leaves are unfolding. Newly hatched nymphs (2 mm in length, yellow-green to light green, oval shaped with black cornicles) having five instars (females). Nymphs begin to feed immediately on developing leaves, and are initially present on terminal shoots, moving later to older cluster leaves. After feeding for about two weeks and molting several times, nymphs mature into wingless adults that reproduce without mating. These adults (2 mm in length, oval shaped and bright green with black cornicles and legs) can have wings or be wingless. Give birth to live (50-100) young, with populations building rapidly. Young aphids develop in 8-10 days. There are many generations per year. Adult aphids in a colony are generally wingless until crowded conditions induce the formation of winged individuals that disperse to new hosts.

Damage

This pest attacks primarily the growing terminals of apple plants. Green apple aphid populations build slowly on apples in early spring fall which increases rapidly with the rise in temperature. Their infestation is more during July and early August. Depending on weather conditions, one life cycle takes two to three weeks on apple plantations. Green apple aphids usually remain on apple plants throughout the summer. The infestation of green apple aphid was found to be more in the apical parts of the plants. Both nymphs and adults suck the sap from leaves, twigs, branches and young fruits, as a result of which the affected leaves curl up, blossoms shed and the young fruits drop prematurely due to this quality of fruits is greatly affected resulting in stunted growth.

Interaction between Plants and Aphids (Infested Plants by Aphids)

In severe infestation like other aphids they secrete honey dew which may cause russeting and provides a site for the growth of blackish grey fungus that causes shooty mould resulting in retarding fruit quality and yield lowering market value.

Management

Number of natural enemies such as lady bird beetle, lacewings, syphrid flies, predatory bugs can help to keep green apple aphid under control and spray of insecticidal soaps horticultural oils and neem insecticides can be helpful inadequate suppression of green apple aphid, are less damaging to natural enemies are organically acceptable than other broad spectrum insecticides.

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BIOCOMMUNICATION IN INSECTS

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Biocommunication is any specific type of communication within (intraspecific) or between (interspecific) species of plants, animals, fungi, protozoa and microorganism. Communication basically means sign-mediated interaction following three levels of (syntactic, pragmatic and semantic) rule.

Communication in inscets

The majority of insect's species live a solitary life, with few contacts between conspecific individuals. Social insects however, are characterized by communities in which they live in permanent contact with their nest mates. Bees and bumble bees, wasps, ant and termites since long have fascinated man because of their well organized and often impressive colonies.

Types of communication

Communication in insects is meanly divided into 4 groups.

1. Visual communication
2. Chemical communication
3. Tactile communication
4. Acoustic communication

(1) Visual communication

Most visual communication are effective during daylight, but some insects can generate their own light and use visual signals that can be seen at night. Also for partner location, prior to mating, the males' big compound eye can help in finding the females. Male dragonflies recognizes female dragonflies.

Light production

Intrinsic luminescence, i.e., light produced by the insects, is known to occur in various Coleopterans, primarily in the family Lampyridae (fireflies).

The light-producing organs occur in various parts of the body. The collembolan Onychiurus emits a general glow from the whole body. In most beetles the light organs are relatively compact, and are often on the ventral surface of the abdomen. In male (Coleopterans) there is a pair of light organs in the ventral region of each of the sixth and seventh abdominal segments. In the female the organs are smaller and often only occur in one segment. The larvae have a pair of small light organs in segment eight, but these are lost at metamorphosis when the adult structures form. Larvae and females of railroad worms (Phengodidae, Coleoptera) have 11 pairs of dorso-lateral light organs on the thorax and abdomen and another on the head. In (Hemiptera) the light organ is in the head. The light organs are generally derived from the fat body, but in the glow worm fly Arachnocampa (Diptera) they are formed from the enlarged distal ends of the Malpighian tubules.

Bioluminescence

When oxygen combines with calcium, Adenosine tri phosphate (ATP) and the chemical luciferin in the presence of luciferase, a bioluminescent enzyme, light is produced. Like a light bulb, which produced a lot of heat in addition to light, without a lot of energy being lost as heat. The photons is needed to oxidize the reaction

(2) Chemical communication

Insects are prodigious users of chemical signals and cues, which play diverse and fundamental roles in the transfer of information both within and between species. Indeed, it is likely that no other group of animals makes such sophisticated use of chemical signaling in their biology.

Types of pheromone traps:

Funnel trap: It consists of funnel base with handle and attached to a support of the stick. It's meanly used to collect larger moths with the help

of lures or pheromones kept inside. Ex. Spodolure, Helilure, Gypsy moth lure etc.

Delta trap: It is used pheromone baits, it is a triangular trap made by plastic card. Insects that fly into the trap are caught on surface treated with a special type of non-dying glue.

Wota trap: It is used for mass trapping pest in the field crop such as sugarcane, Wota -Trap is easy to assemble on a single pole. It consists of an adapter basin to hold water mixed with kerosene/detergent and a lure holder with a canopy. Ex- INB lure, and TSB lure.

Fruit fly trap: This trap has yellow bowl with entry hole and also a translucent dome. It is used against for Melon fruit fly. Ex- Bacu lure.

Anti-aphrodisiac pheromones: Used by a male to mark a mated female, to render her unattractive to other males; benefits male by helping to ensure his paternity, benefits female by reducing harassment by courting males.

Epideictic or marking pheromones: Deposited on the surface or inside a resource, such as a fruit or parasitized host egg, to indicate that it has already been exploited; benefits the marker by reducing competition for its progeny.

Trail pheromones: Used by social and semi-social species to indicate the location of exploitable resources with respect to the position of the colony; benefits the colony by increasing the efficiency of foraging**.**

Alarm pheromones: Emitted in response to danger, such as an attack by a predator; benefits receivers as they modify their behavior to defend the colony, or to reduce the probability of being captured.

Aggregation pheromones: Results in aggregations of conspecifics; potentially beneficial to all individuals because it decreases the risk of predation or parasitism, improves the exploitation of a resource and/or increases the probability of locating a mate.

Anti-aggregation pheromones: Emitted when a resource is in danger of being over-exploited; benefits both emitters and receivers because it reduces intraspecific competition.

Pheromones of social insects: Numerous pheromones produced to coordinate activities within the colony. For example, the cuticular lipids contain signals that serve in recognition of nest mates, caste, reproductive status and even whether an individual is alive or dead. Queen pheromones serve many roles, including the suppression of worker reproduction and the organization of workers to feed and groom the queen.

(3) Tactile communication

"Keep in touch" for you, it's probably just a metaphor but for some insects it's really a channel of communication. Since many insects have poor vision and sound perception, physical contact provides an important avenue of communication.

Termite tactile communic-atio:

It's not clear exactly what information may be exchanged, but it certainly involves nest mate recognition and leads to exchange of food through trophallaxis.

(4) Acoustic communication

Nature and transmission of acoustic and vibrational signals: Insects produce communication signals by stridulation, percussion, vibration, click mechanisms and air expulsion. In most species neuromuscular activity leads to mechanical vibration of some exoskeletal structure. These vibrations are transduced (either directly or indirectly) as cycles of compression and rarefaction to the surrounding medium or a contacted solid substrate. Mechanisms producing substrate vibration may also generate air-borne sounds and either one or both components of the signal may be detected and evaluated by the receiver.

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TENDU LEAF GALL FORMING INSECT

Trioza obsoleta (Psyllidae; Homoptera) AND THEIR MANAGEMENT

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Tendu leaves are good source of revenue generation to the state forest departments due to their role in wrapping bidi or Indian cigarette and play significant role in the livelihood of tribals of central India. Various kind of bugs, flies, thrips and borer are found to infest tendu plant. Among the insect pests, leaf gall forming insect, *Trioza obsoleta* is a sap feeder and one of the key insect pest which causes galls in leaves and deteriorates the leaf quality causing heavy losses in economic terms.

Nature of damage

It causes reddish yellowish galls on leaves which locally known as 'matta' or 'pox disease' which deteriorates the leaf quality causing heavy losses render unsuitable for bidi wrapper. Vaishampayan and Bahadur (1986) reported a mean damage of 50 % and 13 % to the utilizable leaves in Madhya Pradesh, Maharashtra and estimated the losses in terms of rupees 9 crores and 44 lakhs respectively during 1978 tendupatta season.

Life history

There are two types of gall forming occur on tendu, one is closed gall forming insect known as *T. obsoleta* and other is pit gall forming insect of *Trioza* spp.

a. Close gall former (*Trioza obsoleta*) Buck (Homoptera: Psyllidae)

Mathur and Beeson (1935) and Beeson (1941) have mentioned the occurrence of *T. obsoleta* on the leaves of tendu. Recently Kumar *et al*., (1989) have investigated the biology of the pest in detail. The cream white eggs (0.3 mm in length) are laid singly but scattered on the exposed surface of young foliage and buds and attached to the tissues by means of a stalk. The incubation period varies form 6-8 days. After hatching young nymphs grow corresponding with the growth of galls. Ventrally galls are characterized by a closed astiole in beginning but on maturity stage a lacerated crack appear in the bulge which open completely in old galls. There are five nymphal instars, moulting of four instars, occur inside the gall but the moulting in 85 % cases occurs outside the galls. The nymphs are flocculent and exude globules of sugary fluid which attracts ants. The body of active nymph is fringed with white filament. A portion of the population from each of several generation enters diapause while the remain continue the normal development. During diapause stage, the fringed waxy filaments become enlarged in size and nymphs change their colour from creamish white to dull blackish at the dorsal side. It is found that 90.37%, 9% and 0.53% galls are occupied by one, two and three nymphs respectively. The freshly emerged adults are green in colour but turn from greenish to pinkish and at maturity ferrugineous and shining black. The life span is 4 to 7 days in caged conditions. Mating takes place for short time (30 second to 1 minute) during day time but more frequently at 8 to 10 a.m. Nymphs are parasitized by *Brachymeria*

Leaves damaged by leaf gall forming insect *Trioza obsoleta*

suturalis (Coccinellidae: Coleoptera) and unidentified spiders. The seasonal history of *Trioza obsoleta* is of great interest. Insect completes 5 overlapping generations, two from February to the end of April, one during July-August and two during August to the next February at irregular intervals. Those eggs which are laid in the first week of April, developed into adults in 96 % cases while a part of population undergo in diapause while 2 % develop into adults in May and June. In November, no diapause nymphs present in the galls which are formed during April and May. This reveals that all the diapausing nymphs of April and May either develop into adults or destroyed by predators and parasites. In last week of July, fresh galls having first instar nymphs are seen in natural tendu growing area and in first week of August, only 11.63 % diapause nymphs remain in these galls while rest develop into adults. Symptoms of gall initials on leaves may frequently be seen during July to November.

b. Pit-gall forming insect *Trioza* spp.

Vaishampayan and Bahadur (1986) have investigated the biology of this insect species in detail which has been supported by Kumar *et al*., (1989). Eggs and young nymphs are more or less similar as those of close gall forming insect. The young nymphs after hatching crawls on the surface for 2-3 days and finally settle at a point mostly on margins of upper surfaces of leaves. As nymphs grows in size small protuberance on the opposite surface of the leaves grows. During feeding nymphs exude thick sugary substance in the form of globules which attracts ants. Nymphs moulted 5 times before emerging into adults and all moults occur on the leaf surface. The nymphal period varies from 15 to 30 days during March to early April. In April nymphs undergo in diapause and reactivate only in next February and thus take about 300 days to complete the life cycle. The pest completes, three generations, two between February to early April and one from April to next February from pit-gall forming nymphs.

Control measures

- Treatment of synthetic pyrethroid, deltamethrin (decis) 2.5 EC. @ 0.002% followed by cypermethrin 20 E.C. @ 0.03% was found to be most effective against gall forming insect, *Trioza obsoleta*.
- Further, the first pruning i.e. first week of March including control fire was found to be most effective for minimizing the incidence of leaf gall forming insect, *T. obsoleta* and increasing the leaf weight and area of leaf.

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OIL CAKES

PLAYS A POTENTIAL ROLE IN PLANT DISEASE MANAGEMENT

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Oil cakes are organic origin, now days in the agriculture scenario, which are highly emerging one because people moving towards the organic origin. Oil cakes plays the different roles like as fertilizer, feed etc. The different Edible oil cakes which can be safely fed to livestock like as Groundnut cake, Coconut cake etc., and another kind non edible oil cakes which are not fit for feeding livestock, Castor cake, Neem cake, Mahua cake etc. The oil cakes provide the medium for microbe's multiplication, provide the nutrients to plants and produce secondary metabolites against the harmful soil borne pathogens.

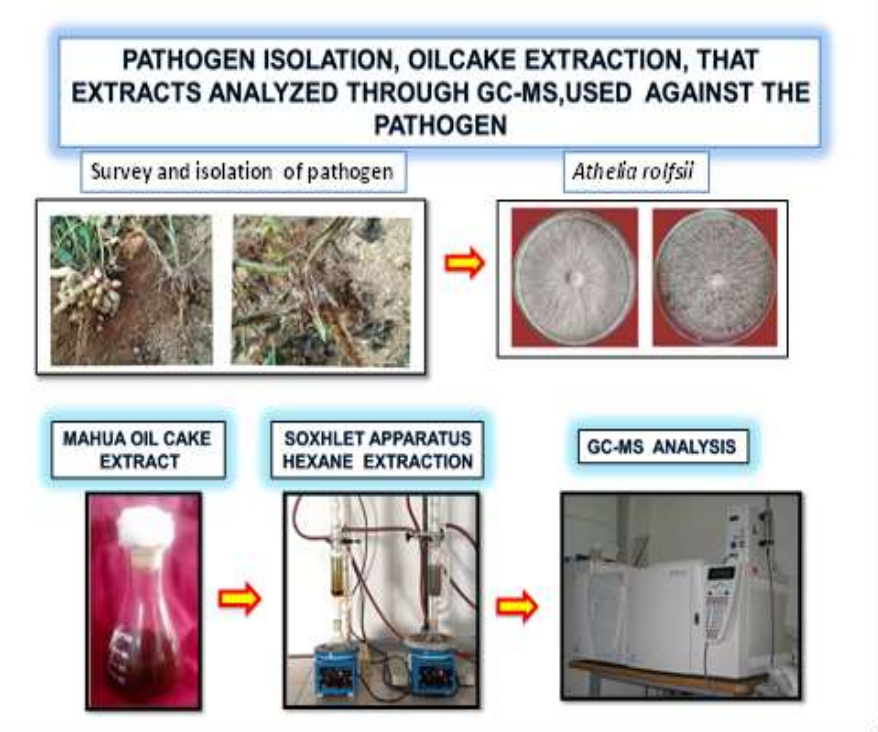
Mode of action of oilcakes

The oil cakes very often inherit high amount of biochemical constituents, including fungitoxic bio-molecules, originally present in the respective oil yielding seeds. Oil cakes not only reduce the disease severity but also enhance the antagonists, soil fertility and crop yield to a significant level. Terpenoids and other volatile compounds which are released through hydrolysis of incorporated plant tissues or seed meal extracts or oilcakes. The amendments were believed to suppress soil-borne pathogens by boosting the saprophytic soil microbial population, either through antibiosis or competition. Oilcakes released antifungal terpenoids and other volatile chemicals that hydrolyse the host pathogen cell wall. The oilcakes having antifungal secondary metabolites such as phenolic acids and flavonoids (total phenols and total flavonoids), as well as their total antioxidative activities (*via* 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging activity, oxygen radical absorbance capacity (ORAC), ferric reducing antioxidant power (FRAP), iron chelating cap. The disease management using oilcakes increased plant growth by improving soil structure, water holding capacity and cation exchange capacity, which also inhibits soil-borne plant diseases, while oil cakes served as a source of nutrients and a breeding ground for antagonistic microbes.

Oilcakes act as medium for mirobes multiplication

The mustard cake (5%) and neem cake (1%) successfully inhibited sclerotial germination of *S. rolfsii*. The use of bioagents and oil cakes has no negative impact on the environment and really improves the long-term viability of field soils. The pooled application of *Trichoderma harzianum* (4g/kg seeds) and neem cake (10%) (w/w) in the pot had significantly declined the incidence of *Rhizoctonia bataticola* causing dry root rot in *Vigna radiata* (87.26 %). The mahua oil cake extract at 10 per cent was effectively suppressed the mycelial growth, sclerotial production and sclerotial germination of *S. rolfsii* by 79, 95 and 73.3 per cent respectively as compared to control. The eight different organic amendments namely neem cake, farmyard manure (FYM), sesame cake, ground nut cake, decomposed coir pith, pungam cake, castor cake and vermicompost for the management of fruit rot of tomato caused by *Phytophthora capsici*.

Neem oil cake



Oilcakes improve the soil health

Oil cakes management as it improves soil structure, water holding capacity and cation exchange capacity and promotes plant growth. Some compost also suppresses soil-borne plant pathogens. Cotton seed oil cake contain sufficient amount of macro and micro elements which justify its suitability in agro-industrial uses. Cotton seed oil cake can be used for the production of bio-fertilizer in agricultural sectors. Both edible and non-edible oil cakes can be used as manures. However, edible oil cakes are fed to cattle and non-edible oil cakes are used as manures, antifungal and antibacterial activity especially for horticultural crops. Nutrients present in oil cakes, after mineralization, are made available to crops 7 to 10 days after application.

Conclusion

Oilcakes plays a diverse role in different discipline. We have to suitable oilcakes along with the compatible bio control agents will make the high antagonist spore multiplication followed by successful plant disease management. But the lack now is poor production of oil cakes and correct amount of application and suitable time of application make biosafener to the plant.

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DEFENSE MECHANISMS

IN PLANTS AGAINST PLANT PATHOGENS

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Plant are attacked by various plant pathogens like fungi, bacteria, nematodes, virus, parasitic plants etc. but plants defend themselves against these by combination of weapons from two ways. The first defense mechanism involves altering their structural characteristics that act as physical barrier and inhibit the pathogen from gaining entrance and spreading through the plant, and secondly the biochemical reaction, which takes place in the cells and tissues of the plant and produce substances that are either toxic to the pathogen or create conditions that inhibit their growth.

Introduction

Each plant is affected by different kinds of pathogens. The Mechanism by which Plant Protect themselves from the attack of Plant Pathogens by Structural and Biochemical Means is known as Plant defense mechanism. Plant defense themselves against Plant pathogens by two way-Structural as Physical Barrier and biochemical reaction that take place in cell and tissues that are toxic to pathogens.

What is plant defense mechanism

- Plant defense mechanism is referred to mechanism that helps the plant to restrict the entry of pest and diseases by help of Physical and biochemical means of weapons.
- It can be also referred to Protection and defense mechanism of plant.

Type of defense mechanisms in plants

Defense mechanisms in plants are explained under following groups for clarity and sequence.

Pre-infectional or Pre-existing Defense

Pre-infection defense mechanisms involve mechanical or structural barriers such as waxy cuticle, thick epidermal cell walls, structure of natural opening, etc. or biochemical barriers such as strategically positioned reservoirs of anti-microbial compounds.

These are two types:

a) Pre-infectional structural mechanisms.

b) Pre-infectional Biochemical mechanisms.

Physical protection

The various Physical features that brings about protection are:

A. Structure of cuticle

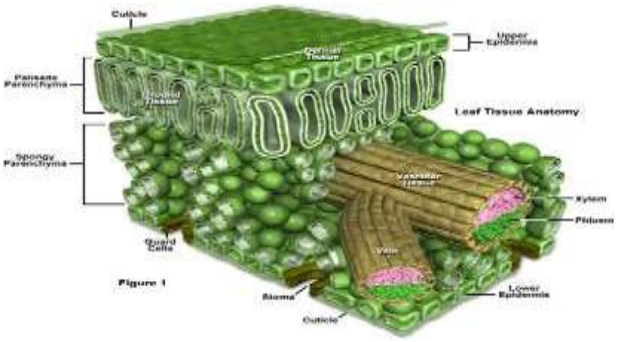
B. Epidermal

C. Structure of Stomata

A. The cuticle

- A thick cuticle may increase resistance to infection of disease.
- The surface of the plant cell walls directly exposed to the air is covered by the non-cellular, membrane known as cutin.

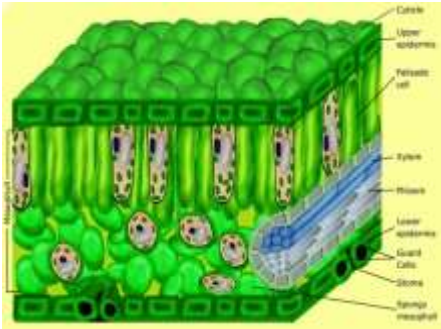
This layer is generally attached to the pectinaceous layer of the cells and is often embedded in waxes.



B. Structure of Epidermal Cell Wall

- The thickness and toughness of outer wall of epidermal cell are apparently important factors in the resistance of some plants to certain pathogen.

Thick walls of epidermal cells make direct penetration by pathogen difficult or impossible



a) Pre-infectional structural mechanisms (physical protection)

- The first line of defense in plants is present on its surface.
- The surface layers provide a physical barrier to penetration, and toxic chemical on the surface layers or inside the host cells prevents the establishment of pathogens.

b) Post-infectional Defense Mechanisms

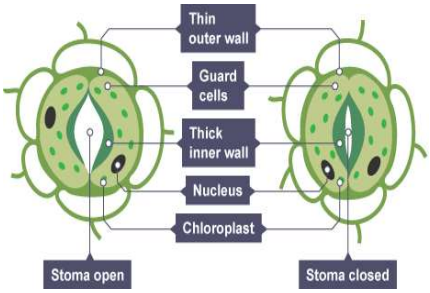
- These structures consist lignified cells and cork layers, development of abscission layers and formation of tyloses, gum deposition,etc.
- Lignification – There is strong evidence that lignification is an important mechanism for plant disease resistance.

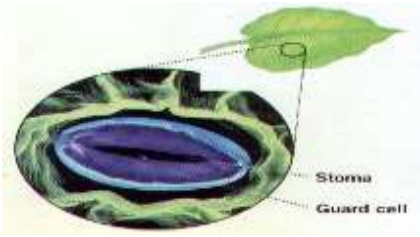
C) Structure and Number of Natural Openings

- Many fungi and bacteria can enter the host only through the natural openings such stomata and lenticels.
- The structure of the stomata ,e.g., a very narrow entrance, broad elevated guard cells, may also confer resistance to some varities against bacterial pahtogens(figure given below)

D. Pre-infectional Biochemical mechanisms

Some compound released by certain type of plants however seen

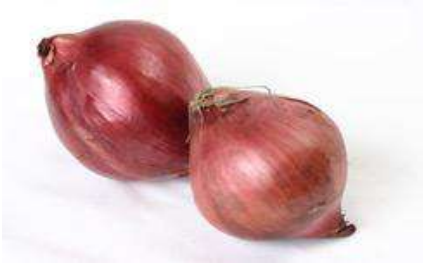




to have an inhibitory action against certain pathogen. Example-In contrast to red and white onions, white onions do not contain significant quantities of certain phenolic chemicals (one is catechol).

Conclusion

- Plant species is affected by approximately 100 different kinds of fungi, bacteria, mollicutes, viruses and nematodes.
- Plant defense themselves against pathogens by combination of weapons from two arsenals: the



Resistant

Susceptible

structural characteristics that act as physical barriers and inhibit pathogen from gaining entrance and spreading through plant and Biochemical reaction that take place in the cells and tissues of plant and produce substances that are either toxic or create condition that inhibit the growth of pathogen in the plant.

*****

ROLE OF SILICON
IN PLANT DISEASE CONTROL

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Silicon (Si) is the second most abundant element in the earth's crust, being surpassed only by oxygen. Silicon present in the soil solution in the form of monomeric or monosilicic acid (H_4SiO_4) and is readily absorbed into the root system. It improves tolerance to drought, gives greater resistance to metal toxicity and lower intensity of diseases and pests. The beneficial effect of Si was associated with reducing disease intensity, initially in monocots, including grasses or poaceae, in the 60s, because of its ease of uptake, translocation and accumulation. In rice, it was associated with lower incidence and severity of rice blast, brown spot and sheath blight and many other important agricultural crops.

Modes of silicon in plant disease control

1. Physical barrier formation

There is the hypothesis of a possible physical barrier formation, which is based on the form of Si accumulation in plants, mainly in the cell wall. In its upward movement, via apoplast, from the roots to the leaves, silicon polymerization occurs in the extracellular spaces, accumulating on the walls of the epidermal cells of leaves and xylem vessels. Si is absorbed in roots, in the form of monosilicic acid, and is transported passively through transpiration stream and deposited beneath the cuticle ultimately forming a double layer cuticle-silica.

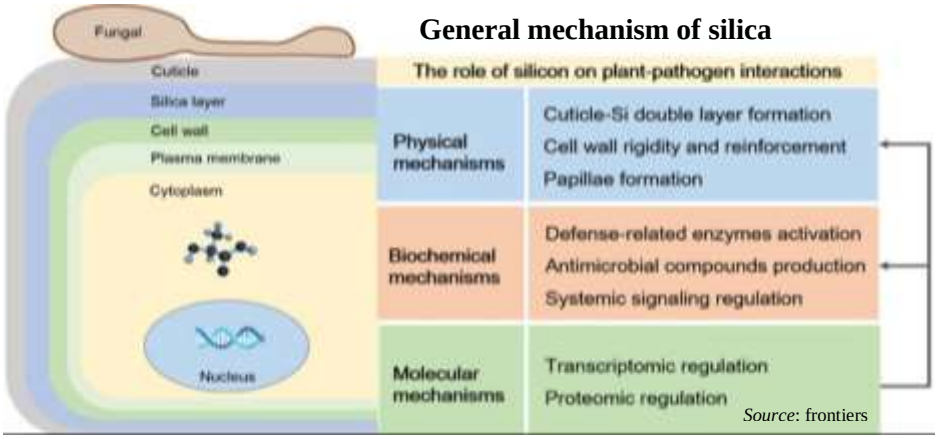
2. Biochemical mechanism

Increased production of phenolic compounds, phytoalexins and lignin, the activity of enzymes related to defense such as chitinases and β-1, 3 - glucanases, as well as increased expression of genes associated with plant resistance to pests and diseases. Studies on cucumber leaves treated with Si showed that the resistance to infection may be involved in the expression of the gene encoding proline-rich protein (PRP1).

Conclusion

Undoubtedly, silicon can contribute to reduce the intensity of diseases in the field. Silicon is absorbed and translocated and can be found at the infection sites, especially in monocotyledons, forming both physical and biochemical resistance barriers. Moreover, silicon is reported to interfere with the absorption of essential nutrients to plants, including horizontal resistance to form barriers as the wax layer and the cell wall, among others. In future silicon regulated plant microbe interaction, such as plant signaling transduction and transcriptome regulation of defense related pathways are needed for further study.

General mechanism of silica



Source: frontiers

S. No.	Pathogen	Causal organism	Type of defence	Mode of action
1.	Rice blast	*Pyricularia grisea*	physical	Cuticle- silica double layer
2.	Grapes powdery mildew	*Uncinula necator*	physical	Silica layer in leaf cuticle
3.	Cucumber powdery mildew	*Sphaerotheca fuliginea.*	Physical	Polymerization of potassium silicate in cuticle
4.	Cercospora leaf spot	*Cercospora coffeicola*	Physical	Thicker epicuticular wax layer,
5.	Downy mildew of rose	*Podosphaera pannosa*	Biochemical	Flavonoids and other phenolic compounds
6.	Sorghum anthracnose	*Colletotrichum sublineolum*	Biochemical	Si deposition on infection site, ultimately fewer or small acervuli

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