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CRISPR/CAS9 GENOME EDITING REGULATIONS AND PERCEPTIONS

By Kumari et al.

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Article ID: 22/08/100640

CRISPR/CAS9 GENOME EDITING REGULATIONS AND PERCEPTIONS

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INTRODUCTION

Gene editing (also known as genome editing) is a set of technologies that enable organism DNA or RNA to be altered. Their key feature is their ability to precisely alter nucleotides in the DNA/RNA of an organism. The alterations can range from altering one base to deletion/replacement/structural reorganization of a large region of the genome. These changes could be the same as natural mutations or they could be attainable through conventional mutagenesis. The introduction of specific foreign DNA/RNA not available in the natural gene pool of the host plant species could also result in the introduction of novel traits through genome editing. Genome editing has many applications including crop improvement, crop nutrition enhancement, crop protection, biofuels, pharmaceuticals, and other high-value secondary metabolites (Robbins *et al.*, 2021).

Since the technology involves genome manipulation we need to analyze if any of the products are subject to biosafety or environmental safety regulations because of the Indian ratification of the Cartagena Protocol. Thus, creating appropriate biosafety frameworks so that genome editing technologies can be utilized for agricultural and food research, development, and commercialization is essential. Specifically, this document outlines the biosafety and/or environmental safety concerns and describes the regulatory procedures to be followed when undertaking the genome editing of plants, intending to develop and implement Genome Editing Technologies in India.

THE REGULATION OF GENOME-EDITED PLANTS

The activities related to Genetically Engineered plants (GEP) or cells and hazardous microorganism are regulated as per Rules, 1989 (Rules, 1989) notified by the Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India under the Environment (Protection) Act, 1986 (EPA 1986). However, GEP via CRISPR/Cas9 technology falls for exemption of regulations. Genome-edited plants are categories under Site-Directed Nuclease SDN-1/-2, which do not contain any new combination of the genetic material of foreign material or any exogenous DNA. Thus, the SDN-1 final products are the same as naturally occurring loss of function or changes in gene activity, or those that are the result of induced mutation breeding or loss of function (http://www.dbtindia.nic.in).

As well, products from naturally occurring mutations or those that have been induced by mutation breeding are not regulated under the 1989 Rules; therefore, the final SDN-1 genome-edited plants are exempt from the 1989 Regulations and risk assessments as they have been proven to contain no exogenous DNA.

However, in the early stages of research and development before official approval of the removal of gene editing reagents by genetic segregation or by any other suitable means, the existing research requirements for rDNA will apply. Genome-edited plants in the SDN-2 category have specific nucleotide substitutions introduced through DNA repair templates (e.g., targeted edits or targeted allele replacements) and are not carried with exogenous DNA (Fig. 1). They are comparable to naturally occurring mutants or variants that result from conventional mutagenesis (http://www.dbtindia.nic.in).

Genome-edited plants belonging to the SDN-2 category carry specific nucleotide substitutions (e.g., targeted edits or targeted allele replacements) introduced through DNA repair templates but do not carry any exogenous DNA and are comparable to naturally occurring variants or mutants obtainable through conventional mutagenesis (Figure 1). The same products produced by naturally occurring mutations or those derived through mutation breeding are not regulated.

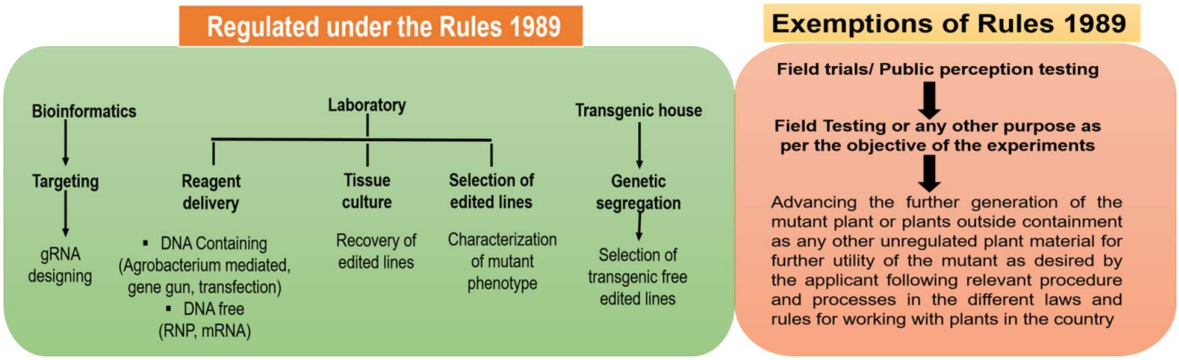

Fig. 1: Genome editing in plants: Workflow for SDN-1 and SDN-2 type modifications

PERCEPTIONS OF RISKS AND BENEFITS

CRISPR/Cas9 technology has the potential to contribute to food security. Public attitude can shape the direction of acceptance of edited plants and will improve the adoption of edited plants into the food and agriculture system. New technologies are accepted depending on how they are perceived in terms of risks and benefits. There are four key groups of perceptions about gene editing applied to agriculture (scientific experts in genome editing, farmers, policymakers, and the general public). The public's perception of risk is not based solely on objective data or scientific understanding but also includes subjective and value-laden components (Robbins *et al.*, 2021).

The scientific community demonstrated a high level of technical expertise regarding the technology, emphasizing its precision, target, power, and potential, but they acknowledged risks associated with off-target mutations. Moreover, policymakers also demonstrated a fairly high level of technical sophistication while emphasizing the perceived benefits for society. Despite acknowledging the potential for controversy and ethical concerns with CRISPR, they spoke broadly about potential benefits to society, focusing on feeding the world's population. Farmer's use of scientific terminology was not high but their representation of the technology was generally positive. Generally, they highlighted perceived personal economic benefits, such as reduced chemical inputs. Farmers also expressed concern about perceived risks relating to genome editing. There is a low level of prior knowledge of genome editing and CRISPR among the general public, which can be seen by the fact that their responses rely on terms included in the essay prompt. They expressed uncertainty and cautious optimism, framing their responses in evaluative terms, and of course expressing a low level of understanding. Despite the lack of a developed social representation, CRISPR presents an opportunity to communicate the potential risks and benefits of the technology (Robbins *et al.*, 2021).

CONCLUSION

Genome-edited plants provides a new opportunity for crop development. As CRISPR moves towards deployment, agricultural policy professionals will play an increasing role in understanding the technology and its potential benefits for agriculture and society. Generally, these results suggest an openness to new information about technology, as well as opportunities for interaction.

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Website: http://www.dbtindia.nic.in (Guidelines for Safety Assessment of Genome Edited Plants, 2022)

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MAJOR DISEASES OF RICE (*ORYZA SATIVA* L.) AND THEIR SUSTAINABLE MANAGEMENT

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INTRODUCTION

Rice (*Oryza sativa* L.) being the most essential cereal is consumed by about 50% of the world population. According to FAO, it is considered a staple food providing 2400 calories/ day which is the least food safety required for a person/per day. In 2004, "Rice is Life" was the theme of the International Year of Rice that reflecting the importance of rice, which hold the key to our country's ability to produce enough food for our people. India is the second-largest rice-producing country contributing production of 112.91(MT) in an area of 43.79 (000ha) with a yield of 2578 kg/ha after China (DES, 2018). In India, west Bengal is the leading state in rice production followed by U.P, Punjab, T. Nadu, Andhra Pradesh, and Bihar. Unfortunately, this crop is susceptible to several diseases which reduced its economic importance. So different diseases caused by a pathogen (Fungus, Bacteria, and Viruses) are listed in table 1.

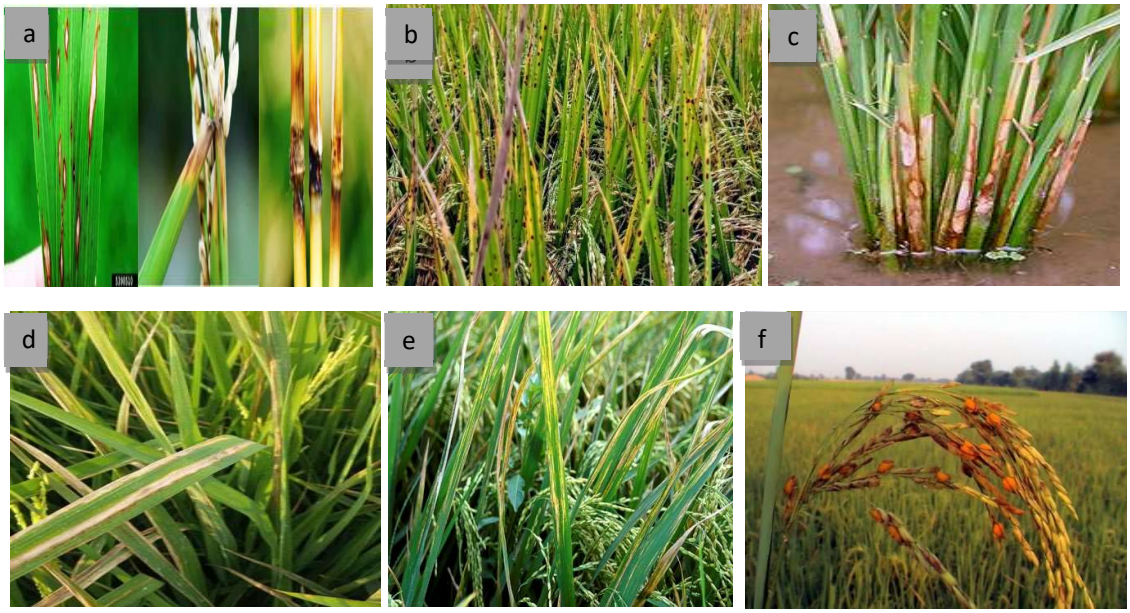

Fig. 1. Rice diseases (a) Blast (b) Brown spot (c) Sheath blight (d) BLB (e) BLS (f) False smut

Table. 1. Major diseases of rice and their management

Diseases & causing agent	Symptoms	Managements
Fungal diseases		
Rice blast (*Pyricularia grisea)*	The fungus invades nearly all above-ground parts of the crop. Depending on the site, rice blast symptoms are- Leaf blast, an elliptical or spindle-shaped lesion with brown borders having grey centres is produced which under favourable conditions becomes enlarged and coalesces eventually killing the leaves. A collar blast appears when the pathogen infects the collar which later kills the whole leaf blade of the crop. The node of the stem starts turning blackish and can break easily, the condition called a node blast. Infected neck (neck blast) symptoms showed girdling by a greyish brown lesion which leads the panicle to fall over the severe infection. The formations of brown lesions on the branches of panicles and the spikelets are also produced by a fungus.	1. Minimize the use of nitrogenous fertilizer. 2.Treat the seed with Tricyclazole 75 WP @ 2 g/kg or Carbendazim 50 WP @ 1 g/kg. 3. Spray Tricyclazole 75 @ 0.6g/litre or Carpropamid 30 SC @ 1ml/litre. Or Isoprothiolane 40 EC @ 1.5 ml/litre or Iprobenphos 48 EC @ 2ml/litre or Kasugamycin-B 3 SL@2.5 ml/litre or Carbendazim 50 WP @ 1 g/litre. 4. Adoption of blast-resistant varieties like Rasi, IR 64, Prasanna, IR 36, Vikas, Tulasi, Sasyasree, etc.
Sheath blight (*Rhizoctonia solani*)	Symptoms initiate with lesions formation on the leaf sheaths although leaf blades may also be affected. Normally, small, ellipsoid or ovoid lesions of greenish-grey colours are developing near the water line in lowland fields. Under favourable conditions, lesions become enlarged and coalesce resulting in the formation of bigger lesions having an irregular outline and greyish-white centre with dark brown borders. On plant leaf sheath the presence of numerous large spots causes the death of the whole leaf.	1. Spray of Validamycin 3 L @ 2.5ml/litre or Thifluzamide 24 SC@ 0.75 g/litre or Hexaconazole 5EC @ 2 ml/litre or Propiconazole 25 EC @ 1ml/litre or Carbendazim 50 WP @ 1g/litre found effective. 2. Apply 2-3 split applications of nitrogen fertilizer.
Brown spot (*Bipolaris oryzae*)	Brown spots may also appear as seedling blight, foliar, and glume disease. On seedlings, small, circular, and brown lesions are produced which may girdle the coleoptile and leads to distortion of the primary as well as secondary leaves. The root discolorations of the infected plant are also produced during infection. On the leaves of older plants, circular to oval lesions having light brown to grey centre is surrounded by a reddish-brown margin produced by the fungus. Further severity causes coalition of the lesion which results in the killing of large areas of affected leaves. The fungus may also infect the glumes	1. Proper crop nutrition with clean cultivation. 2. Avoidance of water stress. 3. Treatment of seed with Mancozeb (63%) + Carbendazim (125) @ 2g/kg of seed is effective in the control of the disease. 4. Resistance varieties such as Rasi, IR36, and Jagannath should be grown.

	producing dark brown to black oval spots, and later the grain also gets infected and leads to black discoloration.	
Sheath Rot (*Sarocladium oryzae*)	Normally, rotting will occur on the leaf sheath which encloses the young panicles. The oblong or somewhat irregular spots lesion of 0.5-1.5 cm long, with grey to light brown centres that are surrounded by dark reddish-brown margins is formed. Later, lesions enlarge and coalesce which cover major parts of the leaf sheath. Lesions may also concur with sow reddish-brown discoloration in the sheath. Profuse whitish powdery growth may also find inside the affected sheath. The panicle may fail to emerge completely at severe infection so the young panicles remain within the sheath or only partially will emerge. Non-emerged panicles tend to rot, which turns florets red-brown to dark brown.	1. Seed treatment with Mancozeb 75 WP @ 2.5 g/kg or Captan 50 WP will be effective in disease control. 2.Spray of Mancozeb 75 WP @ 2.5 g/kg or Hexaconazole 5 EC @ 2 ml/litre or Propiconazole 25 EC @ 1 ml/litre or or Thiophanate methyl 70 WP @ 1 g/litre control the progress of the disease.
False Smut (*Ustilaginoidea virens*)	The disease occurs from the hard dough to the mature stage of the crop. The individual grains of the panicle get transformed into greenish spore balls having a velvety appearance. Initially, the spore balls are small and then visible in between glumes, which gradually grow to reach 1 cm or more in diameter and cover the floral parts. At further growth, the membrane gets bursts and releases spore balls. Later on, the ball becomes orange and yellowish-green or greenish-black. The ball surface gets cracked at this stage. The outermost layer of the ball is green and consists of mature spores together with fragments of mycelium. The outer soporiferous area has three-layered. The outermost layer is greenish-black having powdery spores; the middle layer is orange while the innermost layer is yellowish.	1. Use of disease-free and healthy seeds for sowing. 2. Hot water treatment of seed @ 52ºC for 10 min 3. Removal of diseased panicles in the field. 4. Seed treatment with Carbendazim @2.00g/kg seed. 5. Spray Propiconazole 25 EC @ 1 ml/litre or Chlorothalonil 75 WP @ 2 ml/litre or Copper oxychloride at around flowering.
Bacterial diseases		
Bacterial Blight (*Xanthomonas oryzae* pv. *Oryzae*)	Usually, water-soaked lesion starts at leaf margins, a few cms from the tip, and spread to the leaf base; affected areas become yellowish to light brown due to drying; with the yellowish border between the dead and green portion of the leaf which usually observed at the maximum tillering stage and onwards. In severe infection, it causes withering of leaves or entire young plants (refers as kresek) and the production of pale-yellow leaves at a later stage of the growth which also reduced grain	1. Application of judicious amount of fertilizer (60-80 kg N and required dose of K), Apply N in 3-4 splits. 2. Destroyed infected stubbles and weeds. 3. Use of resistance varieties like Ajaya, IR64, IR-20, etc. 4. Spray 0.05g Streptocycline and Copper Sulfate.

	quality.	
Bacterial Leaf Streak (*Xanthomonas oryzae pv. Oryzicola*)	Firstly, short water-soaked streaks between the veins, appear which later become longer and translucent, and then the colour turn to light brown or yellowish-brown. The large leaf area becomes dry due to heavy streak infection. At the later stage, it is difficult to distinguish BLS from BLB.	1. Removal of weed host and stubbles. 2. Application of balanced N fertilizers. 3. Sowing of resistant varieties suppresses the disease. 4. The spray of copper-based fungicides at the crop heading stage.
Viral diseases		
Tungro (Rice tungro bacillifor virus and spherical virus)	Stunting of the infected plant which later changes leave colour to orange-yellow or yellow. The discoloration of leaves initiated from the tip and spread to the lower parts of the leaf blade. The new young leaves give mottled symptoms while the old leaf gives the appearance of rusty-colored specks of various sizes. The inflorescence (panicle) of the infected plant becomes small and is not completely exerted and mostly bears partial grains covered with dark brown specks. Infections also lead to delays in flowering. The viral is mainly transmitted by green leafhoppers.	1. Adopt resistance varieties *viz;* IR-36/MTU-9002, and 1003 2. Field sanitation. 3. Apply Carbofuran 3G @10kg/ac or Phorate 10 G 2 5kg/ac found effective in the control of the disease in the nursery. 4. Spraying of Monocrotophose 36EC @400ml/ac or Cabaryl 50WP @600g/ac, etc. is found effective against the disease.
Grassy Stunt (Rice grassy stunt virus)	Infected plants show severe stunting; excessive tillering, with short leaves that are narrow and, pale green to pale yellow. The plant may have newly-expanded leaves that might be mottled or striped and may also have numerous small, irregular, dark brown, or rust-colored spots. Brown planthopper is a carrier of the virus.	1. Removal of the infected plant from the field. 2. Grow resistance varieties viz; Nidhi, Radha, Triveni, etc. 3. Use of Carbofuran 3G @10g/ac or Isazophos 3G @10g/Ac in a nursery. 4. Spray monocrotophose 36EC @400ml/ac.
Ragged Stunt (Rice ragged stunt virus)	Initially, symptoms begin with stunting of the tillers. The damaged leaves become short, dark green, serrated along one or both edges which hives a ragged appearance. The leaf blades start twisting and form a spiral. Ton the leaf sheath, there is an appearance of vein swellings. The disease is transmitted by brown planthopper.	1. Resistance varieties *viz;* Nidhi, Radha, Triveni, etc suppress the disease rate. 2. Application of Carbofuran 3G @10g/ac or Isazophos 3G @10g/ac in a nursery controls the insect population. 3. Spraying of Monocrotophose 36EC @400ml/ac is found effective against BPH.

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HEALTH BENEFITS, USES, AND SIDE EFFECTS OF SAFFLOWER OIL

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INTRODUCTION

Safflower (*Carthamus tinctorius L.*) is the most significant oilseed crop which is grown in semi-arid areas. It belongs to the family of Compositae or Asteraceae. It is grown throughout the world, including in North America, primarily for its oil, though it is also used as animal feed. safflower oil is rich in polyunsaturated fatty acids (75 percent) and alpha-tocopherols (Furuya et al., 1987) and it is utilized as margarine, cooking oil, and salad oil.

SAFFLOWER OIL NUTRITION:

Safflower contains 23-36% oil content depending upon the variety used. Safflower oil is high in polyunsaturated fatty acids like tocopherol and linoleic acid, which are used in both medical and dietetic applications (Han et al., 2009). unsaturated fatty acids like linoleic and oleic acid are present in high amounts, accounting for 77.9-79.5% and 9.5-11.3% of total fatty acids, respectively (Mihaela et al., 2013). While Saturated fatty acids are present in smaller amounts accounting for 9.7 to 10.8% of total fatty acids. Palmitic and stearic acids are the most common saturated fatty acids accounting for 7.2-8.6% and 2.0-2.4%, respectively (Ben Moumen et al., 2013). safflower oil is rich in antioxidants i.e., α-tocopherol (46.05e70.93 mg/100 g), β-tocopherol (0.85e2.16 mg/100 g) and γ-tocopherol (from trace amount to 0.45 mg/100 g oils) l (Matthaus, Ozcan, & Al Juhaimi, 2015). The human body needs these fats to function. Unsaturated fatty acids are more beneficial than saturated fatty acids. These are essential for the regulation of hormones.

SAFFLOWER OIL BENEFITS & MEDICINAL USES

There are two types of heart-healthy safflower oil: high-oleic safflower oil and high-linoleic safflower oil. They Both are good for the heart and decrease the cholesterol level. Safflower oil with a high linoleic content is good for skin issues like acne and pimples.

1. **Hypercholesterolemia (High Cholesterol levels)**

   Safflower oil content is high-oleic and high-linoleic both lowering the cholesterol levels. Both contain lower saturated fat (shortest-chained omega-6 fatty acid). However, polyunsaturated oil has a higher amount. Linoleic acid (LA) decreases LDL cholesterol, or "bad cholesterol," and defends the heart and blood vessels.

2. **Atherosclerosis**

   safflower oil also reduces the chance of developing atherosclerosis by lowering total serum cholesterol and LDL cholesterol. polyunsaturated fatty acids (PUFA) also prevent atherosclerosis by lowering inflammation and pro-inflammation situations.

3. **Stroke & Heart Attack**

   It also prevents strokes and heart attacks through similar mechanisms to those explained under hypercholesterolemia and atherosclerosis. Additionally, it has anti-ischemic and anti-thrombotic qualities that aid in preventing ischemia and the development of thrombus in the blood vessels.

4. **Obesity – Weight Loss**
   Safflower oil significantly reduced trunk adiposity (abdominal fat), whereas Conjugated Linoleic Acid (CLA) considerably raised trunk adiposity. Additionally, it was shown that CLA decreased total lean mass while safflower seed oil enhanced overall lean mass.
5. **Anti-inflammatory**
   Safflower oil has anti-inflammatory qualities, which its vitamin E content may be responsible for. Safflower oil comprises omega-6 fatty acids, thus mixing it with oil that is high in omega-3 fatty acids can produce the best benefits. It is probably better to use it with olive oil when cooking.
6. **Acne**
   Acne can be treated with Safflower oil, which has a high linoleic content. Linoleic acid, which is abundant in safflower oil, helps to reduce sebum buildup beneath the skin and thereby reduces acne, whiteheads, pimples, and blackheads.
7. **Pruritus (Itchy Skin)**
   Localized usage of cold-pressed, high-linoleic safflower oil helps to lessen the acute itching that can be brought on by a variety of underlying conditions, such as dry skin, rashes, and skin infections.
8. **Wound healing**
   Healing wounds is aided by cold-pressed, high-linoleic safflower oil. In cases of old, non-healing wounds, it is quite helpful. Regular application speeds up the healing process and protects wounds from infection.
9. **Constipation**
   according to Ayurveda, Safflower oil aids in the treatment of constipation.
10. **Premenstrual Syndrome (PMS)**
    cold-pressed safflower oil helps control prostaglandins in the body due to its high amount of linoleic acid. so, it decreases sudden hormonal fluctuations.

Safflower Oil Side Effects

Due to its effects on blood thinning, it may slow blood clotting.

Pregnancy & Lactation

Safflower oil may be safe for pregnant women if consumed as a food in a quantity that is manageable and simple to digest.

Safflower Oil Allergy

The common symptoms of safflower seed oil allergy are:

- Sneezing
- A runny nose
- Nasal congestion
- eye irritation
- Sinus headaches
- Post-nasal drip
- Skin rashes
- Hives
- Difficulty breathing

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TERRAFORMING: FEASIBLE OR FICTION

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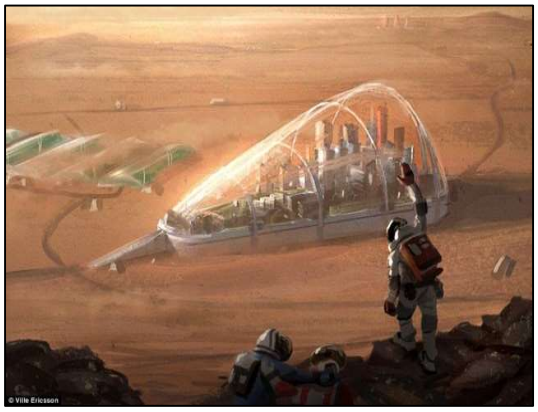
ABSTRACT

The hypothetical process of purposefully altering a planet, moon, or other body's atmosphere, temperature, surface topography, or ecology to be comparable to Earth's environment in order to make it habitable by Earth-like life is known as terraforming. NASA lists "extended expanses of liquid water, conditions favourable for the construction of complex organic molecules, and energy sources to support metabolism" as the three main criteria for habitability. The "worldhouse" idea is another name for paraterraforming. A planet can be made habitable by terraforming, and this enclosure ultimately expands to cover the majority of the planet's usable surface. Geoengineering (in a sense, "terraforming" Earth itself) is the large-scale, intentional manipulation of the planet's environment. On the other side, terraforming's proponents have faced opposition and their cases contain obvious flaws. We should conserve water, use less oil, adopt green energy, cut back on trash and single-use plastics, and plant more trees in order to rescue the Earth.

WHAT IS TERRAFORMING?



The hypothetical process of purposefully altering a planet, moon, or other body's atmosphere, temperature, surface topography, or ecology to be comparable to Earth's environment in order to make it habitable by Earth-like life is known as terraforming.

REQUIREMENTS FOR HABITABILITY

Energy is a necessity for life, but the idea of planetary habitability suggests that many additional geophysical, geochemical, and astrophysical requirements must be satisfied before the surface of an astronomical body is capable of supporting life. The combination of elements that have supported both basic organisms and large, multicellular species on Earth is particularly intriguing. Planetary science and the newly

developed field of astrobiology both include research and theory in this area. NASA lists "extended expanses of liquid water, conditions favourable for the construction of complex organic molecules, and energy sources to support metabolism" as the three main criteria for habitability.

PARATERRAFORMING

The "worldhouse" idea is another name for it. A planet can be made habitable by terraforming, and this enclosure ultimately expands to cover the majority of the planet's usable surface. Compared to the conventional method of terraforming, paraterraforming provides a number of benefits. The worldhouse starts out small in size, but those sections are livable right away, giving investors a rapid return. Reducing the amount of atmosphere that will be added to planets to create Earth-like atmospheric pressures is known as paraterraforming. Even bodies that would otherwise be unable to keep an atmosphere at all (such as asteroids) could be provided a habitable environment by using a solid envelope in this way.

GEOENGINEERING

Geoengineering (in a sense, "terraforming" Earth itself) is the large-scale, intentional manipulation of the planet's environment. The idea that human civilization has already unintentionally changed Earth's climate through the industrial emission of greenhouse gases is currently the subject of intense debate, and plans have been made to counter any such consequences by more intentional geoengineering.

PROBABLE SITES

Possible candidates for terraforming -

1. Mars
2. Venus
3. Mercury
4. Moon
5. Large moons of Jupiter or Saturn (Titan, Callisto, Ganymede, Europa, Enceladus)
6. Dwarf planet, Ceres

CHALLENGES

1. Ethical issues - The morality of terraforming other planets is a topic of philosophical discussion in biology and ecology. If nature is allowed to run its course, Earth will eventually be destroyed, leaving humanity with the very long-term option of terraforming other planets or letting all terrestrial life go extinct.
2. Economic issues - Projects like planetary terraforming would need enormous upfront costs, and its infrastructure would need to be created from scratch. Such technology has not yet been created, let alone made financially practical.
3. Political issues - Terraforming a planet raises a number of potential political difficulties, such as who would control the extraterrestrial land on the new planet. Potential owners include national governments, multinational businesses, the United Nations, and individual residents.

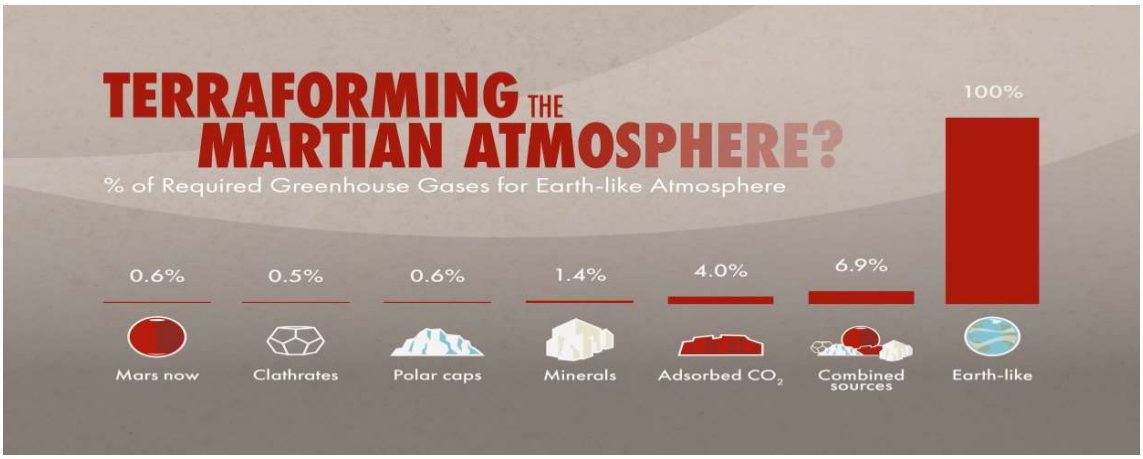
WHY WOULD WE WANT TO LIVE ON MARS?

It serves as the human race's fallback strategy in the event that a global catastrophe occurs on Earth. Threats that could be fatal include pandemics, asteroid impacts, and nuclear war. If the worst were to happen, colonizing other planets might guarantee the survival of humanity.

CAN MARS BE TERRAFORMED?

No, is the swift response. It is not feasible with present technology. The research team identified all potential carbon dioxide stores on Mars and their potential contributions to the atmosphere using data from rovers and spacecraft that have been monitoring the planet. Recent expeditions to Mars have revealed that the vast majority of the planet's once-habitable atmosphere has been stripped away by solar wind and radiation and

lost to space. Gas that has been lost will be ionized and transported away by the solar wind extremely quickly. Once lost, anything cannot be found again.



CONCLUSION

Terraforming is a fascinating and intriguing concept. Potentially useful in oxygenating the atmosphere are photosynthetic species. This gives us reason to think that an oxygen-rich atmosphere might be created with more plants and more time. There are numerous factors at play, but terraforming ethical debates are regrettably the most prevalent. On the other side, terraforming's proponents have faced opposition and their cases contain obvious flaws. We should conserve water, use less oil, adopt green energy, cut back on trash and single-use plastics, and plant more trees in order to rescue the Earth. We should make Earth green again.

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FIREFLIES : THE LIGHTNING BEETLES UNDER THREAT

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ABSTRACT

Fireflies are most charismatic beetles due their property of bioluminescence among all the coleopteran insects. They are often categorised as nocturnal insects, however some of them are diurnal, and others exhibit both nocturnal and diurnal traits. They are found in varieties of habitats such as ponds, streams, mangroves, marshes, and desert seep. Globally there are about 2400 described species and only 35 species are present in India. Due to the various anthropogenic activities the population of this most fascinating beetle is under threat. So they should be declared as protected species by law so that the threats can be eliminated.

INTRODUCTION

Adult of Firefly

Due to their capacity to produce breathtaking bioluminescent displays, fireflies are among the most endearing insects on the planet. Beetles have evolved successfully over the course of their 297 million year history (Zhang *et al.* 2018), making up 38 percent of all known insect species (Stork 2018). Fireflies are one of the most charismatic beetles (Coleoptera: Lampyridae), and their unusual bioluminescent courtship behaviours could serve as a model for other insects in need of protection. They are often categorised as nocturnal insects, however some of them are diurnal, and others exhibit both nocturnal and diurnal traits. Due to their capacity to emit light, they are often referred to as luminous insects. Many cultures and lifestyles find fireflies to be appealing, and they evoke pleasant childhood memories of earlier rural living. Fireflies are economically important in many countries, because they represent a growing ecotourist attraction (Lewis 2016).

WHAT ARE FIREFLIES?

Fireflies during night in a forest

Fireflies are a very diverse group of beetles with more than 2000 species worldwide, belonging to the Lampyridae family. The lightning bug due to its ability to emit light, is referred to as a firefly. *Pteroptyx, Luciola, Colopthia, and Lychnuris* are the four genera into the Lampyridae family of fireflies (Nada & Kirton, 2004). They are among the most fascinating insects in the world due to their many species, which include nonluminous adults, flightless female fireflies, and lightning bugs (Lewis et al. 2020). A few other names for fireflies are woodland stars, lighting bugs, fire devils, flying embers, moon bugs, glow flies, and blinkers.

DISTRIBUTION

In addition to grasslands and woods, fireflies can be found in a variety of habitats, such as ponds, streams, mangroves, marshes, and desert seeps (Lloyd, 2002). There are 11 subfamilies and roughly 2400 described species worldwide. Only roughly 35 species have been described in India. There hasn't been a systematic study of fireflies in India yet, according to science. Both tropical and temperate regions have them as signs of peak vegetation. Fireflies emit chilly light devoid of infrared and other dangerous wavelengths. Adults occasionally act as pollinators and predators and are crucial for a stable ecology. Adults are responsible for eco-tourism.

DESCRIPTION

Sexual dimorphism is visible in firefly adults. The semicircular pronotum of the males, which extends dorsally and covers the head, is usually an identifying feature. Contiguous and well-developed eyes are present. The forewings, which are flexible and delicate tegmen, do not completely round the abdomen. On the ventral side of the abdomen, the sixth and seventh segments of adults feature a photogenic organ that is often more noticeable in males than females. Larvae typically have lateral extended pleurae and are flat, cylindrical, or worm-like (Platyform type). Being carnivores, they have increased intestinal digesting. Aquatic species' larvae frequently have decreased sclerites and may have gills. A molecule called **luciferin,** which is a monocarboxylic acid, is oxidised in the presence of the enzyme luciferase to create the light. Using luminescence during courtship and reproduction, attracting prey, alerting predators, or other purposes.

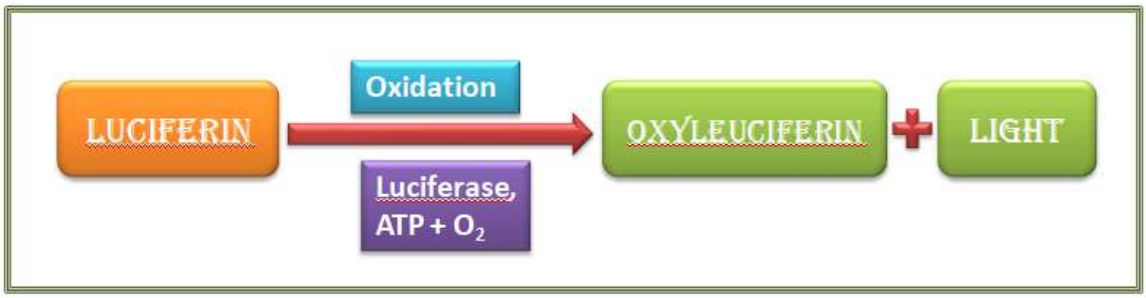

Fig. 1 The chemical reaction showing the production of light in fireflies

Life cycle

Fireflies are the holometabolous insects (presence of complete metamorphosis).The life cycle includes eggs, larvae, pupae and adults. The entire life cycle may be of six to seven months (about 150-200 days). Female fireflies lay their eggs on mossy or wet soil. The time it takes for an egg to grow into a larva is around 15- 20 days. And the larvae will turn into pupae in 23 months. The pupae will mature into adult fireflies in 9-12 days. While the lifespan of mature fireflies is only thought to be 2-3 months, the process of converting them from egg stage to adult stage takes around 6-7 months (Ohba & Sim, 1994).

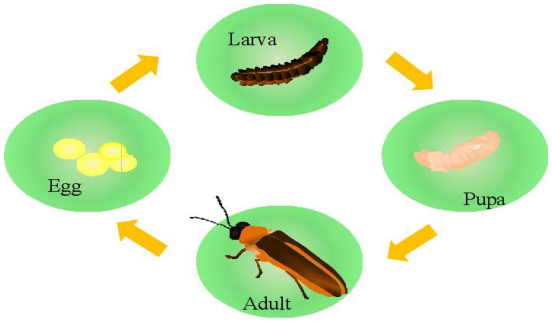

Fig. 2 Life cycle of Firefly

CONSERVATION

Anthropogenic activities challenge all the wildlife around the world including fireflies. The number of fireflies is steadily diminishing. Naturalists, foresters, administrators, scientists, and other groups haven't given fireflies the attention they need. Due to their abundance when they gather among mangrove trees, watching fireflies has grown into a successful global industry. In locations where there are a lot of firefly, ecotourism has taken off. However, the fireflies are in danger due to habitat loss, pesticide use, invasive species, climate change, artificial nighttime lighting, urban development, human interference, and habitat fragmentation. As a result, appropriate conservation strategies, research, and awareness-raising activities should be carried out. Populations are dwindling, and even the fundamentals of firefly biology, such as species diversity, bioecology, and behaviour, are poorly understood in India. Fireflies are therefore a problem for our nation because they are important from both an ecological and economic standpoint.

CONCLUSION

Fireflies are the one of the most fascinating insects due their ability of producing light and responsible for eco-tourism. Adults serve as pollinators, predators and are essential for stable ecosystem functioning. Due to the various anthropogenic activities their population is declining. So, they should be declared as protected species by law and various firefly habitats having tourist potential should be declared 'Protected habitats'. So that the threats that causes firefly population decline can be eliminated.

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BEE PRODUCTS AND THEIR APITHERAPEUTIC VALUE

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INTRODUCTION

Since ancient times in many parts of the world insects and insect-derived products are used as medicine. The term apitherapy refers to a kind of treatment where bee products are used, especially honey, bee pollen, propolis, and royal jelly. However, there are two directions in this field: scientific apitherapy and holistic apitherapy. The holistic approach to apitherapy is considered as a part of complementary and alternative medicine that has been widely promoted in books, apitherapy congresses, and beekeeping conferences. Apitherapy is a type of alternative therapy that uses products that come directly from honeybees. People are realizing that modern medicine is not the only way to treat infections. As a result, many of us are looking to the past for alternative approaches with the fewest possible side effects, such as apitherapy. This article discusses the use of bee products and their clinical significance in human healthcare. Science advancements have given us a better understanding of the ingredients found in bee products, and there is a lot of interest in using them for medical purposes. These bee products aid in healing by increasing circulation, reducing inflammation, and stimulating a healthy immune response. Thus, Apitherapy is a simple, convenient, and readily available method, is used in traditional self-health care and holds promise for the treatment of periodontal diseases, mouth ulcers, and other diseases of the oral cavity.

WHAT IS API-THERAPY?

Apitherapy is the medicinal use of honey bee products (such as honey, pollen, bee bread, propolis, royal jelly and bee venom) derived directly from honeybees in the prevention and treatment of various diseases, as well as in increasing the human body's resistance (Apimondia 1989; 1990). According to Dr Stefan Stangaciu, editor in chief of the International Federation of Beekeepers' Association, apitherapy is, 'the art and science of treatment and holistic healing through the honeybee and her products for the benefit of mankind and all the animal kingdom'. Alternatively it's also known as Api-therapy, Api-treatment, Bee Therapy, Bee Treatment, Bee Venom Therapy and Honey Bee Venom Therapy. Apitherapy can be traced back over 6000 years to medicine in ancient Egypt. It is commonly used to treat multiple sclerosis, osteoarthritis, rheumatoid arthritis, post-herpetic neuralgia, and bee sting desensitization. Cough, herpes simplex virus, premenstrual syndrome (PMS), sulcoplasty, allergic rhinitis, improving athletic performance, hyperlipidemia, and the common cold are also treated with it. At the current state of medical science and technology, the state of medical care refers to societal medical insurance and medical care systems, as well as self-health care. As a result, popularizing and spreading apitherapy, which has been used successfully for thousands of years, is worthwhile because it is a simple, convenient, and easily accessible method of self-care.

API-PRODUCTS USED IN APITHERAPY

I. BEE VENOM

Bee venom is produced by female worker bees. It is capable of being administered straight from a bee sting. A stainless steel micro mesh can be used to administer the bee sting to the skin. This permits venom to reach the skin without the stinger being embedded, which would kill the bee.



II. HONEY

This delicious sweet substance is produced by honey bees. It is also harvestable. Apigenin, acacetin, quercetin, galangin, crysin, luteolin, and hesperitin are bioactive metabolites in honey that have antibacterial, anti-inflammatory, and anti-oxidant activities. It is a powerful inhibitor of *Helicobacter pylori*, the causative agent of peptic ulcers and gastritis. The mechanism of action was related to prostaglandin generation, honey antioxidant qualities, salivary conversion of nitrate ($NO3^-$) to nitrite ($NO2^-$), and intra-gastric creation of nitric oxide (NO), the latter engaged in the maintenance of gastric mucosa capillaries and the stimulation of mucus secretion. It also has health advantages for reducing weight, boosting immunity, treating coughs, colds, and wounds.

III. ROYAL JELLY

This enzyme-rich meal is consumed by the queen bee. It has a lot of vitamins that are good for health. Royalisin, jelleines, thiamine, riboflavin, niacin, and biotin are bioactive substances found in royal jelly that have antibacterial and anticancer properties. It exhibits bio-stimulant action owing to increased respiration and oxidative phosphorylation, notably in the liver (Vittek, 1995), as well as increased oxygen intake in the brain. It has health advantages such as wound healing, lowering blood pressure, and reducing cancer side effects.

IV. PROPOLIS

This is a mixture of beeswax, tree resins, honey, and enzymes produced by bees to defend the hive from external threats such as germs or viruses. As a result, it has potent antiviral, antifungal, anti-inflammatory, and antibacterial activities. Streptococcus mutans, the bacterium that causes dental caries, has been found to be inhibited by propolis extracts containing the components pinocembrin and galangin. Propolis health advantages include wounds, cold sores, cancer and diabetes etc.

V. BEESWAX

Honeybees produce beeswax in order to construct their hive and store honey and pollen. It is often used in cosmetic goods.

CURRENT USE OF APITHERAPY

Apitherapy is used to treat a variety of illnesses, the most widely known to be post-herpetic neuralgia, multiple sclerosis, osteoarthritis, rheumatoid arthritis, and bee sting desensitization. Premenstrual syndrome (PMS), sulcoplasty, allergic rhinitis, enhancing sports performance, hyperlipidemia, and the common cold are additional conditions for which it is prescribed. There are four types of medical procedures: bee acupuncture, beeswax treatment, bee venom electro hydronium introduction, and bee ultrasono-therapy.

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BIOFERTILIZERS FOR SUGARCANE

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Fig1: Sugarcane crop

INTRODUCTION

Biofertilizers are preparations containing live or latent cells of efficient nitrogen-fixing strains, Phosphate or cellulose-degrading microorganisms are used to fertilize seeds, soil or as compost areas with the aim of increasing the population of specific microorganisms and accelerating certain microbial processes to improve nutrient availability. The nutritional requirements of sugarcane are very high and at present they are met mainly by chemical fertilizers. Integrated nutrient

management is important to stabilize and maintain sugarcane yield. Biofertilizers provide one or more nutrients, increase their availability, and improve the physical, chemical and biological properties of the soil. Therefore, bio-fertilizer should be an important of integrated nutrient management practice.

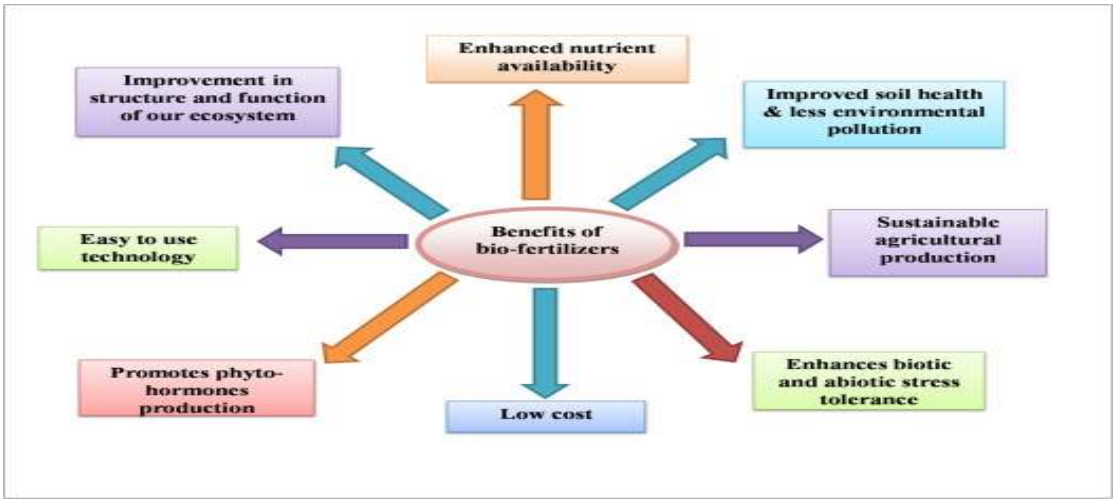
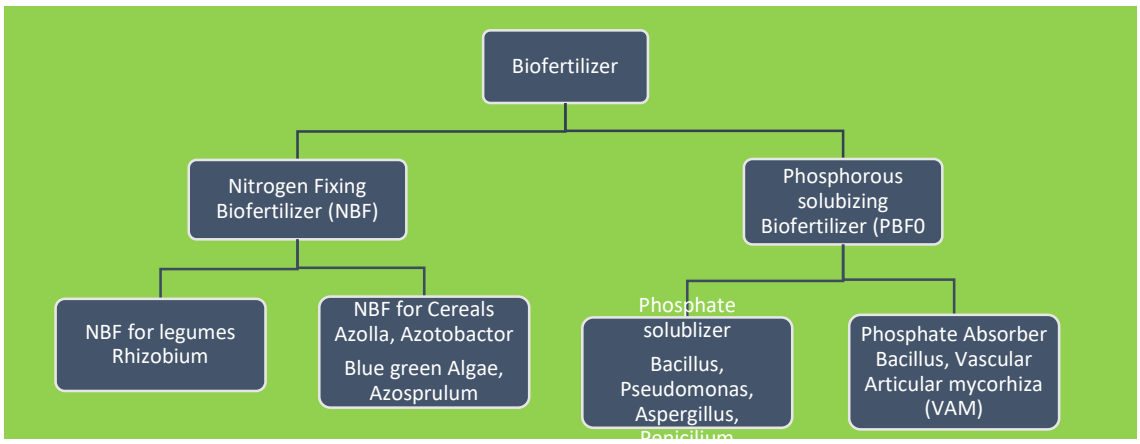


Fig 2: Benefits of Biofertilizer

Classification of Biofertilizer



Biofertilizers used in sugarcane

Nitrogen fixing biofertilizers:

Nitrogen-fixing organic fertilizers contain efficient microorganisms that can fix nitrogen elements in a form that plants can use. . In sugarcane, three bacteria viz. *Azotobacter, Azospirillum and Acetobacter* are used as nitrogen fixing biofertilizers.

1. Azotobacter is an aerobic, free-living bacterium found in large numbers in the rhizosphere. Azotobacter uses soil organic matter and plant root exudates to fix atmospheric nitrogen and produce growth-promoting substances such as gibberellic acid and indoleacetic acid, as well as polysaccharides that improve soil properties. They are relatively effective in soils rich in organic matter.

2. Azospirillum is an efficient nitrogen-fixing bacterium that can colonize plant roots. Conditions of low oxygen availability at the root surface of the rhizosphere are ideal for their growth and nitrogen fixation. It also produces growth-promoting substances and polysaccharides.

3. Gluconacetobacter diazotrophicus (also known as Acetobacter diazotrophicus) is found primarily in sugar cane, as well as in crops such as sorghum, coffee and sweet potatoes. This bacterium is an end ophyte that can colonize the surface and interior of sugarcane roots. This bacterium fixes large amounts of atmospheric nitrogen and efficiently transfers the fixed nitrogen to sugar cane.

Numerous field trials have been conducted across the country that have shown that the application of Azospirillum as a biofertilizer is more suitable than Gluconacetobacter. Application of Azospirillum saves nitrogen fertilizer by 25% and improves juice quality. It is advantageous to apply an organic fertilizer with a lower N content than the recommended N content.

PHOSPHATE SOLUBILIZING BIOFERTILZERS

Phosphorus is an important nutrient for higher yields of sugar cane and sugar. But in most soils, phosphorus availability is very limited due to immobilization, i.e. the conversion of available phosphorus to an unavailable or less available form. Only 15-20% is available to the crop to which it is applied. Many bacteria and fungi in the soil convert this insoluble inorganic phosphate into a soluble form through the production of organic acids. These microorganisms are called phosphate solubilizing microorganism.

The efficient phosphate solubilizing microorganisms are *Bacillus mageterium, Pseudomonas striata* and *Aspergillus awamori*. Among these, *Bacillus magaterium var. phosphaticum* (phosphate solubilizing bacterium, PSB) has been found suitable for sugarcane. Field experiments conducted at Sugarcane breeding Institute indicated considerable increase in cane yield. There were also improvements in the juice quality and available P status in the soil. When phosphobacteria is applied, costly super phosphate can be substituted with cheap rock phosphate up to an extent of 50 per cent on nutrient basis.

QUALITY OF BIOFERTILIZER

To produce biofertilizers, the microorganism concerned are grown in suitable nutrient medium and mixed with stabilized carrier materials like peat or lignite. This biofertilizer material should contain about 25 to 35 per cent moisture and sufficient microbial population. As per BIS standards the biofertilizer should contain 1×10^8colony forming units (population) per gram and 1×10^7 colony forming units per gram at expiry.

Dosage: The recommednded dose of biofertilizer is 10 kg *Azospirillum* and 10 kg phosphobacteria per hectare for soil application and 2 kg *Gluconacetobacter* for sett dipping.

METHOD OF APPLICATION

For sett dipping, mix 2 kg of biofertilizer in 500 litres of water, soak the setts for 30 minutes and plant immediately.

For soil application, apply the recommended dose of biofertilizer in two splits. For fields where in fertilizers are to be done in two splits (45 and 90 days), apply biofertilizers on 30 days of

top dressing of nitrogenous fertilizer and 60 days after planting, at the rate of 5 kg *Azospirillum* and 5 kg phosphobacteria each time. For fields where in chemical fertilizers are applied in three splits (30,60 and 90 days after planting), apply biofertilizers on 45 and 75 days after planting, at the rate of 5 kg *Azospirillum* and 5 kg phosphobacteria each time. Mix *Azospirillum* and phosphobacteria thoroughly with about 500 kg of powdered farmyard manure and apply uniformly near the base of the sugarcane clumps, immediately give a light earthing up and irrigate.

Overall Benefits

- Save 25% nitrogen and phosphate fertilizers
- Ability to replace 50% of super phosphates with rock phosphates
- Improved crop growth leads to approximately 10% increase in sugarcane yield
- Improves soil quality and health

General Precautions

Bio-fertilizers are just supplements to chemical fertilizers to meet the nutritional needs of plants. They add nitrogen and improve the availability the scope for using cheap low-grade P sources. Allow ten days between the applications of biofertilizers and chemical fertilizers. The effectiveness of biofertilizers can be improved by adding organic fertilizers. Maintain sufficient soil moisture for best results. Do not mix bio-fertilizers directly with chemical fertilizers, pesticides, herbicides or fungicides. Store the bio-fertilizer package at room temperature, away from direct sunlight. Biofertilizers must be from a reliable source.

Fig 3: ***Azospirillum***

Fig 4: ***Acetobacter***

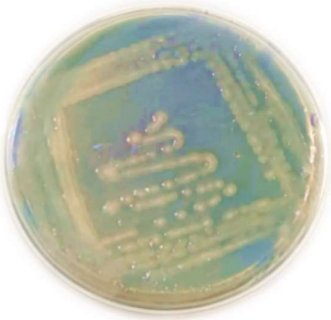


Fig 5: ***Azotobacter***

Fig 6: ***Bacillus***

Fig:7 ***Pseudomonas***

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PREDICTION OF SEED LONGEVITY THROUGH SEED VIABILITY NOMOGRAPHS

The initial driving force for the development of seed conservation science and technology was the need to provide seeds-men and seed producers with advice on how best to store agricultural seeds between growing seasons. To meet this demand, and the needs of the seed conservationist, seed viability models have been developed, over the last years, to characterize how environmental conditions impact on seed survival during storage. The international Board for Plant Genetic Resources (IBPGR) recommends that, in general, seed for long-term conservation should be stored at -20^{0}C and at 5 per cent moisture content and regenerated when viability has fallen by 5 per cent, in order to avoid the accumulation of genetic damage which is associated with loss of viability (Abdalla and Roberts, 1968).

Three basic viability equations were developed for rice (Roberts, 1961) and wheat (Roberts, 1960) which were subsequently shown to be applicable to a wide range of species (Roberts, 1972). These equations allow accurate predictions to be made of the percentage viability to be expected after any given period under any combination of temperature and moisture content within the range of medium-term storage conditions.

Ellis and Roberts (1980a) modified the viability equation by covering the lacunas with respect to the genotypic variation and differences in seed quality resulting from the various environmental factors which affect seeds before storage, by adding K_i (probit per cent viability at the beginning of storage) term, logarithmic moisture term and negative quadratic temperature term in the equation, seed viability nomograph.

$$v = K_i - \frac{p\left(K_E - C_W \log m - C_H\, t - C_Q\, t^2\right)}{10}$$

- v - Probit percentage viability,
- p - Storage period (days),
- K_i - Probit percentage viability at the beginning of storage
- m – Moisture content (%)
- t – Temperature (^{o}C)
- K_E- Species constant
- C_W- Constant of logarithmic moisture term
- C_H- Constant linear temperature term
- C_Q- Constant of quadratic temperature term

The viability nomograph for different crops was constructed using temperature, moisture content and period of viability. This is helpful in predicting the retention of seed viability in defined storage environment for a particular period or to determine combinations of temperature and moisture content which will ensure the retention of a desired level of seed viability for a specific period. The development of such an equation could able to influence the design of seed storage facilities and culminated in adoption of international gene bank standards (Genebank standards, 1994).

Ellis and Roberts (1980b) also validated the improved viability equation by conducting storage experiment of barley cv. Proctor in 52 hermetic storage environments covering a range of temperature from 3 to 90^0C and 5.5 to 24.6 per cent moisture content. And it was observed that under any constant storage conditions the frequency distribution of seed deaths in time is normal. The error sum of square remaining after fitting the data to the improved nomograph equation was less (1.42357) as compared to basic viability equations (5.17018).

Likewise, many scientists have experimented on the use of seed viability nomograph for the prediction of viability in crops such as lettuce, barley, cowpea, groundnut *etc*. and they found an efficient correlation between observed and predicted seed longevity.

Kew Royal Botanical Garden has designed an online portal for viability prediction (https://data.kew.org/sid/viability) which can be used along with seed viability nomograph for the better and effective prediction of the viability.

CONCLUSION

The seed survival curve shows a negative cumulative normal distribution for any given constant moisture and temperature. The improved seed viability nomograph helps us to predict the viability of any seed lot under wide environmental conditions, which is helpful for selecting particular storage chamber and better conditions. The probit-fitting of the seed viability (germination) data to the equation will give the constants which is specific for each species. This is a very useful method of seed viability prediction for the long term storage of the seeds such as in gene banks.

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AGRICULTURAL INPUT MARKETING IN INDIA

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ABSTRACT

India is an agriculture nation with a major part of economy dependent on it. To meet the demand of the country's growing population the focus of agricultural policies is on increasing the agriculture productivity. This will not only help in alleviating poverty in the country but will also provide employment in this sector. The basic requirement of the agriculture sector is agriculture inputs and services. The quality farm inputs are required for increasing the productivity of the farm crops, livestock etc. The agribusiness sector which is mainly concerned with business of farm inputs such as fertilizers, pesticides, farm machineries control the supply chain, sales and distribution of Agri-inputs as well as the farm produce and related services. The rise in agricultural productivity can be ensured by an improved system of delivery for agricultural inputs and services. The biggest problems faced by the farmers and Agri input dealers are access and supply of Agri-inputs, and the major role is being played by the poor distribution system in the country. This paper highlights the country's Agri input industry, its flaws, the existing marketing distribution network. Also, the challenges faced by the industry, recent changes, and growth potential of the industry.

INTRODUCTION

Agriculture is a major source of livelihood, food security and poverty alleviation in our country (Pandey, S. & Pandey, M. 2018). The proper Agri input supply could ensure the sustainable development of agriculture. Agri-input constitutes farm crop related inputs such as seeds, fertiliser and crop protection products, feeds and machines which support crop and allied production (Singh, S. 2018; A. 2017). The current status demands the reorientation of Agri- input marketing to make them at par with the principles of sustainable agriculture. Agri inputs can be classified into consumable inputs, the ones which can be used once or only in one cropping season and needs to be purchased again for example seeds, fertilizers, pesticides and other ones being durable inputs like tractors, harvesters, threshers, pump sets etc. Agriculture marketing comprises of various processes like developing the product, pricing, promoting and distribution of the farm specific product and services. The peculiarities of this industry are widespread customer base, multi-tier distribution system and inaccessibility to millions of farmers. Poor input quality and economics puts the entire agribusiness sector at compromise specifically for farmers and output users whose costs increase, and benefits are reduced (Salokhe, S. S. 2019; Singh, S. 2015). However, it is required to understand that the Agri input sector is the most significant in order to address issues with quality, safety of food, and cost competitiveness (Singh, S. 2015). Also, the Agri-inputs are crucial for small farmers in terms of yield enhancement, cost cutting, and better-quality production for better price realization (Salokhe, S. S. 2019; Singh, S. 2015).

CURRENT STATUS OF AGRI INPUT MARKET IN INDIA

The three main sub sectors od Agri inputs industry are crop protection (pesticides), crop nutrition (fertilizers) and seeds. According to a report by FICCI, the value of Agri input industry stood at US$ 5 billion in

2018 and the has the potential to reach US$ 8.1 billion by 2025 with an annual growth rate of 8.1%. Indian Agri input industry is facing international competition due to the release of new WTO norms and facing pressure on its profitability because of fiscal deficits faced by the government (Pandey, S. & Pandey, M. 2018). The key players in the Agri input marketing in India are IFFCO, Mahyco, Agricare organics, HPM, Rasi seeds, DuPont India, Monsanto India. The recent scenario says that the government is taking various steps to incentivise research and development in this sector, providing subsidies for marketing and promotion of the Agri inputs in the country. Initiatives like Protection of Plant Varieties and Farmers rights act, 2001 , Pesticide management Bill 2008, Insecticides (second amendment) rules 2017 are few of the steps in positive direction.

IMPORTANT ASPECTS OF AGRI INPUT MARKETING (4 P'S)

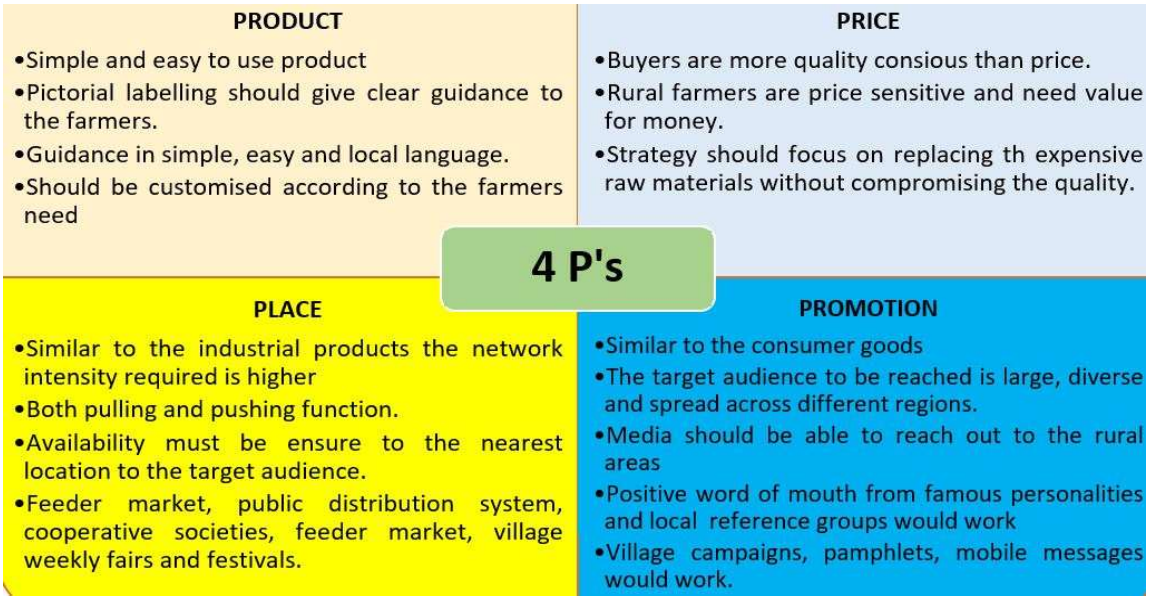

Fig. 1: Marketing Mix for Agri-inputs

CHALLENGES FACED BY AGRI INPUT MARKETING IN INDIA

1. The vast terrain – the rural farming area are vast, with different cropping patterns which makes it difficult for Agri input industry to create the desired influence.
2. The lack of all-season roads poses transportation problem of the inputs making it difficult the timely delivery of the pesticides, fertilizers.
3. The inadequate storage infrastructure.
4. The lack of availability of soil health cards in hand to farmers to get adequate knowledge about their input requirements.
5. Low risk-taking ability of the farmers.
6. Lack of availability of adequate finance at the time of need for the purchase of essential quality Agri input.
7. The accessibility of the farm input to the farmers is one of the major issues.
8. Low literacy rate among the farmers pose difficulty for them to understand new farm technology.

GROWTH POTENTIAL

1. Increasing income level, awareness level and demand for speciality foods.
2. The large population of the country created opportunity for huge growth of Agri input industry
3. The rising modernisation in farm practices and durable farm equipment at rural level.
4. To meet the consumption demands of the country the rise in purchase of inputs will be there.
5. The rise in awareness level has led to huge rise in market growth rate.

6. The continuous support from the government through various schemes and subsidies promoted the growth of this sector.

SUGGESTIONS AND CONCLUSION

At present, what needs to be understood is that need for increased agriculture production is more of necessity than desire. Majority of the farmers in the country do not have idea about the demand and supply of their produce and also the specific technology they can use to improve it. For any industry to flourish, consumer awareness is foremost priority and requirement. Not only we need to ensure the use of advance Agri inputs but sustainable use of Agri inputs is required and right amount. Each Agri input is characterised by unique market structure. They should be technically appropriate and have economic viability. The Agri input industries along with quality and sustainable product also needs to hand hold the farmers and guide them for sustainable use and for better crop management practices. The marketing of Agri inputs should be done according to crop requirement of different Agri climatic zones. Encouraging private players in this sector can help in introducing new technology and advanced Agri input industry which will make Indian products competent with world standards and leading to overall prosperity of farmers and nation as whole.

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ENTOMOREMEDIATION (PLASTIVORES) FOR PLASTIC BIO-DEGRADATION

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INTRODUCTION

Every year, the globe generates approximately 380 million tonnes of plastic. Plastics not just contaminate the environment, but they are also difficult to manage in an environmentally responsible manner and can last for millennia. It is non-biodegradable due to its physical, mechanical, and chemical features such as high tensile strength, elongation properties, inertness, high molecular weight, and hydrophobic nature. Traditional waste management options, such as hydrolysis, photo-degradation, and thermo-oxidative degradation, are increasingly inadequate to handle the increasing volume of such garbage, putting us on the verge of an ecological calamity. Given how much plastic is generated globally, finding new, sustainable techniques for plastic management is still an important problem. Entomoremediation, which uses insects to accelerate the biodegradation of plastics, is one of the most recent and exciting possibilities **(Bulak *et al*., 2021)**. Recent techniques to plastic bio-degradation using insect larvae and their gut microbes have yielded promising results.

Insects have been ingesting hydrocarbon polymers for a long time, thanks to gut microorganisms. As man-made plastic polymers are chemically unique, it's indeed realistic to expect insect or microbial systems to be developed to swiftly deteriorate them. Numerous insect species can be used as both animal and human food **(Lee and Liew, 2020)**. The capacity to break down plastic polymers is present in certain of these insects. Although the biodegradation of plastic by insect larvae has the potential to be environmentally favorable, most of the insects that have been discovered so far have limited capabilities.

INSECTS FOR BIO-DEGRADATION OF PLASTIC

Because of insect capability to chew and degrade synthetic polymers, larvae of insects have recently piqued the interest of plastic bio-degradation researchers. Plastic eating insect species include *Rhyzopertha dominica*, *Lasioderma serricorne*, *Sitophilus oryzae*, Yellow mealworm *Tenebrio molitor*, superworms *Zophobas atratus*, *Tribolium castaneum*, *Plesiophthalmus davidis*. Many lepidopteran species including Greater wax moth, *Galleria mellonella*; Indian meal moth, *Plodia interpunctella*; and lesser wax moth, *Achroia grisella* have the ability to digest polymers like polystyrene. Cassone *et al*. (2020) coined the word "plastivore" to describe insect larvae that consume plastic. Plastic pieces are chewed and ingested by the larva, but they are also biodegraded by the aid of symbionts present in the gut. However, the process is immensely reliant on the kind of polymer. *Exiguobacterium spp.* from the mid-gut of *T. molitor*, for instance, develops on polystyrene, degraded polymer surface, and also lowered the hydrophobicity of the polymer.

Since then, researchers have become increasingly interested in separating possible plastic degraders from the guts of larvae, which primarily comprise members of the groups Enterococcaceae, Spiroplasmataceae, and Enterobacteriaceae. For instance, bacteria *Pseudomonas aeruginosa* and *Exiguobacterium spp.* were

obtained from guts of *T. molitor* and *Z. atratus*, respectively, having the ability to bio-degrade polystyrene. The bacteria *Acinetobacter sp.* obtained from *T. castaneum*; *Bacillus sp.* and *Enterobacter asburiae* were isolated from the intestines of *P. interpunctella* with ability to degrade polystyrene. Both the fungus *Aspergillus flavus* and the bacteria *Acinetobacter sp.*, both with a clear potential to degrade polyethylene, were obtained from the intestine of *G. mellonella*. Similarly, microbes *Bacillus aryabhattai, Lysinibacillus fusiformis*, and *Microbacterium oxydans* were obtained from *G. mellonella* body extracts and shown in-vitro bio-degradation of polyethylene.

Despite these fascinating discoveries, there are limitations to the thorough bio-degradation of polymers in the larval gut, and a significant amount of the eaten polymer remains in the larval frass. The limited ability of these symbionts to biodegrade plastic outside of their host further suggests a functional interaction between the host and microbial symbionts in the bio-degradation process, the contribution of digestive enzymes of the host, the collaborative involvement of a microbiota instead of solitary microbial strain, or the unique physicochemical properties of the gut micro-environment. Some social insects, like termites, which are distinguished by cooperative brood care, group unity, labour division, and overlapping generations inside their colonies, have also shown similar traits. Given that some invertebrate species can consume wood or other polymeric materials, this exceptional strategy against plastic polymer breakdown is typically credited to their gut symbionts.

MAJOR LIMITATIONS

Amidst all the advancements, biological methods for degrading plastic pollution have some limitations.

- Maintaining the insect population that could consume the plastics.
- Secondly, it is expensive to maintain an insect culture.
- Third, the formation of microplastic with negative environmental effects is a possibility.

CONCLUSIONS

The vast majority of plastic produced by humans each year ends up in landfills and bodies of water. These plastic polymers have a significant negative influence on both human and environmental health. Edible insect farming is becoming popular as an environmentally sustainable method of producing frass fertilizer, handling food waste from human, and providing a source of protein for animal feed **(Houben *et al*., 2020)**. The deployment of insect for plastic bio-degradation is suggested under this theory as an appealing alternative for handling plastic waste, but more research is needed to determine its long-term viability and, in particular, the environmental safety of any potential byproducts, such as fertilizers derived from frass. Different bacterial species are used to break down plastic materials. Invertebrates gut contains a number of bacteria that are beneficial in this regard. The biodegradation of plastics requires in-depth investigation, particularly the discovery of insect microbiota that is in association with plastic bio-degradation. They do, however, also have some shortcomings. Thus to protect the environment and ourselves, it is best to reduce our use of plastic.

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ROBOTICS IN AGRICULTURE

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ROBOTS

- A robot is an automatic, freely programmable, artificial agent and is usually an electromechanical system. In Czech robota means – Forced labour or work
- It is a device that, because of software programming, makes complicated tasks easy to perform**.** It require multiple sensors and controls (set of algorithms) that allow them to move in an unknown environment.
- Joseph Frederick Engelberger is the "Father of robotics" and George Devol is considered as "The Father of modern robotics"

AGRICULTURAL ROBOTS OR AGRIBOTS

- It is the use of automation technology in bio systems such as agriculture, horticulture and forestry etc and replacing the conventional techniques to perform the same tasks with efficiency.

NEED

- Increasing global population
- Shortage of labour
- Canwork in hazardous/dangerous situations
- Cando repetitive tasks efficiently
- Cando work with accuracy
- Increasing awareness on ill effects of pesticides

Classification of Robots

Autonomous Robots

- Work completely under the control of computer programme

Tele-controlled / Remote-controlled robots

- Work under the control of humans or computer programme with a controller

Types of robots used in Agriculture

1) **Demeter**

- It is robot that can harvest crops
- It has cameras on it that can detect
- It can drive, steer and control the cutter head
- It fallows path with accuracy of up to 3cm

2) **Weed control robots**

- A four-wheel-drive weed-seeking robot

- Hoe removes the weed between rows of crop
- Intelligent hoe uses vision system
- Weed identification is based on colour photography

3) Forester robot

- This is a special type of robot used for cutting up of wood, tending trees, and pruning of X- mass tree.
- Used for harvesting pulp and hard wood and in the forests.
- It employs a special jaws and axes for chopping the branch

4) Fruit picking robot

- Pick ripe fruit without damaging the branches or leaves of the tree.
- Mobility is a priority, and the robots must be able to access all areas of the tree being harvested.
- The robot can distinguish between fruit and leaves by using video image capturing.
- If a match is obtained, the fruit is picked.

5) Drones

- To get a bird's eye view of the land
- Offers a quick and easy way to check on the progress of crops and determine where they may need to replant or direct pesticide applications

6) Agricultural robot suit

- The robot suit is designed specifically to help out with tough agricultural work like pulling radishes.
- The suit has eight motors fitted over the shoulders, elbows, back and knees to provide a power boost to the wearer.
- The current model weighs 55 pounds and uses 16 sensors to function

Disadvantages

- Low receptivity between camera and robotic arm leads to low efficiency
- Liable to access the technology
- Human presence in the field is necessary
- Change the culture /emotional appeal of agriculture
- Costly

Future Scope

- Robotic systems with modularity, flexibility and adaptability may permit the integration of different technologies.
- Selective harvesting needs sensing technology with high receptivity information shared by different modules.
- Application of inexpensive navigation sensors to the robot farming system makes the system economically adaptable with the environment
- Advances in drone research will be critical for maintaining safety considerations.
- More drone applications were anticipated in the coming decade.
- Designing of the robo suit with reduced weight would reduce the strain to the aging farmers

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AYURVEDIC PERSPECTIVE ON FOOD AND NUTRITION

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INTRODUCTION

One of the first healthcare systems to emerge on the Indian Subcontinent is ayurveda. The words *ayu* (life) and *veda* (knowledge), which make up the name ayurveda, deal with numerous aspects of health and welfare in its various forms, such as a joyful life, lasting happiness, and longevity. Ayurveda claims there are three basic states of a being:

- Physical (Including Physiological)
- Mental
- Spiritual

Ayurveda's fundamentals are based on Panchmahabhutas (five element theory). The *Tridosha* is a representation of the five elements combined, such as *Vata* (Earth + Air), *Pitta* (Fire), and *Kapha* (Water + Earth). *Doshas* are a three-way classification of physiological processes used extensively and efficiently in Ayurveda:

- *Vata dosha*, focused with movement and input–output functions
- *Pitta dosha*, focused with turnover, i.e., digestion and metabolism
- *Kapha dosha*, focused with energy storage, growth, and lubrication

FOOD FOR DOSHIC CONSTITUTIONS

Keeping the *doshas* in balance is essential for health. The pathogenesis within each clinical condition is linked to one or more *doshas* growing gradually out of balance; on the other hand, imbalances in *dosha* functions result in disease.

	Vata constitution	***Pitta constitution***	***Kapha constitution***
The body's dosha's functions	Bodily movements, the elimination process, and regulating the nerve system	*Pitta builds up throughout the rainy season and becomes worse during October*	Promotes immunity, binds cells together, forms muscle and bone, and controls how the body is structured
Individuals' constitution posses	The dry, light, cold, quick, irregular and rough qualities.	*Hot, penetrating or sharp, flowing liquid, slightly oily and light qualities in them*	Slimy, cold, heavy and soft qualities
Intake	Fresh, warm food with sweet, sour and salty tastes	*Fweet, bitter and astringent eat vegetarian diet*	Fow carbohydrate, low-fat diets without sugars
Avoid	Too much fasting and use of spicy food to regulate their digestion.	*Cool foods and drinks, especially in hot weather*	Frequent eating, frozen edibles and cold water

FOOD FOR MIND

According to Ayurveda, we should consume *sattvic* (pure and fresh) foods avoiding *rajasic* (fiery) and *tamasic* (spoiled) foods. We can maintain regular digestion, absorption, and elimination with the use of ayurvedic eating practises. Our brain will be healthy and active since our meals will be natural and pure.

Sattvic diet	***Rajasic diet***	***Tamasic diet***
Sattvic means pure essence. People who want to lead a quiet, peaceful and meditative life.	*Rajasic* causes mind restless It increases fervour, outward motion, creativity and assertiveness	*Tamasic* unhealthiest food They work well at slowing us down, depressing us and enhancing inertia
Foods include sprouted whole grains, fresh fruit, land and vegetables, pure fruit juices, milk and cheese, legumes, sprouted seeds, honey and herbal teas.	Food includes too much spicy, salty and sour foods. Sour and spicy preparations, pickles, tea, coffee, alcohol and vegetables like onion, garlic, etc.	Foods include fried and frozen foods, fast foods, microwaved foods, processed foods, left overnight foods, fish, eggs, onion, alcohol, etc.
Foods which do not agitate your stomach at all	Food aggravate *pitta* and *vata doshas*	Foods increase the inner darkness and confusion

AYURVEDIC FOOD HABITS

The *Charak Samhita* and *Sushruta Samhita*, written around 1000 BC, provide a comprehensive overview of Ayurvedic dietary practises. Immune systems are strengthened, and the gut is helped to work more efficiently. Sitting on a raised platform, one should eat the right amount of food at the right time. After meals, we should sit comfortably like a king and then have a short walk. Ayurveda advises: (a) consuming just a minimal amount of raw food and vegetables, (b) learning about herbs' effects before using them, and (c) avoiding antagonistic food pairings such as bananas with milk.

IN SUSHRUTA SAMHITA

When eating, we should begin with a sweet taste, followed by salty and sour flavours, and finally, pungent, bitter, and astringent flavours.

IN CHARAKA SAMHITA

Explains about various types of grains and pulses; various types, qualities and benefits of fruits and vegetables, milk and dairy products, sugarcane preparations, honey; and its types, waters, wines. etc.

IN ASHTANGA HRIDAYA

Vagbhatacharya urges to take the food while seated on the floor which intensifies the digestive fire. And also, the food plate should also be kept a little bit above the floor. At noon time, one should consume lighter meal, juice or buttermilk. We should have our dinner before sunset, as the digestive fire is dormant once the sun sets. We should get in the habit of laying on our left side after eating. Lying on the left side activates

the pingala (soorya) naadi on the right side of the body. Activation of pingala nadi in turn activates the digestive fire. This is necessary for asthma, diabetes and vata diseased patients.

TRADITIONAL DIETARY PREPARATIONS IN AYURVEDA

Ayurveda has a stronger emphasis on disease prevention than on disease treatment, and it obviously stresses the best foods to eat in order to achieve and maintain good health. The Ayurvedic term for the traditional food preparations listed below is *pathya*, which literally translates to "that which is healthful and pleasant to our body".

- **Manda**: Only the supernatant liquid part is taken leaving the boiled rice (14 times of water)
- **Peya**: Equal solid rice and liquid portion are taken (4 times of water)
- **Yavagu**: More solid rice portion and less liquid part are taken together (6 times of water)
- **Vilepi**: Only solid rice part is obtained (4 times of water)
- ***Anna Kalpana***: Properly washed rice is soaked in water until the rice particles swell a little and later boiled with water, filtered and the solid portion used (4 times of water)
- ***Khichadi****:* It alleviates *kapha* and *pitta dosha*, provides energy and subsides *vata dosha* (*vata*, *pitta* and *kapha doshas* are basic constituents of the body)
- ***Takra****:* It is a liquid preparation prepared by continuously churning the curd for one *prahara* (3 h) with different ratios of water added. It is indicated in indigestion, piles, fever, diarrhoea, anaemia, dysentry, etc.
- ***Kurchika****:* The *kurchika* preparations are the inspissated milk or its products. Wherein the products are boiled to a diminished fluidity state.
- ***Saktu****:* The *churna* of the roasted *dhanya visesha* is called as *saktu*. Wheat, barley, rice, ragi, maize, etc. are roasted properly and later brought into fine powder.
- ***Supa****:* It is the preparation where any of the *simbi dhanya* (red gram, green gram, etc.) are soaked, dehusked and boiled with enough quantity of water along with the required quantity of salt, oil/ghee and other spicy ingredients
- ***Rasala****:* To prepare this, the curd is added with the required quantity of sugar, chilly, ghee and honey. This is churned properly and added with little quantity of *karpura* for good odour
- ***Visyandana****:* Raw wheat flour is boiled with an equal quantity of ghee and milk to a state where it is neither solid nor too liquid.
- ***Saskuli****:* These may be prepared with rice, wheat, *ragi*, flour, etc. The flour is mixed with required quantity of *tila*, *kamala kanda* and water to bring it in paste form. A part of this paste is placed in a special instrument and pressed. The drug comes out in a thick thread form of special designs. This is put into edible oil placed over fire. After proper frying, it is taken out, allowed to cool down and used
- ***Mamsa rasa****:* A soup prepared by boiling chopped meat with required quantity of water. Two, four, six or eight times of water are added considering the nature of meat with the chopped *mamsa* and boiled over moderate fire to get it in desired consistency
- ***Vesavara:*** Boneless meat is steamed and smashed. It is boiled with the required quantity of *guda*, *ghrita*, *pippali churna*, *marica churna*, *sunthi*, *lavana*, etc. along with enough quantity of water

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BIOTECHNOLOGY AND BEEKEEPING

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WHY AND WHAT IS THE NEED OF BIOTECHNOLOGY IN BEEKEEPING?

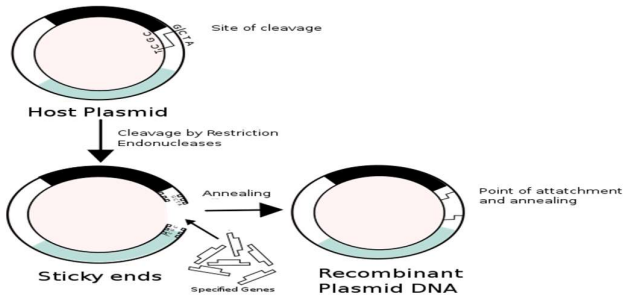
India is one of the leading Asian nations for beekeeping training and research. Despite all the facilities available, one of the main obstacles to the expansion of beekeeping in India is bee health, which is one of the many challenges and researchable topics. The use of new medications and chemicals has led to the emergence of disease-causing organisms having increased resistance, contaminating bee products, and the failure of the conventional methods of disease control. In order to create resilient and productive strains of bees, creative or biotech interventions will eventually be required. Bee health also includes management of various disease and pests infestations associated with beekeeping. Since *Varroa jacobsoni* has now been discovered in India (Abrol *et al.,* 2006) and it is too late to eradicate it. Efforts are therefore needed to combat the threat of *Varroa* depredations and management strategies for the control of this species and strains that are tolerant to mite attack must also be developed (Abrol, 2018).

RECOMBINANT DNA TECHNOLOGY (rDNA)

rDNA stands for recombinant DNA technology and is also called as genetic engineering , used for producing artificial DNA through the combination of genetic materials (DNA) from different sources (Figure 1). This technology was developed by Boyer and Cohen in 1973.

Functions:

- helps in locating or assembling specific genes and placing them in chromosomes of an organism.
- Made possible to move from traditional methods of controlling genetic changes in organisms to such as controlled breeding programme and selection, to the ability to directly manipulate the DNA and the genetic code itself.
- Various attempts have been made to use this technology to honeybees and are limited to *Apis mellifera* only**.**



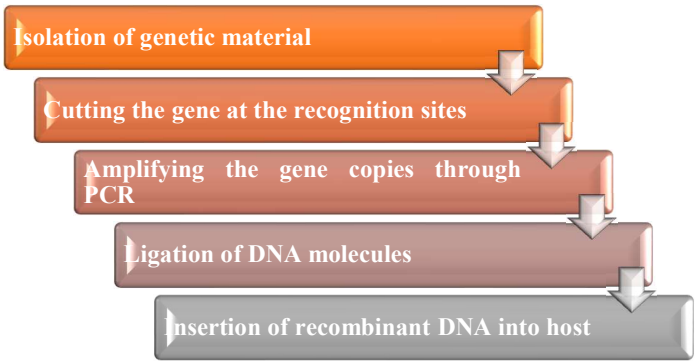


Fig. 1: Procedure of recombinant DNA technology

BIOTECHNOLOGICAL INTERVENTIONS AND THEIR APPLICATIONS IN BEEKEEPING (APICULTURE)

1. **Disease resistance:** The genes that code for cecropins are considered to be one of the most promising gene classes for honey bees. These genes, which were identified from insects, result in proteins that, even at low concentrations, exhibit extraordinarily potent bactericidal and fungicidal properties. Thus, by adding a single gene to honeybees, American foul brood resistance can be achieved (AFB). The simultaneous acquisition of chalk brood, European foul brood (EFB), and both is possible. The presence of cecropins in honeybees is conceivable, but in some instances, they are either induced or turned on after the larva has already contracted the infection, failing to offer an adequate level of resistance. Therefore, it may be feasible to alter the cecropin protein sequence by studying honey bee DNA.

2. **Mite resistance:** Recently, genomic data for numerous important honey bee parasites, including a partial genome sequence for the parasitic mite, has been produced. The gut trypanosomatid parasite *Lotmaria passim* (previously known as *Crithidia mellificae*), which has been linked to colony losses in Europe, has a draught genome sequence. The whole genome sequences for the gut microsporidian parasites *Nosema apis* and *Nosema ceranae*, which have been associated with increased mortality and colony loss, have also been published. Recent introductions of *Varroa* mites to honey bee populations in Hawaii, New Zealand, and Kenya made it possible to quickly analyze these populations in order to ascertain the extent of the spread of Varroa-associated viruses and their effects on bee health (Martin *et al.,* 2012). *A. cerana* is the natural host of *Varroa jacobsoni,* but in some ways it is resistant to the effects of this mite to keep the levels very low. It would be ideal for *A. mellifera* to exhibit the same resistance as *A. cerana* does as an alternative to chemical control techniques. Recombinant DNA technology is the sole way to spread this resistance as these two species do not hybridise. To make this transfer, however, the resistance mechanism must be discovered, the genetic underpinnings established, the precise regulatory genes located, the desired genes eliminated, and the genes transferred.

3. **Virus resistance:** A strand-specific RT-PCR-based technique developed by Humberto *et al.* (2009) for the investigation of Deformed Wing Virus (DWV) replication in honey bees and in honey bee parasite mites, *V. destructor*. These sequences genomic data can be used to create molecular diagnostic markers and identify pathogen/parasite-specific gene sequences for RNAi-based control methods. Four more viruses (Aphid Lethal Paralysis virus, Big Sioux River virus, Lake Sinai viruses 1 and 2), identified by high-throughput sequencing of RNA isolated from honey bee colonies of US migratory beekeeping operations (Runckel *et al.,* 2011). Later, comparable molecular screens found Lake Sinai viruses 3 and 4 in populations of US and European honey bees (Cornman *et al.,* 2012).

   An important problem for *A. cerana* is a virus disease, i.e. Thai sac brood. This disease is caused by virus which would not be affected by the cecropin protein. Identification of a gene in *A. mellifera* which conferred resistance to this sac brood virus would be important to *A. cerana* and would only be available through

recombinant DNA technology. *A. cerana* have significant potential to be improved by recombinant DNA technology. As it is resistant to diseases and parasites and has spectacular potential for genetic improvement to increase economic production.

4. **Genetic variations:** The genetic diversity of *A. mellifera* is well established. However, in case of *A. cerana,* only three species have been recognized from India. All these subspecies seems to have different geographical populations/sub-groups or ecotypes (Verma *et al.,*1992; Abrol and Khan, 2002) which can be used for improvement through selective breeding along with suitable management practices.

5. **Using genomics to reveal hidden diseases**: Genomic approaches have greatly facilitated the identification of previously unknown or uncharacterized pathogens and parasites in honey bee populations.

6. **Purity of Honey:** Tolba *et al* (2007) identify several bacterial isolates from honey produced in Northern Ireland, and which belonged to the genus *Bacillus*, through employment of a molecular identification scheme based on PCR amplification of universal regions of the 16S rRNA operon in combination with direct automated sequencing of the resulting amplicons. Seven samples of honey and related materials (propolis) were examined microbiologically and were demonstrated to have total viable counts (TVC) ranging from <100 to 1700 colony-forming units/g.

7. **Defence:** Lourenco *et al* (2005) studied Phenoloxidase (PO), a melanin-synthesizing enzyme known to play an important role in insect defense, is found as a zymogen (ProPO) in hemolymph and cuticle, where it is activated by proteolysis. They characterized the first proPO cDNA in an eusocial insect, the *A. mellifera* honey bee. It was subsequently shown that IAPV was present in the US before the occurrence of CCD, but more comprehensive longitudinal studies indeed demonstrated that colonies with high levels of IAPV are less likely to survive the winter.

8. **Other applications**: Recently, the piggyBac derived transposon was used to transform honey bees and drive expression of an exogenous green fluorescent protein gene, which, together with the development of general genome editing tools such as CRISPRs and TALENs, lays the groundwork for the development of transgenic bees with enhanced genetic resistance to different stressors (Schulte *et al.,* 2014). It should also be possible to generate transgenic strains of beneficial bee gut microbes, which could produce key nutrients, pesticide detoxification enzymes, or biotic factors targeting parasites or pathogens (Rangberg *et al.,* 2015)

Conclusion

As far as the above mentioned traits were considered, there is a need for biotechnological interventions for bridging research gaps existing in the field of bee science and using conventional and biotechnological tools to document the biodiversity of honey bees in India. The studies can help to understand clearly about the morphological and genetic diversity of Indian honey bees with which the present stock of the bees can be improved to increase their honey yield as well as their pollinating efficiency in future.

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ESSENTIAL OIL: CHEMICAL CONSTITUENTS, PHARMACOLOGICAL PROPERTIES AND ITS USES

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INTRODUCTION

Essential oil is a concentrated hydrophobic liquid with strong aromatic components extracted from different parts of plants such as leaves, stems, flowers, roots, seeds, barks, resins or fruit rinds. They are also known as steam volatile oils, aromatic oils, ethereal oils or simply as the oil of the plant material from which they are extracted. They differ significantly from the well-known vegetable oils which are made up of various fatty acids. These are usually colorless and have a very high commercial value due to its pharmacological properties. This chapter focuses on the use sources of essential oil, its uses, chemical constituents and pharmacological properties of essential oil.

SOURCES OF ESSENTIAL OIL

Essential oils are generally evolved from various parts of plant, such as leaves (e.g. Cinnamon, Bay leaf, Eucalyptus, Oregano, Peppermint, Patchouli, Rosemary, Spearmint, *Curcuma* spp., Wintergreen, Basil, Melaleuca, Lemon Grass, jamrosa, *Ocimum*spp.), flowers (e.g. Hyssop, Jasmine, Lavender, Manuka, Clove, Clary Sage, Geranium, Chamomile, Orange, Marjoram, Ylang-Ylang, Rose), peel (Lemon, Tangerine, Grape fruit, Orange, Bergamot, Lime), seeds (Almond, Nutmeg Oil, Cumin, Anise, Celery), woods (Rosewood, Sandalwood, Camphor, Cedar), roots (e.g. vetiver, angelica, sassafras, valerian, saussurea), fruits (lemon, orange, juniper, bergamot) and rhizomes (e.g. curcuma,calamus, ginger, orris) (Rai and Suresh, 2004).

CHEMICAL CONSTITUENTS OF ESSENTIAL OIL

Essential oils are complex mixtures of volatile fraction and non-volatile residue in which the differences between compounds are minimal. Moreover, the essential oils are highly complex and also include oxygenated compounds (Rao *et al.*, 2005).

VOLATILE FRACTION AND NONVOLATILE RESIDUE OF ESSENTIAL OIL

Volatile fraction comprising of 90–95% of the oil in weight, containing the monoterpene and sesquiterpene hydrocarbons, as well as their oxygenated derivatives along with aliphatic aldehydes, alcohols, and esters. On the other hand, nonvolatile residue consists 1–10% of the oil, containing hydrocarbons, carotenoids, sterols, fatty acids, waxes and flavonoids (Rao *et al.*, 2005).

PHARMACOLOGICAL PROPERTIES OF ESSENTIAL OILS

ANTISEPTICS

Essential oils have antiseptic properties and are active against a wide range of bacteria as well as fungi and yeasts. The most common sources of essential oils use as antiseptics are: Citral, Thyme, Cinnamon, Clover,

Linalool, Culin savory, Lavender, geraniol and Eucalyptus**.** They are also known to be active against Candida (Bhaskaracharya *et al*., 2009).

EXPECTORANTS And Diuretics

Essential oils increase microcirculation when use externally and provide a slight local narcotic action. Oral administration of essential oils like eucalyptus or pin oils, encourage ciliated epithelial cells to secrete mucus. Moreover, essential oils are used in a number of ointments, cream and gels, whereas they are known to be very constructive in releasing sprains and other coherent pains. On the renal system, essential oils are known to increase vasodilatation, as a result bring about adiuretic effect (Meyer-Warnod, 1984).

SPASMOLYTIC And SEDATIVE

Mentha species and verbena are believed to decrease gastrointestinal spasms. The essential oils of those plants increase secretion ofgastric juices. They are also known to be effective against insomnia (Bhaskaracharya *et al*., 2009).

Other pharmacological properties of essential oils are cholagogue, anti-inflammatory, cicatrizing etc.

USE OF ESSENTIAL OILS

Essential oils have shown numerous beneficial effects for health maintenance and treatment of various diseases. These essential oils are primarily used in the perfumery industry and also use in a wide variety of consumer goods such as detergents, soaps, hair rinses, incense, toilet products, cosmetics, pharmaceuticals, confectionery food products, soft drinks, distilled alcoholic beverages (hard drinks) and insecticides. Several countries produce numerous kinds of essential oils. India ranks second among the different countries of essential oils (Rao *et al.*, 2005). Essential oils from *Curcuma* spp., particularly *C. longa*, have exhibited several health-related biological activities and various essential oil companies have newly marketed Curcuma oils.

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MOLECULAR MECHANISM OF MULTIPLE DRUG RESISTANCE

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INTRODUCTION

With the begining of existence of humans and animal life, a competition for survival between host and pathogen started. If the host could overcome the pathogen, they survived but if the pathogen won, it resulted into the disease and sometimes death of the host. Bacteria are one of the most common pathogen that always remained in close association with humans. Though good bacteria provided benefits to humans but several pathogenic bacteria like Mycobacterium tuberculosis, *Salmonella* Typhi etc caused serious halth problems. Human beings made continuos efforts to fight these pathogens. Fleming developed first antibiotic Penicillin in 1928 against pathogenic bacteria.These chemical compounds were used to treat the disease as they selectively targeted microorganisms, not the host (Sah *et al*., 2019). With the invention of Penicillin, new more effective antibiotics were developed continuosly and categorised as first generation, second generation, third generation, fourth generation antibiotics and fifth generation antibiotics. These antibiotics saved the life of millions of people but on the othr hand bacteria also developed their tools to make these antibiotics ineffective. Bacteria developed resistance against many antibiotics.

To overcome from the problem of drug resistance, a combination therapy with more than one antibiotic was practiced (Zhi-Wen *et al*.., 2015) and the drugs like Doxycycline, Amikacin and Cefaperazone sulbactum were used in combination but very soon questions were raised against the efficacy of the combination therapy. Few bacteria like Pseudomonas and Acinetobacter exhibited resistance for the antibiotics belonging to the different groups. These organisms were termed as Pan resistant organism and may prove as threat in future (Sah *et al*., 2019). Mainly four different methods; R plasmid mediated esistance, Accumulation, multiple drug efflux system and Transposons mediated gene transfer were found to be responsible for the development of multiple drug resistance (Peterson and Kaur, 2018).

MOLECULAR BASIS OF DEVELOPMENT OF MULTIPLE DRUG RESISTANCE

At molecular level, bacteria developed different phenomena for the dvelopment of drug resisance. In these processes, the target molecules were different and modified by different ways.

(a) MUTATION OF TARHET PROTEIN

In this method, the organism modified the target molecule of the drug inside the bacterium. Fluoroquinolones act on DNA Topoisomerase and cause blocking of DNA synthesis. Resistance in bacteria for Fluoroquinolones was developed as a result of mutation in DNA Topoisomerase (Redgrave *et al*., 2014). Aminoglycosides sct on ribosomal protein to block protein synthesis, mutation in ribosomal protein resulted in aminoglycosides resitant Mycobacterium (Sanz-Garcia *et al*., 2019).

(b) PLASMID MEDIATED GENE TRANSFER MUTATIONS

Plasmid, once transformed from environmental bacteria to pathogenic bacteria caused mutations at target site of the antibiotics. As a result of the mutation, the susceptible bacteria become resistant for

the drug. Transfer of plasmid coded ern gene resulted into mutations of adenosine of 50 rRNA (methylation). The mutation resulted into resistance for Macrolides like erythromycin (Woodford and Ellington, 2007).

In case of few pathognic bacteria, plasmid provided the genes responsible for the resistance in susceptible bacteria. In case of Penicillin, the enzymatic inactivation of β lactamase resulted into Peniciliin resistance (Ramirez *et al*., 2014).

(c) ACQUISITION OF GENES FROM OTHER SPECIES

The susceptible bacteria acquired the resistance genes from non-pathognic bacteria and resistant pathogenic bacteria also. The part of tra gene was transferred to Streptococcus pneumoniae and resulted into formation of mosaic protein. The formation of mosaic protein by tra gene developed resistance to Penicillin in Streptococcus pneumoniae (Von Wintersdorff *et al*., 2016).

(d) MODIFICATION OF TARGET MOLECULES

Vancomycin binds to penta peptide of alanine to block the protein synthesis of bacteria. Once as a result of mutation, the second alternative of penta peptide to D-lactic acid and result into resistance to vancomycin (Gardete and Tomasz, 2014).

(e) PREVENTING DRUGS AVAILABILITY TO TARGETS

In this mechanism, bacteria prevent the availability of drugs to the target molecules by several ways. Some bacteria develop drug specific efflux system, in which protein motive force dependent system pumps out drug outward (eg- Tet-Mg complex) (Dinesh *et al*., 2013). In the process of local inhibition, plasmids produce some proteins (like Qur protein), which bind to target molecules (like Topoisomerase) and make it resistant to antibiotics (Li *et al*., 2019). Porins are outer membrane proteins, which act as transport channel for the intake of the drug. Mutations in the porin proteins also reduce the intake of drug and may dvelop resistance for the drug (Choi and Lee, 2019). Formation of biofilm around the bacteria also results into reduced intake of drug to bacteria (Bowler *et al*., 2020).

SOURCES OF DRUG RESISTANT GENES

There are different sources in the environment, soil and water from which the antibiotic resistant genes may be transferred to pathogenic bacteria. Many antibiotics have been produced from the microorganism like vancomycin. The homologous genes have been isolated from vancomycin resistant bacteria (Cetinkaya *et al*., 2000).

From the microorganism of soil and environment like (Serratia and Proteus), the genes were transferred to pathogenic bacterium and resulted into the resistance in the pathogenic bacteria. Streptomyces of soil were found to be resistant for several antibiotics as they were continuosly exposed to low concentration of antibiotics in the soil. These streptomyces also transferred antibiotic resistant genes to pathogenic bacteria (Wiener *et al*., 1998). Most of the drug resistant genes were transferred via transposons or R-plasmid. R-plasmid is a low copy number plasmid but is stably maintained in the bacteria. It has high transformation capacity and it contain genes for resistant for several antibiotics. It also contains genes for killer elements and killer proteins as R-plasmid has very high transformation capacity. It has transferred the drug resistant genes from resistant bacteria to susceptible bacteria (Peterson and Kaur, 2018). The misuse of antibiotics as feed additive or in low dose has enhanced the process of multiple drug resistance development. In several viral diseases, antibiotics have been used for the treatment. The improper disposal of antibiotics has slowly increased the level of antibiotic in the environment especially in the soil (Ventola, 2015). The use of antibiotics at sub-therapeutic levels also play important role in the development of multiple drug resistance in bacteria (Scheld, 2003). WHO has made several recommendations to avoid the development of multiple drug resistance for human medical practitioners and Veterinarians. It has been recommended that the antibiotics should not be used until they are essentially required. The duration and the dose of the antibiotics should be optimum. Efforts should be made to develop database of each antibiotic responses. The patients should also be careful to complete the due antibiotic

course and proper care of the disposal of antibiotics is essentially required. Antibiotics are to be used for treatment not as feed additive or in food chain.

National government should undertake robust action to tackle multiple drug resistance and provide all necessary support to researchers and industries to develop better and efficient antibiotics.

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USE OF REMOTE SENSING IN AGRICULTURE

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ABSTRACT

Remote sensing is a precision technology with origins in the defense and aerospace sectors used to acquire information about objects without direct contact. Remote sensing offers an efficient and reliable means of collecting the information required, in order to map and acreage and also the structure information on the health of cropping system. The mapping technology used helps in precision agriculture where specific land soils are used for specific purposes. Rapid production of maps helps in interpretation of crops for increased sustainable production in an ecofriendly and pollution free environment. Remote sensing technology can give accurate estimates of the expected crop yield in a planting season using various crop information such as the climatic condition, crop quality, soil fertility, moisture level in the soil as well as in the crop, disease and pest incidence of the crop and the crop cover of the land. it. Thus, when all of this data is combined it gives almost accurate estimates of soil and crop health which determines the overall productivity of the crop.

In order to ensure sustainable development, it necessary to develop accurate, updated and comprehensive scientific databases on habitats, protected areas, water quality, environmental indicators and carry out periodic assessment of the soil health. The modern scientific tools of remote sensing, GIS and GPS are extremely valuable in development of databases and to analyze them in the integrated manner and derive management action plans (Shanmugapriya *et al*., 2019).

Remote sensing is a tool for collection, processing and analysis of data to extract information from earth surface without coming in to physical contact with it. It is an art and science of obtaining information about an object or feature without physically coming in contact with that object or feature. Remote sensing is the science of obtaining information about an object or area through the analysis of measurements made at a distance from the object (Wójtowicz *et al*., 2016). It collects data from reflected electromagnetic energy and converts it into images using satellites or airplanes. Satellites used in remote sensing- RRS-IA, RRS-IIB, RRS-IIIC, for agriculture purpose. Thus, remote sensing is the process of inferring surface parameters from measurements of the electromagnetic radiation (EMR) from the earth's surface. This EMR can either be reflected or emitted from the earth's surface.

Basic Concepts of Remote Sensing

The word "remote sensing" was coined by Fischer in 1960 AD. There are two basic interactions between electromagnetic energy and earth surface feature. These interactions are considered as basic concepts of remote sensing (Vadrevu *et al*., 2019):

1. The propositions of energy reflected, absorbed and transmitted will vary for different earth features, depending on their material type and condition. These differences permit to distinguish different features on an image.

2. Even within a given feature type, the proportion of reflected, absorbed and transmitted energy will vary at different wavelengths.

Principles of Remote Sensing

Different objects reflect or emit different amounts of energy in different bands of the electromagnetic spectrum. The amount of energy reflected or emitted depends on the properties of both the material and the incident energy (angle of incidence, intensity and wavelength). Detection and discrimination of objects from the object. A device to detect this reflected or emitted electromagnetic radiation from an object is called a sensor. A vehicle used to carry the sensor is called a "platform". Remote sensing can be conducted through satellites, aircraft, or ground-based platforms.

Satellite Remote Sensing

Is primarily for large-scale studies (>1 km²) but sometimes not adequate in applications that require finer spatial resolution (Khanal *et al*., 2020). In India, production forecasting of certain crops, crop yield modeling and crop stress detection are done using remote sensing data. India has launched INSAT series satellites (INSAT-1B, INSAT-1C, INSAT-2D, INSAT- 2E and INSAT-3E etc.) are in geo-stationary orbits.

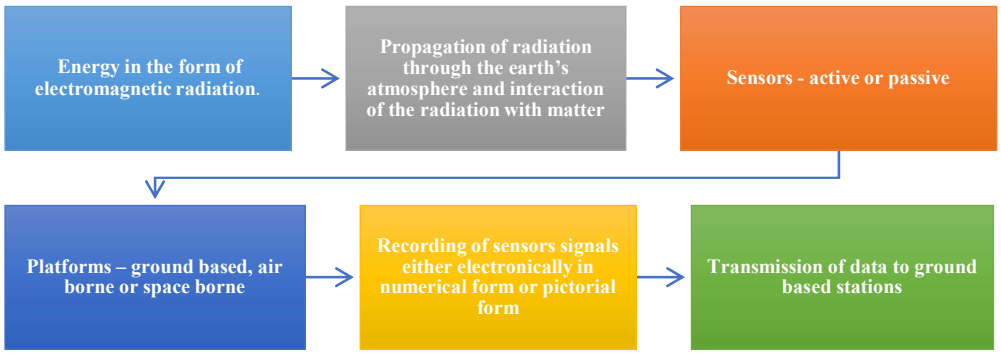
Airborne Remote Sensing

is flexible and able to achieve different spatial resolutions with different flight altitudes. An MS4100 multi-spectral camera (Geospatial Systems, Inc., Rochester, NY) was the central component of the airborne multi-spectral imaging system. This MS4100 camera is a 3-chip, multi-spectral HDTV-format digital camera with more than two million pixels per sensor (Atzberger, 2013). Three-chip image capture combined with advanced image processing provided excellent image quality. The camera supports three standard models for RGB, CIR and RGB/CIR with blue band in between 437 and 483 nm, green band in between 520 and 560 nm, red band in between 640 and 680 nm, and Near Infra-Red (NIR) band in between 767 and 833 nm. Green plant leaves typically display very low reflectance and transmittance in visible regions of the spectrum (i.e., 400 to 700 nm) due to strong absorbance by photosynthetic and accessory plant pigments.

Ground-based Platforms

such as handheld spectra diameters, are typically used for ground truth study. The number of ground-truth measurements needed may prove too excessive for practical spectral distinction of arthropod stress effects on plants to other stress factors. To achieve timely and accurate information on the status of crops, an up-to-date crop monitoring system may provide accurate information. The earlier and more reliable the information, the greater is the value. As the spectral reflectance of a tea field always varies with respect to the phenology, stage type and crop health, these could well be monitored and measured using the multispectral sensors and to detect stress associated with moisture deficiencies, insects, fungal and weed infestations and to take effective measures (Chang *et al*., 2019).

The remote sensing system mainly comprises of the following steps which has been described below in the flowchart.



Use of Remote Sensing in Agriculture

1. Crop production forecasting: Remote sensing is used to forecast the expected crop production and yield over a given area and determine how much of the crop will be harvested under specific conditions. Researchers can be able to predict the quantity of crop that will be produced in a given farmland over a given period of time.

2. Assessment of crop damage and crop progress: In the event of crop damage or crop progress, remote sensing technology can be used to penetrate the farmland and determine exactly how much of a given crop has been damaged and the progress of the remaining crop in the farm.

3. Horticulture, cropping systems analysis: Remote sensing technology has also been instrumental in the analysis of various crop planting systems. This technology has mainly been in use in the horticulture industry where flower growth patterns can be analyzed and a prediction made out of the analysis.

4. Crop identification: Remote sensing has also played an important role in crop identification especially in cases where the crop under observation is mysterious or shows some mysterious characteristics. The data from the crop is collected and taken to the labs where various aspects of the crop including the crop culture are studied.

5. Crop acreage estimation: Remote sensing has also played a very important role in the estimation of the farmland on which a crop has been planted. This is usually a cumbersome procedure if it is carried out manually because of the vast sizes of the lands being estimated.

6. Crop condition assessment and stress detection: Remote sensing technology plays an important role in the assessment of the health condition of each crop and the extent to which the crop has withstood stress. This data is then used to determine the quality of the crop.

7. Identification of planting and harvesting dates: Because of the predictive nature of the remote sensing technology, farmers can now use remote sensing to observe a variety of factors including the weather patterns and the soil types to predict the planting and harvesting seasons of each crop.

8. Crop yield modelling and estimation: Remote sensing also allows farmers and experts to predict the expected crop yield from a given farmland by estimating the quality of the crop and the extent of the farmland. This is then used to determine the overall expected yield of the crop.

9. Identification of pests and disease infestation: Remote sensing technology also plays a significant role in the identification of pests in farmland and gives data on the right pests control mechanism to be used to get rid of the pests and diseases on the farm.

10. Soil moisture estimation: Soil moisture can be difficult to measure without the help of remote sensing technology. Remote sensing gives the soil moisture data and helps in determining the quantity of moisture in the soil and hence the type of crop that can be grown in the soil. Apart from determining the soil moisture content, remote sensing also plays an important role in the estimation of the water content in the field crops.

11. Irrigation monitoring and management: Remote sensing gives information on the moisture quantity of soils. This information is used to determine whether a particular soil is moisture deficient or not and helps in planning the irrigation needs of the soil.

12. Soil mapping: Soil mapping is one of the most common yet most important uses of remote sensing. Through soil mapping, farmers are able to tell what soils are ideal for which crops and what soil require irrigation and which ones do not. This information helps in precision agriculture.

13. Monitoring of droughts: Remote sensing technology is used to monitor the weather patterns including the drought patterns over a given area. The information can be used to predict the rainfall patterns of an area and also tell the time difference between the current rainfall and the next rainfall which helps to keep track of the drought.

14. Land cover and land degradation mapping: Remote sensing has been used by experts to map out the land cover of a given area. Experts can now tell what areas of the land have been degraded and which areas are still intact. This also helps them in implementing measures to curb land degradation.

15. Identification of problematic soils: Remote sensing has also played a very important role in the identification of problematic soils that have a problem in sustaining optimum crop yield throughout a planting season.

16. Crop nutrient deficiency detection: Remote sensing technology has also helped farmers and other agricultural experts to determine the extent of crop nutrients deficiency and come up with remedies that would increase the nutrients level in crops hence increasing the overall crop yield.

17. Reflectance modeling: Remote sensing technology is just about the only technology that can provide data on crop reflectance. Crop reflectance will depend on the amount of moisture in the soil and the nutrients in the crop which may also have a significant impact on the overall crop yield.

18. Flood mapping and monitoring: Using remote sensing technology, farmers and agricultural experts can be able to map out the areas that are likely to be hit by floods and the areas that lack proper drainage. This data can then be used to avert any flood disaster in future.

19. Collection of past and current weather data: Remote sensing technology is ideal for collection and storing of past and current weather data which can be used for future decision making and prediction.

20. Water resources mapping: Remote sensing is instrumental in the mapping of water resources that can be used for agriculture over a given farmland. Through remote sensing, farmers can tell what water resources are available for use over a given land and whether the resources are adequate.

21. Precision farming: Remote sensing has played a very vital role in precision agriculture. Precision agriculture has resulted in the cultivation of healthy crops that guarantees farmers optimum harvests over a given period of time.

22. Compliance monitoring: For the agricultural experts and other farmers, remote sensing is important in keeping track of the farming practices by all farmers and ensuring compliance by all farmers. This helps in ensuring that all farmers follow the correct procedures when planting and when harvesting crops.

23. Air moisture estimation: Remote sensing technology is used in the estimation of air moisture which determines the humidity of the area. The level of humidity determines the type of crops to be grown within the area.

Limitation of Remote Sensing

- The interpretation of imagery requires a certain skill level
- It is not suitable small farm or land holders
- Needs cross verification with ground (field) survey data
- Data from multiple sources may create confusion
- Objects can be misclassified or confused
- Distortions may occur in an image due to the relative motion of sensor and source

Conclusion

With the help of remote sensing we can able to obtain imagery of any area over a continuous period of time through which the any anthropogenic or natural changes in the landscape can be analyzed.

Remote sensing can be used for crop intensification that includes collection of important crop data such as the cropping pattern, crop rotation needs and crop diversity over a given soil. Moreover, it plays a key role in mapping land for use for various purposes such as crop growing as well as in weather forecasting and keeping track of the climatic conditions which play an important role in the determination of what crops can be grown where.

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