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KERALA KARSHAKAN

English journal

The First English farm journal from the house of Kerala Karshakan

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WORLD ENVIRONMENT DAY

"Ecosystem Restoration"

INSIDE

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Genetically Engineered Crops

Part I – Principles of Genetic Engineering

Genetically Engineered Crops, also referred to as Genetically Modified Crops (GM Crops) or Transgenic Crops, have gained popularity among farmers worldwide over the past 25 years. Crops such as maize, soybean, canola and cotton have been successfully adopted due to their ability to simplify pest management and to tolerate environmental stress such as drought. Genetically modified crops with nutritional benefits are in the pipeline.

Through a series of articles, let us gain insight into some of the fundamental aspects of GM Crops, objectively access the benefits and risks associated with them, and examine some of the futuristic directions of this technology. In this introductory article let us discuss the principles of genetic engineering.

Everything around man was once a mystery for him. Ancient man had Gods and Goddesses for almost all naturally occurring phenomena. When philosophers started questioning the cause of unknowns, science evolved gradually as a discipline. Soon, the causes of lightning, thunder and rainfall were all explained by science. Today science and technology has advanced to unprecedented levels. We now have answers to some of the most complicated questions. The concept of genetic engineering, however, is widely different from that of other scientific developments as it deals with the underlying mechanisms of life itself. It is therefore essential to have a thorough understanding of the principles of this science to have a sound judgement of its benefits and risks.

The topic on genetic engineering will be delivered in a series of articles. This article will cover the basics of genetic engineering technology. Although genetic engineering has an impact on almost all walks of life including medicine, processed foods, meat and dairy products etc., these series of articles will focus primarily on genetically engineered crops.

First, what is a genetically engineered crop? We all know that the outwardly characteristics of plants and animals are determined by genes. We also know that genes reside in cells - the fundamental units of all living organisms. Genes are actually sections of genetic material known as DNA (deoxyribonucleic acid) that has coded information to eventually determine an organism's physical traits. How is this information coded in a gene or DNA? DNA is essentially composed of long chains of units called bases just like links of a long chain. Although there are millions of these links or bases in a single DNA strand, they are actually made up of four different kinds of bases A, T, G, C. The arrangement of a vast number of these four bases in a DNA molecule can be referred to as the genetic code.

The bases are arranged in a predetermined sequence that make up the genetic code for producing a variety of proteins. Three of these bases code for a certain biochemical called an amino acid, which are the building blocks of proteins. There are a total of twenty different amino acids. The amino acid coded to be produced by the bases depends on their sequence of the gene that is expressing it. The sequence of amino acids in the chain determines the nature and characteristics of these proteins. These proteins eventually determine the physical traits of that particular living organism. Therefore, a slight rearrangement of the bases in a DNA molecule may eventually alter the organism's traits or outwardly characteristics.

Throughout evolution, natural selection has occurred which causes organisms to adapt to their surroundings. These originated from a rearrangement (mutation) of the bases (genetic code) often by natural causes. This is a very slow process. Through reproduction, genes are transmitted to the offspring from the parents. This understanding enabled us to improve crops and domestic animals using traditional or classical breeding techniques. Classical breeding involves human intervention to introduce new genetic material to the offspring by breeding techniques. However, organisms are capable of reproducing only within species or very closely related species. Therefore, classical breeding was limited to generate hybrids within a given species or closely related species.

Through advances in genetic engineering, we are now capable of introducing genes from distantly related species into the DNA of an organism. Therefore, gene from a glowworm could be

introduced into a houseplant to make it glow in the dark! Genetically engineered crops have foreign genes introduced into them. The gene introduced into the plant may have originally belonged to a totally different plant, or a microbe, or even an insect or an animal. For example, the GM (genetically modified) crop, Bt corn, has genes belonging to a bacterium called *Bacillus thuringiensis*. By nature, this bacterium is capable of infesting the insect called European corn borer through its chemical secretions. By virtue of the bacterial genes introduced into Bt corn, the corn can produce chemicals of *Bacillus thuringiensis* to infest the insect.

When an European corn borer larva feeds on Bt corn, it ingests some of these chemicals and die as a result. The corn, thus becomes resistant to the serious pest. Similar are the mechanisms of herbicide resistance of Roundup Ready soybean (where the genes introduced into the crop are capable of producing enzymes, which are also proteins, that can break down the herbicide into harmless by-products) and certain other GM crops. The scope of genetic engineering is so vast that it can be left to one's imagination. Biotechnology as a science is still in its infancy. Thus, research in years to come will give us a better picture of its long-term effects. As with any new technological advance, genetic engineering comes with a several benefits and risks. It would be premature to completely rule out the usefulness of this technology or to embrace it in totality. Currently, a great deal of interest has been focused on the pros and cons of this technology. In the following issue, some of the benefits and risks of genetically engineered crops will be discussed.

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ADVISORIES TO **COCONUT FARMERS IN COVID-19 LOCKDOWN AND MONSOON PHASE**

Coconut, eulogized as "Kalpavriksha", is an excellent ecological service provider which delivers food, fibre and fuel to mankind and fosters livelihood security to more than 12 million farm families. Unprecedented summer showers coupled with significant crop loss due to the cyclone "Tauktae" in this COVID-19 lockdown phase-2021 had definitely impacted farming in general and coconut farming in particular, that derailed timely farm operations. We present hereunder some precautions to

be followed meticulously by all coconut farmers to combat this new-normal situation.

a) Nutrient leach out and replenishment

The current cloudy situation and intermittent precipitation in synergy with timely forecast of South-West monsoon could impair nutrient availability to palms because the summer showers had already taken off the nutrients from soil. The prevailing nutrients available in the soil may be insufficient to support a sustainable yield. This had already manifested in coconut palms with various conditions of nutrient deficiency like yellowing and button shedding. Therefore, the coconut farmers are advised to properly plan and effectively utilize the rain free days before the onset of south west monsoon for timely farm operations.

If the coconut basins are not yet opened it is recommended to open basins with shallow depth and apply 1 kg dolomite or lime per palm in order to neutralize the soil acidity. About 100 g cowpea seeds shall be sown around the basins with the available residual soil moisture. Incorporating the cowpea in coconut basins after 6 to 8 weeks of growth at the time of flowering will contribute nearly 25 kg of organic matter in the palm rhizosphere. Furthermore, it improves the nitrogen availability in the soil and prevents soil run-off during monsoon showers. Sowing and incorporation of cowpea is also advisable in coconut interspaces in flood prone areas which could resist soil hardening and nutrient loss from water stagnation.

Adult palms with more than 3 years of age require 1.1 Kg of Urea, 1.5 Kg Rajphos or Mussooriephos, 2.0 Kg Muriate of potash every year. The first dose of fertilizers can be applied two weeks after dolomite/lime application. In order to avoid nutrient leach out, half of the above mentioned dose should be applied at the start of south west monsoon. Fertilizers should be applied around the coconut basins at least 1 m distance away from the coconut trunk and incorporate equally around the areas of 1 to 2 m radius from the trunk. Remaining half of the recommended dose can be applied during September-October along with soil incorporation of cowpea

grown in basins. Application of 500 g of Magnesium sulfate is recommended after one week of applying second dose of fertilizers in root (wilt) disease endemic zones. Care should be taken to avoid fertilizer application during heavy downpour.

b) Encourage soil aeration

Opening of drainage channels, presence of rain water harvesting pits, ponds etc. in the coconut gardens will ensure proper drainage of rain water. This would ensure effective water conservation and overcome flooding in coconut gardens as well. Water stagnation in palm basin would suffocate roots and rotting would take an upper hand for which adequate water drainage to encourage aeration is mandatory to improve palm health. In flooded palm basin, mild soil raking after water drainage would also aid in soil aeration.

c) Deferment of planting time

Planting time of coconut seedlings can be adjusted based on the water draining ability of soil. Seedlings can be planted during May-June months by preparing pits of dimension 1 m x 1m x 1m on a leveled land where rain water do not stagnate for long period. It is always better to chose September-October as the planting time in flood prone areas. The farmers from flood prone areas, who had already purchased the seedlings, can temporarily plant them in elevated terrains to safe guard from flooding and defer planting in the main field during September-October. Alternatively, they can also plant the seedling in raised bunds or by planting in shallow pits along with yearly addition of soil. Pit size should be adjusted based on the soil type viz. 1.2 m. in hard laterite soil and 75 cm. in sandy soil and 1 m. in other soil types. Application of 1 to 3 kg of *Trichoderma harzianum* enriched bio-suppressive compost at the time of planting will benefit good seedling growth and take guard from soil borne pathogens

d) Disease tolerant coconut varieties /hybrid

Quality planting material with a known pedigree of mother palm is crucial for class determination in the long run for a perennial crop like coconut. ICAR-CPCRI has developed varieties like Kalpasree, Kalparaksha and one hybrid namely Kalpasankara for the root (wilt) disease prevalent tracts. Booking of these seedling are usually made at ICAR-CPCRI during February-March and seedlings are distributed during May-June period.

e) Pest management

In order to protect coconut seedlings from the rhinoceros beetle, naphthalene balls can be placed in 2 to 3 top most leaf axils filled with sand immediately after planting. Seedlings can also be protected from the rhinoceros beetle attack by using old fish nets around the spear leaf. There is also a possibility of increased incidence of rhinoceros beetle, rat etc. as well as different fungal diseases during the monsoon season. Therefore, care should be taken for cleaning the crown and for the removal of excess shades by pruning the trees to improve the availability of sun light to the coconut.

These practices will help in general reduction in pest and disease incidence in coconut. Leaf axil filling of 250 g neem cake mixed with 250 g of fine sand in the top most three leaf axils around the spear leaf would repel rhinoceros beetles. Incorporation of the weed plant, *Clerodendrum infortunatum* plant or the entomopathogenic green muscardine fungs, *Metarhizium majus* in the compost and cow dung pits would reduce the population of rhinoceros beetles by controlling their grubs.

f) Disease suppression

Placement of 3 to 4 numbers of *Trichoderma* harzianum-coir pith cake is an effective bio control agent against leaf rot / bud rot, especially in the gardens where these diseases are prevalent. Palms can be protected from the incidence of leaf rot by the crown application of 2ml Hexaconazole 5EC dissolved in 300 ml of water and by the crown application of 1% Bordeaux mixture for the suppression of bud rot disease. Incidence of bud rot in seedlings and stem bleeding in adult palms were commonly observed in the flood affected gardens during previous years. Palms in such areas can be protected by the basin incorporation of *Trichoderma harzianum* enriched neem cake and by the application of *Trichoderma harzianum* paste as and when the initial bleeding symptoms appear.

As prevention is always better than cure, a careful scrutiny of palms and adoption of aforesaid management solution would be the key to safeguard palms to produce a sustainable yield.

GENOME EDITING OFFERS NEW RAY OF HOPE TO TACKLE MALNUTRITION

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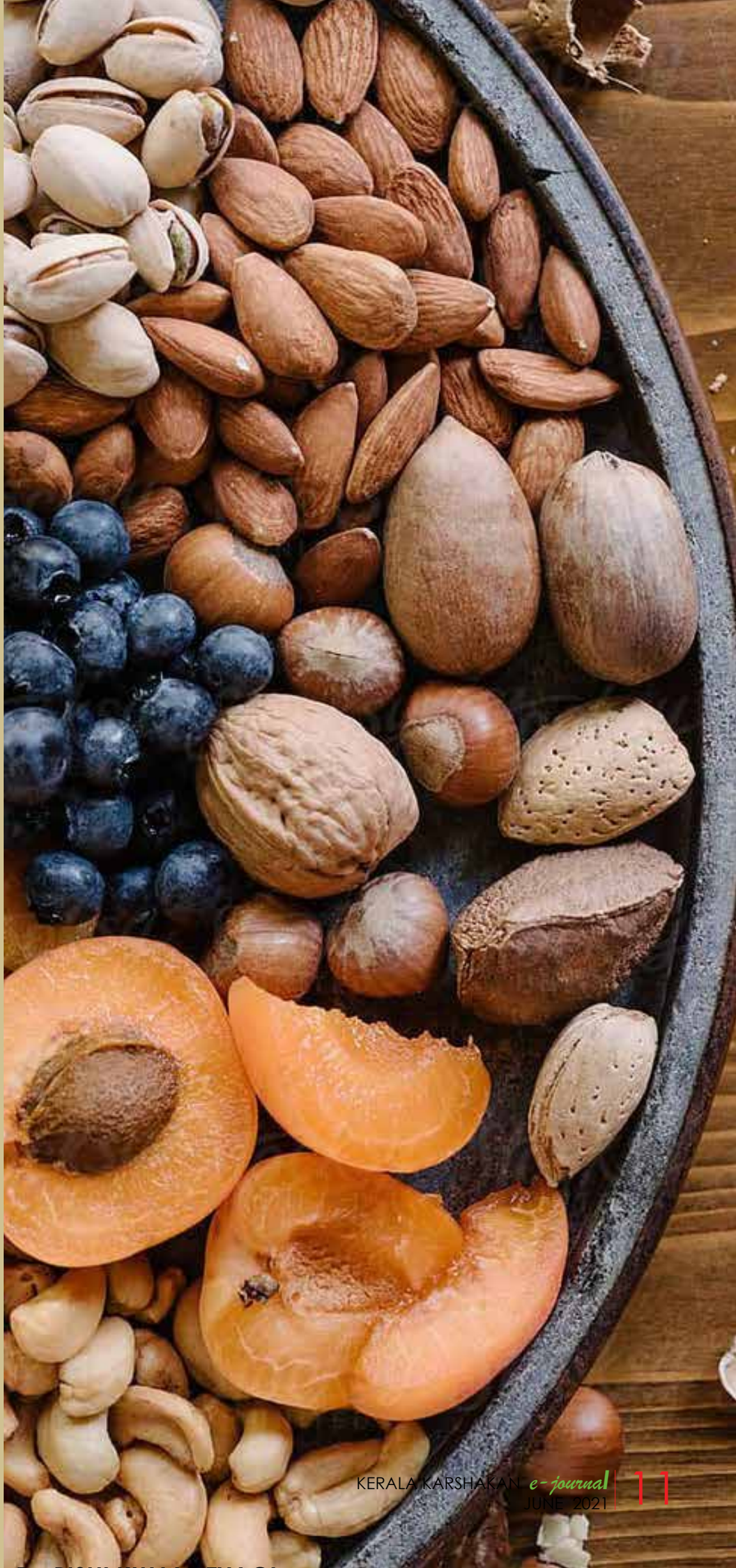
Plant-based diets have been recommended for better planetary health also as it would be more sustainable with lower environmental impacts and improving food and nutritional security of the generations. There is an urgent need to transform current diets for improving health of population and to achieve equity in benefits at social, economic and environmental levels. Furthermore, the ongoing COVID-19 pandemic has posed serious challenges to the humanity across the world. Scientists and researchers are working round the clock to understand its effects and to find an effective solution. In this backdrop, it has become mandatory for us to take every possible measure to keep the

coronavirus away and boosting our immunity is the most effective weapon. There is a need to take proper diet to fight the virus in addition to being well-prepared for the health challenges that are clearly foreseen ahead. This underlines the importance of nutritional dietary guidelines. We must embrace innovations and technological solutions to address the nutrition-related problems.

Vitamins such as A, B6, B12, folate, C, D and E and trace elements like zinc, copper, selenium and iron are known to be crucial in strengthening immune system as they have antiviral and antibacterial properties. Amino acids and fatty acids too are important constituents of the healthy diet. Fresh fruits and vegetables besides grains, nuts and animal products are the best source of these nutrients. The United Nations' (UN) efforts for global nutrition seek to eradicate micronutrient deficiency problems.

It is important to ensure nutrient-rich, balanced diet for masses since arobust immune system will keep the population healthy and reduce medical costs incurred to treat diseases caused by malnutrition. This poses challenges for scientists and policymakers to secure better nutrition at affordable prices for poor communities. Millions of people around the world are prone to malnutrition or inadequate nutrition intake. Biofortification is the process that helps increase the density of nutrients in our routine foods. We can biofortify many crops including fruits and vegetables using genetic engineering. Genome editing, a powerful tool, holds a great promise.



In many countries, the focus of agriculture research is on improving crop production and productivity in order to provide adequate and affordable food to burgeoning populations. And new technologies have made this possible. However, now the focus needs to be shifted to nutritional aspects.

Enhancement of micronutrients can be achieved in a convenient, and faster way by making use of the genome editing tools. Fresh fruits and vegetables are rich sources of micronutrients and bioactive phytochemicals but they are perishable and sensitive to biotic as well as abiotic stresses. Genome editing can lower post-harvest losses by improving shelf life of the produce.

The advance tools of gene editing enable incorporation of traits the same way as through the conventional plant breeding techniques but in a more efficient manner.

Conventional plant breeding techniques are labour-intensive and take years to confirm the results. On the other hand, gene editing facilitates obtain desirable traits in the plants quite faster and with high efficiency and precision, thus, improving plants for multiple qualities, economically. There are a few gene editing tools, of them, the clustered regularly interspaced short palindromic repeats (CRISPR) method appears to be the most feasible, cost-effective and versatile tool to allow precise and efficient editing of plant genomes.

According to the Food and Agriculture Organisation (FAO), over 820 million people did not have enough to eat while 26.4 percent of the world population or about 2 billion people did not have regular access to safe, nutritious and sufficient food in 2019. These people belong to underdeveloped and developing countries.

Gene editing technology has potential to revolutionize crop improvement, with a focus on local crops.

Efforts must be taken to create awareness about the technology and quell unfounded doubts people have about genetic engineering. People and policymakers must be convinced about how the gene editing is a golden opportunity to enhance human nutrition, besides achieving higher yields and greater tolerance to unfavorable growing conditions.

The gene editing techniques can complement the ongoing efforts to provide micronutrient supplements, fortified food and appeals for eating more diversified food. Farmers in rural areas, which are difficult to access by other mechanisms, can breed new crop varieties with higher nutrition content, thus, ensuring a reliable source of micronutrients for the local populations. For developing world, the major area of research is food security, followed by nutrition security.

Modern plant breeding methods and gene editing offer favourable conditions to increase the micronutrient content and enhance the nutritional value of food that people eat daily. Adoption of gene editing and gene edited products can be achieved by disrupting the current bottlenecks to progress towards nutritional security by making intensive efforts for public awareness and acceptance, and enabling policies by the respective governments.

World Environment Day

World environment day is being celebrated every year on June 5th. As for every day, being organized with a great motive, this day is celebrated by planting seeds and saplings in a festive mood for the sake of the day. I myself have witnessed cutting down large fruit trees like mango, jack trees etc. for planting annual ornamentals. Now, in this period of pandemic people are getting aware of the necessity of pure air and maintaining lungs for the area by planting trees for absorbing carbon dioxide and to release oxygen for the entire living world.

The theme for World Environment Day 2020 was "Time for nature", with a focus on its role in providing essential infrastructure that supports life on earth and human development. It provided an opportunity for driving the momentum and public awareness towards the importance of nature

During the current year, on June 5th the United Nations is launching a decade long"ecosystem restoration". 'Development' has taken its toll on the natural ecosystems throughout the globe. Aim of this decade long programme is to revive the natural spaces lost

to development. Though this duration of ten years seems to be very long, these ten years will count most in the fight to avert climate change and the loss of millions of species of plants and animals.

United Nations has planned a 10 staged strategy for generation/restoration of the ecosystem.

Empower the global movement

It aims to stop and reverse the destruction and degradation of billions of hectares of ecosystems from lush forests threatened by wild fires to agricultural soils being eroded leaving behind the truth that there will be only a few more years of harvests. It is a daunting task, made more complicated by the diversity of the ecosystems and the threats each ecosystem is facing. In addition, vested interests also hinder their rejuvenation. No single entity can steer the entire procedure. Groups and organizations can

initiate the work, developing enthusiasm in individuals to join the venture.

Invest in restoration

Restoration need resources. Attempts in this direction often fail due to financial insecurity. United Nations calls to mobilize long term funds from Government, International lenders, development agencies, private sectors and even individuals.

Set the right incentives

In the long term, healthier ecosystem can produce bigger harvests, more secure income and a healthier environment. So, there is a need to incentivize restoration activities and to reduce subsidies for agricultural development, that finance harmful practices which affects the nature.

Celebrate leadership

Over the past few years, we have witnessed incredible momentum around restoration. Many, environmentalists; with the help of local people, have organized campaigns to plant trillions of trees and have captured the attention and created imagination in many communities around the globe. Under the BONN challenge, more than 60 countries have committed to bring 350 million hectares of forest landscape back to life. Indigenous people; mostly tribal people; have acted as the defenders of their ecosystems for generations. They had to face several threats and many have sacrificed their lives. These leaders have to be honored, thereby encouraging new individuals to step in.

Shift Behaviors

Deforestation, depletion of fish stock, local breeds of animals and poultry, degradation of agricultural soils etc. are caused by the global consumption pattern. The United Nations; in this decade for ecosystem restoration, will work with the partners to identify and encourage restoration of ecofriendly consumption patterns.

Invest in Research

Restoration of ecosystem is a very complex process. Strategies for one ecosystem may harm another. Climate change and uncertainties are constantly in a battle with this restoration process and to adapt is very important. Many species might have gone extinct. New resistant or antagonistic species might have emerged. A scientific understanding of how and what to restore is very crucial and time consuming.

Celebrate a culture of restoration

Restoration of ecosystem cannot be achieved through scientific brainstorming sessions, campaigns, new policies or Government orders.Healing the planet needs a cultural change. So the United Nations calls on artists, storytellers, film producers, musicians and environmentalists to join together for restoration/generation of the ecosystems.

Build up the next generation

The current and rapid destruction of ecosystems affect the youth and future generations, more than the current generation. So, they have to be made aware to stand as ecosystem ambassadors. The United Nation's 10 year strategy links the wellbeing of youth and future generations with the goals of restoration/ generation of ecosystem. Educating children about the importance of maintaining the ecosystems will provide them with more sustainable development outlook.

Learn and listen

Restoration of ecosystem is not an easy task. So the United Nations Environment Programme has already surveyed and recorded details of conversationalists, financiers, volunteers and motivators to identify the opportunities, barriers etc. and to spur grass-root level action.

This pandemic situation is the ideal time to initiate this attempt of ecosystem restoration/ generation in the 100 member countries.

Hope the little virus succeeded in making the masses understand the importance of nature, fresh air and peaceful living.

Hope this inturn will lead each and everyone to a wholehearted participation in ecosystem restoration.

Hope our next generation will be able to live in a greener, cleaner and more fresh environment.

Edited by
Editor, KeralaKarshakan

CARBON FARMING FOR INDIA
CONCEPTS, CONSTRAINTS AND INTERVENTIONS

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Globally agriculture sector account about 24% of greenhouse gas emissions (GHGs) and in India it contribute 17.6% of the total net CO_2 eq. emissions (GOI, 2010). Fifty percent of India's methane and large amount of nitrous oxide comes from agricultural sector (Wang et al. 2017). The major sources of emission in Indian agriculture include, enteric fermentation from livestock, rice cultivation, manure management, burning of crop residues, use of nitrogen

fertilizers and ploughing fields after the growing season, which aerates the soil and allows carbon to reach the atmosphere. The emission from enteric fermentation in livestock was 212 million tons of CO_2 eq. constituting 63.4% of the total emission from agriculture sector in India (Sharma et al. 2011). Manure management and rice cultivation contribute 2.44 and 69.87 million tons of CO_2 eq. respectively (NAAS 2014). Total emissions of N_2O from agricultural soils and CH_4 and N_2O from crop residue burning is 50 million tons of CO_2 eq.

India has committed itself to voluntarily reduce its emissions intensity (emissions per unit GDP) between 20 to 25 percent below 2005 levels by 2020. This would require rapid and significant scaling up of mitigation efforts including the agriculture sector. Low carbon development pathways offer opportunities for pursuing GHG reductions. Agriculture sector can help India in meeting this target by taking a systems approach of "climate smart" agriculture involving application of technologies that would increase productivity and income while reducing GHG emissions in the form that has demand in carbon markets.

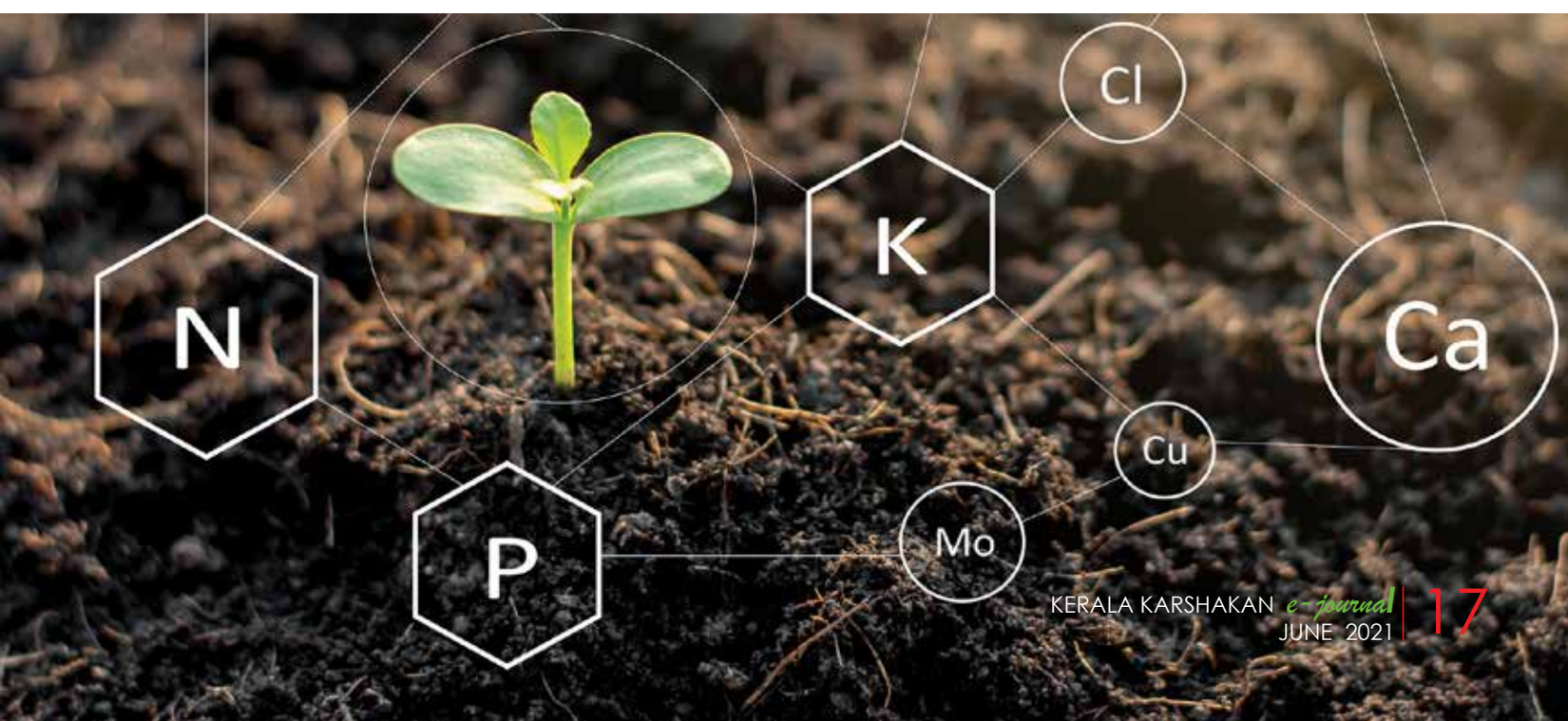
Scope of carbon sequestration in agriculture

A 1% increase in soil OC in one acre is equivalent to storing 18 metric tonnes (MT) of CO_2 underneath our ground. Increasing the carbon content of the world's soils by 0.4 percent in the top 30-40 cm of soils each year would remove around 3-4 gigatons of carbon from the atmosphere, boost soil health and also would stop annual increase in CO_2 in atmosphere. Increasing soil carbon by 0.4 percent a year can enhance crop yields by 1.3 percent. Agriculture, and in particular agricultural soils, can play a crucial role where food security and climate change are concerned. Scientific agriculture can help in mitigating GHGs emission.Thus, agriculture can provide a better answer to the climate crisis than some other sectors, if done right.

A suitable interventions for promoting low carbon agriculture such as: no-till (zero-till) and minimum tillage systems as it has negative costs due to savings on tillage and fuel; sustainable forest management, introduction of superior livestock breeds to reduce numbers (especially unproductive cattle) and increase yield; use of livestock wastes to produce energy for cooking and heating through bio-gas technology can not only reduce methane emission but also save electricity costs for the households and; introduction of carbon credits and exploration of domestic carbon markets.

Carbon farming

Carbon farming (also known as carbon sequestration) is a system of agricultural management that helps the land store more carbon and reduce the amount of GHGs that it releases into the atmosphere. Farmers can manage their grazing lands to conserve and restore vegetation, including tree cover along waterways. This practice helps the land store carbon and remove GHGs from the atmosphere. Farmers would be compensated for increase in



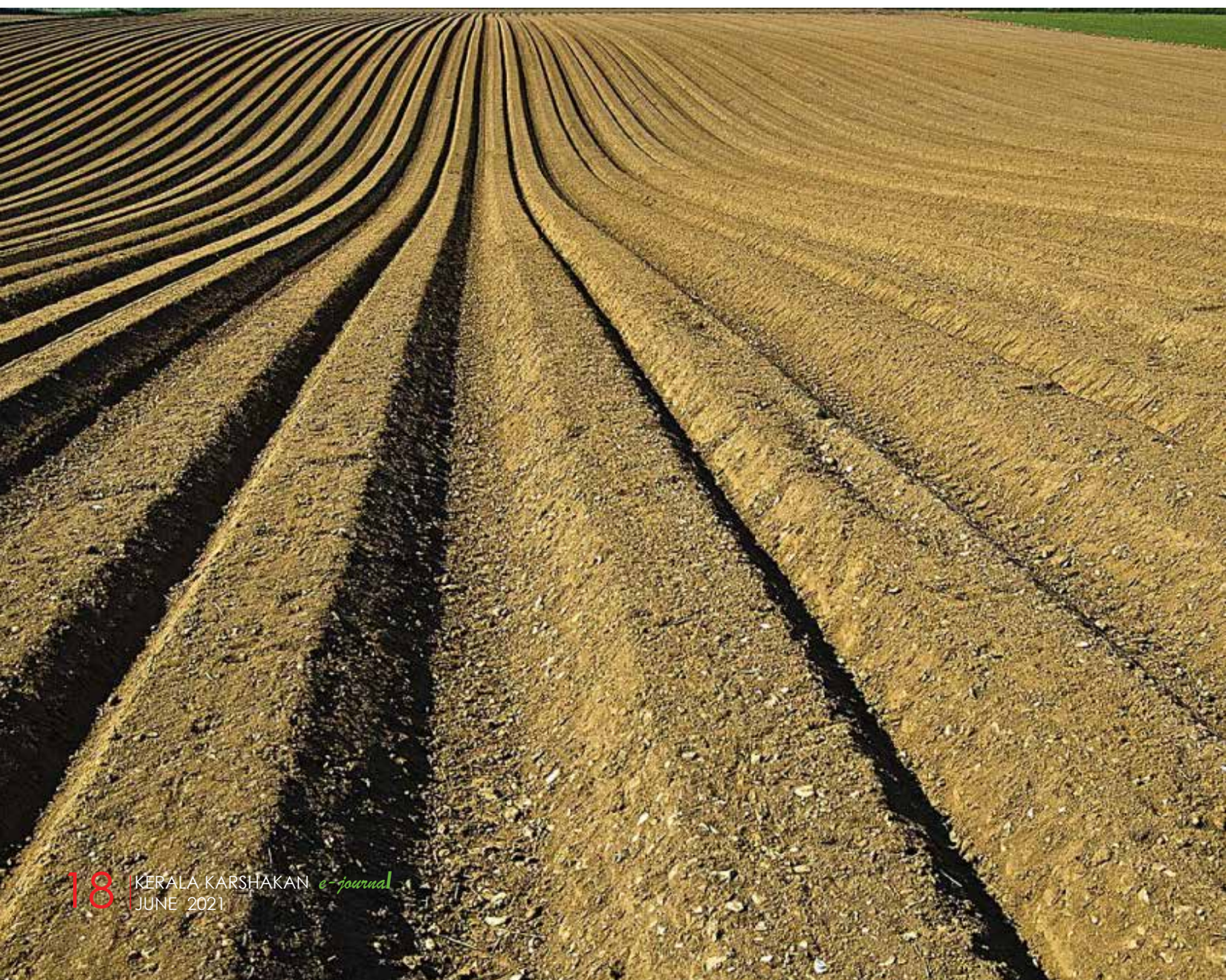
soil carbon by contributions from individuals, private companies, and NGOs concerned about climate change.It will help farmers increase their income as well as store carbon in their soil.

Carbon 'offset'

A carbon 'offset' represents a real reduction of CO_2in the atmosphere and results in the generation of a carbon 'credit.' The difference from a carbon credit is that the credit is generated as the result of a project with clear boundaries, title, project documents and a verification plan. In most cases, carbon offsets generate reductions outside of the organization and, more importantly, outside of any regulatory requirement. Common projects include building wind farms, supporting truck stop electrification projects to reduce tailpipe emissions, and planting trees or preserving forests. Because CO_2 has global not local impact, both credits and offsets have the same reduction in CO_2emissions and have the same benefit to the planet in terms of climate change.

Carbon credits

When landowners/ farmers, initiate a project that can mitigate the amount of carbon in the atmosphere through long-term carbon sequestration. A single carbon credit represents ownership of the equivalent of one MT of carbon that can be traded, sold or retired. Carbon credits are measured in CO_2 eq. and expressed in metric tons (MT) and compared to what would exist in the absence of the carbon project. If an organization is regulated under a cap-and-trade system it likely has an allowance of credits it can use towards its cap. If the organization produces fewer tons of carbon emissions than it is allocated, the organization can trade, sell or hold the remaining carbon credits. When a credit is



sold, the buyer is purchasing the seller's allowance of emissions. A credit becomes tradeable because of a very real reduction in emissions, but the reduction is from an activity you might not be aware of such as flying less or turning equipment off at night.

In India Saguna Rice Technique (SRT),a form of zero-till conservation agriculture, implemented in two districts of Maharashtra state starting with 20 farmers under carbon farming project. This project was the initiative by Shekar Bhadsavale, a California-educated progressive farmer from Nepal, and Emmanuel D'Silva, an agriculture and environment scientist from Mumbai who previously worked at the World Bank. D'Silva had initiated carbon credit programs through tree plantations in 44 tribal villages a decade earlier. Farmers participated in this project were mostly marginal and small farmers. This project aims to provide financial support to each farmers according to their carbon credit of the particular farm.

What Are Carbon Markets?

Carbon markets aim to reduce GHG emissions enabling the trading of emission units (carbon credits), which are certificates representing emission reductions. Trading enables entities that can reduce emissions at a lower cost to be paid to do so by higher-cost emitters. By putting a price on carbon emissions, carbon market mechanisms raise awareness of the environmental and social costs of carbon pollution, encouraging investors and consumers to choose lower-carbon paths. There are two main categories of carbon markets: cap-and-trade and voluntary. Cap-and-trade sets a mandatory limit (cap) on GHG emissions and organizations that exceed these limits can purchase excess allowances to fill the gap or pay a fine. Voluntary markets enable the trading of carbon credits outside of the regulatory environment.

Compliance Carbon Markets

In certain jurisdictions, such as the European Union and California, companies are required by environmental cap-and-trade laws to offset their carbon footprint. Cap-and-trade lets the market find the least expensive way to cut emissions while driving technological innovation and economic growth. The 'cap' is the upper limit on the amount of carbon emissions a company can legally produce. As the cap is reduced for future years, total pollution declines. Electric utilities, refineries and large factories with emissions that exceed a pre-established amount of carbon tons per year must hold allowances (permits to emit one ton of carbon) or offsets (carbon credits) equivalent to their annual emissions. These organizations enter a compliance carbon market where carbon credits can bought and sold.

Methods of enhancing carbon build-up in biomass and soils include

- Adopting conservation tillage
- Reducing soil erosion
- Minimizing soil disturbance
- Using buffer strips along waterways
- Enrolling land in conservation programs
- Restoring and better managing wetlands
- Eliminating summer fallow
- Using perennial grasses and winter cover crops
- Promotion of an increase in forests
- Planting trees on lands that would otherwise remain non-forested
- Installing a bio-digester to capture methane from dairy-cow manure
- Managing tribal rangelands in a way that increases carbon sequestered below ground in roots
- Preventing conversion of grasslands to croplands to avoid releasing carbon stored in the land
- Low carbon rice cultivation technologies
- Technology to reduce methane emission
- Aerobic rice cultivation
- System of rice intensification
- Direct seeded rice cultivation
- Altering wetting and drying, particularly promoting intermittent irrigation and mid-season drainage
- Integrated nutrient management,
- Organic rice cultivation
- Improved organic matter management by promoting aerobic decomposition through composting or incorporating it into soil during off-season drained period;
- Use of rice cultivars with few unproductive tillers, high root oxidative activity and high harvest index; and
- Application of fermented

manure such as biogas slurry in place of unfermented farmyard manure.

Technology to reduce N_2O emission

- Improve nitrogen use efficiency using slow or controlled release fertilizer or nitrification inhibitors such as nitrapyrin and dicyandiamide.
- Integrated nutrient management
- Site-specific nutrient management
- Urea super granule (USG)
- Leaf colour chart (LCC)
- Green manuring (GM)
- Low carbon technologies for wheat cultivation
- Sprinkler irrigation,
- Zero tillage (ZT),
- Integrated nutrient management,
- Organic wheat,
- Nitrification inhibitor (NI),
- Site-specific nutrient management,
- Straw fed to cattle

Benefits of promoting low C technologies:

The major benefits include savings in irrigation water, labour and energy; reduction in GHGs emission, higher water and nutrient use efficiencies, provision of tolerance to moisture and heat stresses, improvement in soil health and increased income (Pathak and Aggarwal, 2012).

Constraints in promoting low C technologies:

Major constraints include high initial cost, infrastructure for installation and maintenance, knowledge intensiveness and technical soundness, high production cost, risks in the rainfed areas, weed problem, yield loss, inadequate market facility, lack of awareness and limited post-harvest facilities (Pathak and Aggarwal, 2012). Establishing baselines and measuring carbon storage in agriculture could be a challenge. Preparing authenticated carbon budget (carbon emission and sequestration) of each and every farm is an uphill task. The long gestation period of some of the programs (e.g. agro-forestry) and uncertainties. Moreover, a large transaction cost is involved in reaching to the stage of C trading. To make it profitable, a considerable size of C mitigation should be generated, for which these technologies need be adopted on a large scale. Since the average size of landholding by the farmers is small in India, a large number of farmers would have to adopt these technologies to avail the benefit of C trading.

Required interventions for promoting low C technologies:

The interventions required to overcome the constraints are creation of irrigation facility, provision of incentives for saving of water, carbon credits for mitigation, subsidy and other incentives for installation of resource conserving infrastructure, trainings for skill development, public awareness generation, development of low-cost, environment-friendly herbicides, accurate weather forecasting, development of post-harvest facilities and refining of technologies for making them simple, cheap and effective. The problem of small farm size could be overcome through forming cooperatives, self-help groups (SHGs), under collaborative efforts of government or even large private companies (Pathak and Aggarwal, 2012). The introduction of carbon credits and exploration of domestic carbon markets could definitely encourage other farmers to take up low carbon technology options.

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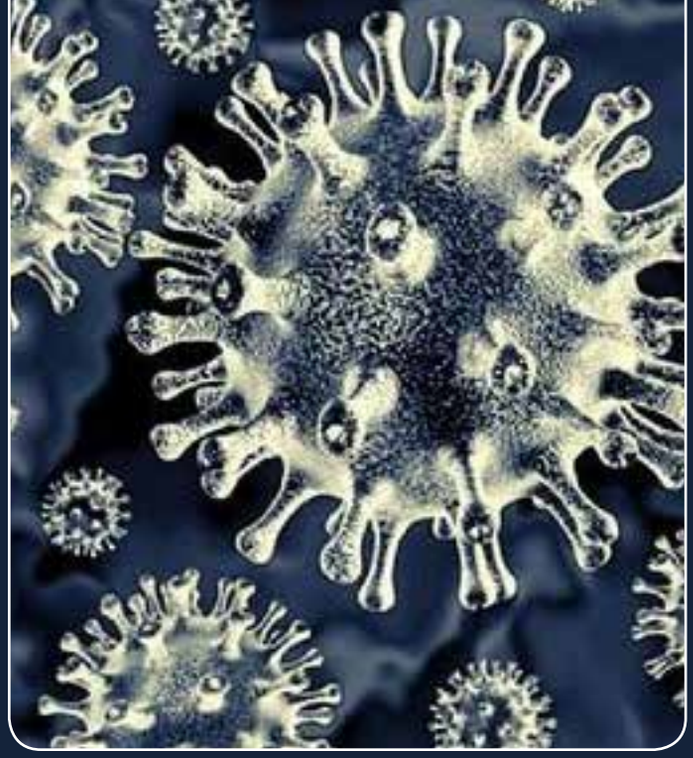

MUCORMYCOSIS

THE EMERGING FUNGAL MENACE AMIDST COVID-19 PANDEMIC PANIC

INTRODUCTION

Mucormycosis, an emerging, potentially fulminant fungal infection has claimed the lives of COVID-19 recovered patients in India and has left several patients blind amidst the second wave of pandemic. Also known as "black fungus", mucormycosis is a rare, angioinvasive fungal infection with exceedingly high mortality rates, ranging from of 50 to 100 per cent depending on the patients underlying condition(Katragkouet al., 2014).Though Aspergillosis and Candida are the most commonly reported fungal superinfections, black fungus is particularly more fatal as it affects the sinuses and the brain. In India, disease was repeatedly reported from the states of Maharashtra, Gujarat, Madhya Pradesh, Delhi, Uttar Pradesh, Bihar, Chattisgarh, Karnataka, Telangana and Kerala. In these states, mucormycosis has affected close to 7,250 people, killing 219 of them, with Gujarat emerging as a hotspot for infection. India's health ministry asked the state governments to declare mucormycosis as a "notifiable disease" under the

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Epidemic Disease Act, 1897 as it seems to be emerging as a new threat among COVID-19 patients (Anony., 2021).Immunocompromised individuals are at the highest risk for infection. Mucormycosis typically affects patients with serious underlying diseases such as diabetic ketoacidosis, haematological malignancies, and those who have undergone organ transplantation or treatment with corticosteroids or cytotoxic drugs.

CAUSATIVE AGENT

Mucormycosis in humans was first described by the German pathologist Arnold Paltauf in 1885 which he named as "Mycosis mucorina". Previously known as Zygomycosis, mucormycosisis caused by fungi in the phylum Zygomycota. This phylum is phylogenetically diverse and comprised mainly of two orders: Mucorales and Entomophthorales. Within Mucorales, the four genera responsible for infection in humans are Rhizopus, Mucor, Lichtheimia (previously known as Abscidia species) and Cunninghamella(Brettholzand Mccauley, 2018). The most prevalent species was *Rhizopus oryzae*, causing upto 70 per cent of the human cases (Riley et al., 2016).

DISEASE TRANSMISSION

Fungi causing mucormycosis are the rmotolerant molds ubiquitously found in the soil as well as in decaying organic matter like compost piles, leaves and rotten wood (Richardson, 2009). Infection is usually acquired through inhalation of sporangiospores. Fungus can also reach the body through scratch, burns, trauma, or contaminated wound dressings. Other least common routes linked to transmission include iatrogenic pathways or ingestion of spores through contaminated food and water. In healthy individuals, spores that gain access to the body are removed through phagocytosis mediated by immune system. In immunocompromised persons with predisposing factors, the fungi transform to its hyphal form affecting sinuses, oral and nasal cavities. It has high affinity for the endothelial cells of blood vessels. The hyphae rapidly and deeply invade the arteries and veins causing thrombosis, leading to ischemic necrosis of tissues involved. Mucormycosis, though highly fatal, is not contagious and it cannot spread between people or between people and animals.

PREDISPOSING FACTORS

Fungal superinfections occur more commonly in persons with organ transplants and also among critically ill patients, especially those admitted to intensive care units with mechanical ventilation. For the past few months, COVID-19 recovered patients were identified as the most important risk group developing black fungus infection. SARS-CoV-2 virus besides causing diffuse alveolar damage in lungs also produce a fall in number of CD4+T and CD8+T lymphocytes (Yang et al., 2020). Extensive use of glucocorticoids in COVID-19 patients to manage pneumonia will lead to prolonged hyperglycemia and immunosuppression. All these factors together with longer duration of hospital stay increase the risk of severely ill or

COVID-19 recovered patients to develop mucormycosis. A strong association was also observed between mucormycosis in patients with a history of COVID-19 together with confounding factors like diabetes and comorbid conditions such as cancer, kidney or heart disease.

In healthy individuals, sporangiospores of fungi entering through respiratory tract and mucosa are taken up and destroyed by polymorphonuclear phagocytes. But in patients having *Diabetes mellitus* and in those suffering from haematologic malignancies with neutropenia, there will be phagocytic dysfunction. Globally, diabetes mellitus and ketoacidosis were identified as the major predisposing factors for mucormycosis. The hyperglycemic state in diabetic patients impairs motility and phagocytic ability of neutrophils. The number of people with diabetes in India is estimated to cross 100 million mark in 2030, increasing the burden of mucormycosis in future also (Whiting et al., 2011).

Patients treated with deferoxamine have a high incidence of mucormycosis, Deferoxamine act as a siderophore, extract iron from sources like ferritin, delivers it to the fungal cells and promote their rapid growth (Ibrahim et al., 2008). Other risk factors for mucormycosis include renal insufficiency, HIV/AIDS, extreme malnutrition and broad-spectrum antifungal prophylaxis, especially using voriconazole (Lionakis and Kontoyiannis, 2005).

CLINICAL MANIFESTATIONS IN MAN

Mucormycosis in man is classified into five major categories based on the clinical signs and site of infection. This includes rhinocerebral, pulmonary, cutaneous, gastrointestinal and disseminated forms of mucormycosis; of these, rhinocerebral and pulmonary infections are the most common (Spellberget al.,2005).

a)Rhinocere bral mucormycosis

This is the most commonly reported form of mucormycosis in patients with diabetes and with renal transplants (Song et al., 2017). The person inhale spores of the fungi into nasal tract and paranasal sinuses from atmosphere. This disease usually follows an acute course with the signs of infection appearing two to three days after the patient has been cleared of COVID-19. The infection starts in the sinus and progresses to the eyes in two to four days, and soon reaches the brain causing fatality.

The symptoms of mucormycosis will vary depending on location of infection. Initial presenting symptoms of rhinocerebral mucormycosis usually appear with or without fever. The commonly observed signs include eye or facial pain, paraesthesia, periorbital and nasal swelling, blurred or double vision, and conjunctival suffusion. If not treated initially the infection will soon spread from the ethmoid sinus to the orbit, causing proptosis, ophthalmoplegia, chemosis and acute loss of vision. Vision loss is due to involvement of optic nerve or vessels supplying the retina. Later it disseminates into the nasal mucosa, oral cavity and finally to the central nervous system resulting in symptoms such as painful, dark necrotic lesions on the nasal bridge and hard palate, brown rhinorrhoea, multiple cranial nerve palsies, and headache.

b)Pulmonary mucormycosis

Pulmonary mucormycosis is usually seen in patients suffering from haematological malignancy with neutropenia and also in those who have undergone organ or stem cell transplant. Infection is mostly acquired through inhalation of fungal spores. Upper lobes of right lung were more commonly affected. If not treated, infection may spread to the contralateral lung affecting the pleura and pericardium(Brettholz and Mccauley, 2018).Symptoms in pulmonary mucormycosis are non-specific and can include fever, non-productive cough, dyspnoea, hemoptysis and chest pain.

c)Cutaneous mucormycosis

Cutaneous mucormycosis is the commonly observed form in people without a compromised immune system. Cutaneous form may be primary or secondary. Primary form results from the entry of fungal spores by direct inoculation through any discontinuity or break in the skin (Petrikkoset al., 2012). This can happen in patients with burns, injury or trauma on the skin. Secondary cutaneous infection develops due to haematogenous spread of fungi. The hallmark sign of cutaneous mucormycosis is a black necrotic eschar, surrounded by a zone of erythema and induration (Petrikkoset al., 2012). When lesion affect only the skin or subcutaneous tissue, cutaneous mucormycosis is considered as localised. When the organism invades fat, muscle, tendon, or bone, the disease is classified as deep form of cutaneous

mucormycosis.

d)Gastrointestinal mucormycosis

This form is less common and is believed to result from accidental ingestion of agent through contaminated food and water. Rarely the infection was noticed in premature infants and malnourished individuals affecting colon, and ileum of digestive tract (Kontoyiannis and Lewis, 2006). Non-specific abdominal pain, distension, nausea, vomiting and gastrointestinal bleeding are the symptoms.

e)Disseminated mucormycosis

Disseminated form occur due to haematogenous spread of pathogen from some other part of the body (Riley et al., 2016). The brain is most frequently affected, although it can also spread to spleen, heart and skin. Disseminated form is more commonly seen in neutropenic individuals with pulmonary infection.

CLINICAL MANIFESTATIONS IN ANIMALS

Predisposing factors underlying mucormycosis in humans apply for animals also. The fungi usually affect an animal when it is immunocompromised or suffering from metabolic disorders.Two clinical conditions of importance seen in cattle are mucormycotic ruminitis and lymphadenitis. Mucormycotic ruminitis is seen as a sequela to intensive antibiotic treatment of cattle (Jensen et al., 1989). The organisms cause granulomatous lesions in mesenteric and mediastinal lymph nodes. Infection may also be disseminated through haematogenous route to other organs like kidney, liver and brain. Clinical signs exhibited by calves and pigs in mucormycosis are vomiting, diarrhoea and gastroenteritis.

DIAGNOSIS

Mucormycosis is often difficult to diagnose because of non-specific signs of the disease. No routine serologic tests for mucormycosis are currently available, and blood tests such as beta-D-glucan or *Aspergillus galactomannan* do not detect mucormycetes. Clinical specimens used in diagnosis are sputum, bronchoalveolar lavage fluid, and biopsy sections of tissues.

Biopsy of infected tissues with histopathological assessment is the gold standard used for the confirmatory diagnosis of cutaneous, rhinocerebral, and pulmonary mucormycosis. Black fungus on biopsy typically appears as wide, ribbon like, aseptate hyphal components, branching at right angles and frequently surrounded by widespread necrotic debris (Spellberget al., 2005). Tissue biopsies can also be used for culture in addition to histopathological assessment. However, a negative culture does not rule out a mucormycosis infection (Phulpinet al., 2013). Imaging techniques like radiography, computed tomography (CT) scan, magnetic resonance imaging (MRI) can be utilised to determine the extent of disease spread in rhinocerebral or pulmonary mucormycosis. DNA-based techniques like polymerase chain reaction (PCR) for detection can help in early diagnosis and prompt treatment especially when cultures are negative.

MEASURES FOR PREVENTION AND CONTROL

The prevention of mucormycosis mainly involves successful management of the underlying immunocompromising conditions and reversal of predisposing factors. Government of India has issued an advisory to prevent mucormycosis among COVID-19 recovered and critically ill patients with the following dos and don'ts.

- Controlling diabetes is one of the foremost prevention methods suggested by Indian Council Medical Research (ICMR). Monitor blood glucose level at regular intervals. Especially in COVID-19 recovered diabetic patients, the control of diabetes and diabetic ketoacidosis is very crucial to minimise risk for mucormycosis.
- In addition to this, steroids and immunosuppressive medications must be used with caution in cancer and diabetic patients with COVID-19.
- Avoid self-medication and always try to use steroids, antibiotics and antifungal drugs judiciously at the correct timing, correct dose and duration. Doctor's prescription should be strictly followed for this purpose.
- It is also important not to miss the early warning signs and symptoms of disease. Do not consider all the cases with blocked nose as cases of bacterial sinusitis, particularly in the context of immunosuppression and/

or COVID-19 patients on immunomodulator.

- A "nib in the bud" strategy based on good personal hygiene is considered as the most appropriate method to stay away from mucormycosis. Patients should maintain proper hygiene by keeping their hands as well as body clean. Wear masks scientifically and always follow good hand hygiene practices to keep both COVID-19 and fungal infections away.

OTHER FUNGAL DISEASES AND COVID-19

Amidst the rising toll of mucormycosis cases, four cases of white fungus were reported from Patna Medical College and Hospital (PMCH) in Bihar. White fungus affects the lungs and other parts of the body like nails, skin, stomach, kidney, brain, private areas and mouth. People with severe COVID-19, such as those in intensive care unit (ICU), are particularly vulnerable to bacterial and fungal co-infections.

Some of the other common fungal infections in patients hospitalised for COVID-19 include aspergillosis or invasive candidiasis. *Candida auris* is an emerging fungus that can cause candidemia, or bloodstream infections in patients with weakened immune systems admitted in healthcare facilities. Other fungal diseases, such as Valley fever (coccidioidomycosis), histoplasmosis, and blastomycosis, can cause fever, cough, and shortness of breath, similar to COVID-19 and bacterial pneumonias. These fungi live in soil and people become infected by breathing in fungi present in the air. Clinicians should consider fungal pneumonias as a possible cause of respiratory illness, particularly if COVID-19 testing is negative. It is important to note that fungal diseases can occur at the same time as COVID-19. Therefore, early diagnosis and monitoring of these fungal co-infections is the key to reduce morbidity and mortality in such COVID-19 patients.

CONCLUSION

Mucormycosis, a rare and fulminant fungal infection with exceedingly high mortality rate pose a significant threat to medical community amidst the COVID crisis. Mucormycetes are usually found in soil and decaying vegetation. Disease is transmitted through inhalation, inoculation or ingestion of fungal spores. Mucormycosis occur more commonly in immunocomprised patients such as COVID positive people with comorbidities like diabetes, cancer, kidney or heart disease. Based on the clinical presentation in man, mucormycosis is categorised into rhino cerebral, pulmonary, cutaneous, gastrointestinal and disseminated forms.Non-specific signs make the diagnosis of mucormycosis difficult hindering the prompt treatment leading to poor prognosis. "Nib in the bud" strategy based on early diagnosis, systemic antifungal therapy and aggressive surgical debridement should be followed for successful management of mucormycosis.

These concurrent epidemics of fungal infections together with second wave of pandemic is compounding India's crisis in public health sector. Hence, a One Health approach is the need of the hour to control these infections.

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Tinting & Dyeing

Techniques for Value Addition of Different Flowers

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Introduction

Flowers are one of nature's gifts that help to make the world a more beautiful place to live. It is an all-year-round gift because different flowers, with their various colours, express different human moods. They represent various emotions and also convey a message. For example, roses are the most symbolic of all flowers, and they come in a variety of colours. Red represents love and passion, whereas white represents purity and innocence. Pink, on the other hand, represents elegance and grace, whereas yellow represents warmth and joy; however, not all colours are available in all flowers. So, in order to have a flower of our preferred colour, they must be tinted.Tinting the flower refers to artificially colouring it. Tinting is an important value addition technology for imparting desired colour shades to flowers. Tinting is an effective technique in flower crops where colour pigments are lacking or dull.

Objectives of Tinting

- **To produce unusual flower colours:** There is always a high demand for varieties of colour. Costumer preference for particular flower colour also keeps on changing with time and fashion.
- **To get higher economic returns:** Tinted or dyed flowers are in great demand for various occasions and are sold at high prices in the market.
- **To improve value of flowers:** Aesthetic value of fresh and dry flowers is enhanced through tinting by making available various beautiful and unusual shades of flowers

Method of Tinting

The theory of capillary action is used in the process of tinting or dyeing the flower. Because of transpiration, the cut end of the stem absorbs more water to replace the water lost. Water and everything it contains, including the dye, travel through the plant through the xylem after being absorbed by the cut stem. The chosen flower stems should be cut at an angle with a sharp knife or scissors, avoiding bruising or crushing the stem, and then placed in a jar or beaker containing a solution of food colouring dye made by dissolving a few drops of liquid food colour in water. 3-4 cm of the spike's cut end should be immersed in the solution. The solution's concentration is typically 0.1- 0.2 percent. The flowers are allowed to soak in this solution overnight. After achieving the desired colour, the tinted spikes are removed and thoroughly washed with water before being placed in plain water. After proper packaging, these tinted flowers can be stored in dry cold storage at 4-5° C for three days.

Actually, the period of tinting varies depending on the flower, the type and concentration of the dye used, the method of tinting, the length of the spike, and the desired colour intensity and pattern. Tinting and dyeing flowers

Tinting in Rose

Tinting in Rose and Carnation

are accomplished through the methods of translocation, immersion and spraying. The intensity of colour induction will be greater along the floret margins than in the middle of the lamina. Tinting time for smaller flowers like candytufts and lady's lace is one to two hours. Tuberoses and Gerberas with herbaceous stems are also tinted within a few hours. Flowers with woody stems require more time to tint. Creating multiple shades in a single flower is possible by first immersing the flowers in one solution for a day and then transferring them to a solution of a different colour later. This will result in the tips of one color's flower petals and the bases of another color's flower petals.

About the dyes used for tinting of flowers

Acidic dye solutions such as Bromocresol green, Bromophenol blue, Phenol red, Eosin, and powdered food dyes such as Orange red, Lemon yellow, Apple green, and others can be used to tint flowers. Food colours are anionic, safe, and preferable for tinting flowers. Liquid food colours are also available. They are water soluble and are used to dye fresh cut flowers that can be used either fresh or dried or preserved. By combining the primary liquid food colouring dyes, new secondary and tertiary colours can be created, which can then be used to tint flowers. Blue, purple and pink, green, and yellow are the most popular colours for tinting tuberose, white carnation, daisy and rose. Food dyes at a concentration of 10% produce good results because the treated flowers develop a higher colour intensity and better uptake of the solution. Dyes are used in conjunction with glycerine preservatives to colour flowers and foliage while they are preserved. The addition of a surfactant, especially when dyeing fresh flowers, is recommended to facilitate dye uptake. Once the dye reaches the flowers, it can be easily tracked as it travels through the xylem or veins. The dye concentration should be chosen based on the desired colour intensity.

If the stems are too woody, flowers can be dyed by spraying colour on the petals.

Although it does not produce a uniformly coloured petal surface, this technique is widely used for dying dry flowers. For this purpose, water colours and paints can be used.

Flower crops suitable for tinting

- Cut as well as loose flowers of Tuberose
- White cultivars of Gladiolus

- White cultivars of Roses
- White cultivars of Carnations, Chrysanthemum.
- Different Orchid species, Daisies and Liliums
- Loose flowers like Jasmine, Crossandra, etc.

Considerations for tinting flowers

- White flowers are best for dying because they achieve a single shade of the colour. Colored flowers can be chosen if one wishes to have multicoloured flowers. However, lighter shades, such as light pink, cream, and so on, should be preferred.
- For the best results, use freshly cut and opened flowers. They must be fully opened and developed.While tinting, flowers should be placed at room temperature and optimum relative humidity should be maintained as these factors influence the intensity of colour induction in the flower.
- Stopping irrigation two days before harvesting improves flower colour.
- Tinting can be combined with pulsing treatment to improve quality.
- Using warm water promotes better colour absorption than cold water.
- Stopping irrigation two days before harvesting improves flower colour.
- Tinting can be combined with pulsing treatment to improve quality.
- Using warm water promotes better colour absorption than cold water.
- Using a sharp knife, cut the flowers under water to prevent air bubbles and tissue damage from clogging the cambial layer of the stem.
- Tinted flowers should not be placed in clear water for more than 24 hours because the water will begin to wash the colour out of the petals, resulting in uneven patterns.
- Thus tinting and dyeing of flowers is an easy method to have brilliantly and uniquely coloured flowers at our disposal, anytime for any occasion. This technique of value addition in flowers has given chances to make the best use of the white coloured flowers by giving them novel hues and colour patterns.

Tinting in Tuberose

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Nutritional and health benefits of Moringa

Introduction

Drumstick (Moringa oleifera L.) is one of the most nutritious and most popular vegetable grown throughout India, with predominant crop culture prevalent in semi- arid regions of southern India. The genus Moringa is derived from Malayalam word Muringo. It is a fast growing, drought-resistant tree of the family. About 33 species in the family Moringaceae have been reported. Among these, 13 species are well known and widely available around the world About 33 species have been reported. It adopts well in different soils and adjusts well even in marginal conditions. Drumstick is widely promoted in areas of chronic malnutrition as nutritional supplements for weaning infants and nursing mothers.

The leaves, seeds and flowers all have good nutritional and therapeutic values used to prevent or treat protein-energy malnutrition and other nutritional related diseases.

India is a major Moringa producing country, accounting for about 80% of global demand. Among the different states area

under cultivation is:

Andhra Pradesh -15,665 ha (area and production)

Tamilnadu -13,042 ha

Karnataka - 10,280 ha

- India having foreign share about 80%
- Export of drumstick leaves – Tamil Nadu, Andhra Pradesh, Odisha
- Indian export – 11.61 Crore (2018) 14.60 Crore (2019)

Nutritional value of Moringa leaves

Moringa leaves have been reported to be a rich source of β-carotene, protein, vitamin C, calcium and potassium and act as a viable and good source of natural antioxidant. Moringa are rich in more than 90 nutrients including 40 powerful antioxidants and contains high amount of protein, iron, carotene, potassium, phosphorus, vitamin C and calcium.

Different parts of plant contain important minerals and nutrients. Every 100g of leaves contain moisture (75g), protein (6.7g), fat(1.7g) carbohydrates (13.4g), fibre (0.9g), minerals (2.3g), calcium (440mg) phosphorous (70mg), iron (7mg), carotene (11,300 IU) and ascorbic acid (220 mg) respectively.

Moringa leaves are excellent source of beneficial phytochemicals such as cytokinins (zeatin), sterols, alkaloids, flavonoids (quercetin, kaempferol and isothiocyanate), tannis, saponins, phenolic and glycoside compounds.

Health benefits of Moringa

1. Lowers blood sugar and protects against diabetes

Moringa is a natural supplement for treating and preventing diabetes, and may even reverse type 1 and 2 diabetes (in studies with rats). In studies, moringa helps prevent sugar spikes after meals and reduces fasting blood sugar levels in both diabetic and non-diabetic animals. Maintaining healthy blood sugar is key to reducing inflammation, boosting your mood, and preventing heart disease and diabetes.

2. Lowers inflammation and oxidative stress

Moringa is a powerful anti-inflammatory agent, and helps soothe chronic inflammation in body by suppressing inflammatory enzymes and boosting production of anti-inflammatory cytokines. it also boasts an impressive arsenal of antioxidants including vitamins C and E, flavonoids and polyphenols. These compounds scavenge harmful free radicals, and protect your cells from oxidative stress, DNA damage and inflammation

3.Protects against viral, fungal and bacterial infections

Several compounds in moringa are naturally antibacterial, antiviral, antifungal, and antiparasitic. This makes moringa useful in food preservation and water purification, and protecting from nasty food-borne infection

4. Moringa fights cancer and triggers cell death

Moringa may play an exciting role in treating cancer, and enhancing cancer treatments such as chemotherapy. Moringa leaves pack a potent dose of antioxidants, compounds that ward off cancers by neutralizing free-radicals that can damage cells and DNA to trigger tumor development. Studies show that specific moringa leaf extracts such as glucosinolates and quercetin help inhibit growth and trigger cell death in growing tumors

5. Helps to treat low-iron anemia

Moringa is an ideal iron supplement, and perfect for vegetarians who may need help hitting their iron and protein intake. On top of providing a potent plant-based iron, compounds in moringa actually improve iron absorption levels, increase red blood cell counts, and prevents the breakdown of red blood cells seen in sickle-cell anemia.

6. Cognitive decline

High antioxidant content present in Moringa has ability to protect your brain tissue against neurodegeneration and damage. Moringa leaf extract may be valuable in treating memory-related disorders such as Alzheimer's and dementia. In one rat study, treatment with moringa helped regulate and restore healthy neurotransmitter levels after Alzheimer's-like brain damage

7. Protects the liver

Moringa consumption help to reduce liver fibrosis and protect against liver damage. Certain compounds present in moringa help to protect the liver against toxins or drug exposure. Moringa has high antioxidant content and ability to detoxify heavy metals make it an ideal supplement for supporting kidney and liver health

8. Protects the kidneys

Moringa is high in calcium oxalates, but not the kind of oxalates that cause kidney stones. Calcium oxalates are non-soluble, which means your body can excrete them without worrying about kidney stones

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CONSERVATION AGRICULTURE IN INDIA IN THE ERA OF CLIMATE CHANGE

RETROSPECT AND PROSPECT

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Attaining food security for a growing population and alleviating poverty while, sustaining agricultural systems under the current scenario of depleting natural resources, negative impacts of climatic variability, spiraling cost of inputs and volatile food prices are the major emerging challenges of the Asian countries. These are caused mainly by intensive tillage induced soil organic matter decline, soil structural degradation, water and wind erosion, insufficient return of organic material and mono-cropping. Therefore, a paradigm shift in farming practices through eliminating unsustainable parts of conventional agriculture such as ploughing/tilling the soil, removing all organic material and monoculture is crucial for future productivity. Conservation agriculture (CA), a concept evolved as a response to

Fig: Zero-till wheat

Fig: Hand punch zero-till seed drill

concerns of sustainability of agriculture globally, has steadily increased worldwide to cover about 156.9 M ha world arable land (FAO, 2017).

HISTORY OF CONSERVATION AGRICULTURE

Tillage, particularly in fragile ecosystems, was questioned for the first time in the 1930s, when the dustbowls devastated wide areas of the mid-west United States. Concepts for reducing tillage and keeping soil covered were introduced and the term conservation tillage was introduced to reflect such practices aimed at soil protection. At the same time theoretical concepts resembling today's CA concept were developed by Edward Faulkner who published a book called Plowman's Follyand Masanobu Fukuoka who published a book called One Straw Revolution. Edward Faulkner's book Plowman's Folly was a milestone in the history of agricultural practices where he questioned the wisdom of ploughing. Some of his statements are: "No one has ever advanced a scientific reason for plowing"; "There is simply no need for plowing in the first instance and most of the operations that customarily follow the plowing are entirely unnecessary, if the land has not been plowed".

CONSERVATION AGRICULTURE IN INDIA

CA is introduced in India, Pakistan and Bangladesh in 1990s. It was the post green revolution period where, excessive use of chemical input lead to stagnant condition in the yield of crop especially in rice-wheat cropping system. During this period gaining sustainability in crop production system was the matter of concern for agronomists. In India CA started in the form of zero-tillage and their efforts failed due to technical difficulties, such as lack of appropriate seeding machinery and difficulties in controlling weed chemically. It all became possible when Peter Hobbs, the regional wheat agronomist from the CIMMYT introduced inverted-T openers for drilling seed, in 1990.A first prototype of the Indian ZT seed drill was developed at GBPUAT, Pantnagar. Presently CA is practiced in 1.5 M ha area in India (FAO, 2016). Except rice-wheat cropping system CA is being practiced in cotton-wheat, pigeon pea-wheat etc.

CONSERVATION AGRICULTURE

According to FAO (2007), CA is a concept for resource saving agricultural crop production that strives to acceptable profits together with high and sustained production level while concurrently conserving all the natural resources. CA is characterized by four linked principles, namely:

1. continuous minimum mechanical soil disturbance
2. Permanent organic soil cover
3. Diversification of crop species

Fig: Turbo happy seeder

grown in rotation, sequences or associations

4. Reduced trafficability.

CA principles are universally applicable to all agricultural landscapes and land uses with locally adapted practices. CA enhances biodiversity and natural biological processes above and below the ground surface.

STATUS OF CONSERVATION AGRICULTURE IN INDIA AND ABROAD

Globally, CA is being practiced on about 180 M ha. The major CA practicing countries are USA (43 M ha), Brazil (32 M ha), Argentina (31 M ha), Canada (19 M ha) and Australia (22 M ha). In India, CA adoption is still in the initial phases. Over the past few years, adoption of zero tillage and CA has expanded to cover about 1.5 M ha (FAO, 2017). The major CA based technologies being adopted is zero-till (ZT) wheat in the rice-

Fig: Soybean cultivation under bed planting system

wheat (RW) system of the Indo-Gangetic plains (IGP). In other crops and cropping systems, the conventional agriculture based crop management systems are gradually undergoing a paradigm shift from intensive tillage to reduced/zero-tillage operations. The CA based resource conservation technologies (RCTs) also help in integrating crop, livestock, land and water management research in both low and high potential environment.

BENEFITS OF CONSERVATION AGRICULTURE

- **Agronomic benefits:** It improves soil productivity by enhancing the soil physical, chemical and biological properties. It increases SOC by adding crop residue continuously. Due to covering of soil by crop residue it conserve soil moisture thereby increase water use efficiency.
- **Environmental benefits:** CA involving zero-till and surface managed crop residue systems are an excellent opportunity to eliminate burning of crop residue which contribute to large amounts of greenhouse gases like CO_2, CH_4 and N_2O, sequester carbon, improve biodiversity and to improve air and water quality.
- **Economic benefits:** CA practices reduce cost of production which is attributed to savings on account of fuel, labour and input costs, particularly herbicides.

CONSERVATION AGRICULTURE PRACTICES IN INDIA

Though major CA-based technologies being adopted is zero-till (ZT) wheat in the rice-wheat (RW) system of the Indo-Gangetic plains (IGP), other CA-based RCTs being adopted in India are diversified crop rotation, crop residue management, bed planting, direct seeded rice and laser land leveling etc.

CONSERVATION TILLAGE

According to the Conservation Technology Information Center USA, conservation tillage is defined as: "any tillage or planting system in which at least 30% of the soil surface is covered by plant residue after planting to reduce erosion by water or where soil erosion by wind is the primary concern, with at least 1120 kg ha-1 flat small grain residue on the surface during the critical wind erosion period. Zero-tillage, mulch tillage, ridge tillage, contour tillage etc are different type of conservation tillage.The prevailing ZT technology in the IGP uses a tractor drawn zero-till-seed drill to seed, wheat directly sown into unplowed fields with a single pass of the tractor. The typical ZT drill has inverted-T openers

Fig: Direct seeded rice

and opens a number (6–13) of narrow slits for placing seed and fertilizers at the depth of 7.5–10 cm into the soil.

Seeding through turbo happy seeder

Turbo happy seeder (THS) is a planter capable of direct drilling seed and fertilizers at desired seed and fertilizer rates, depth and spacing in field with surface retention of residues (>8 t/ha). Zero tillage operation saved labour, water, energy, reduced cost of production and improved/ maintained soil heath while facilitating timely planting with similar or higher crop productivity (Sidhu et al., 2007).

Crop residue management

The permanent soil cover through crops, mulch or green manure cover crops complements zero tillage effects by supplying substrate for soil organic matter build up and for the soil life which is facilitated by not disturbing the soil. Protection of the soil surface by mulch helps in reducing evaporation and avoiding crusting. It also suppresses weed growth. Residue retention under conservation agriculture practices are still valid, as long as sufficient organic matter is supplied to the system to build up soil organic matter and to increase productivity.

Diversified crop rotation

Crop rotation serve different purposes in the system and are linked to the other three principles. Besides the phytosanitary and weed management objectives, crop rotation serve to open different soil horizons with different rooting types.

Applying a diversified crop rotation increases the overall productivity of the cropping system and as such also the long-term profitability, compared to monocropping of economically attractive cash crops which in the long term always proves not sustainable.

Bed planting

Cultivation of crops is done on raised beds and irrigation is applied in furrows, which also act as drainage channels. Under CA the beds would be converted into permanent beds whereas,soil tillage is limited to periodic cleaning and reshaping of the furrows. Crops are sown on 40 cm wide raised beds and providing irrigation in 30 cm wide furrows.

Number of rows varies with different crops: 3 rows of wheat, 2 rows for peas, green gram, soybean, mustard; one row for maize, pigeon pea etc. Benefits of bed plantings are easy intercultural operation,saves nitrogen, water and seed, less germination of weeds on top of beds, less dependency on herbicides, reduces lodging and reduced cost of cultivation.

Laser land leveling

The laser-assisted precision land leveling is precursor technology for adoption of CA practices like zero-tillage, bed planting. It alters the field having a constant slope of 0 to 0.2% using laser equipped drag bucket (land surface smoothening with in ± 2mm from its average elevation). Benefits of laser land leveling are:

1. Increases irrigated area ~ 2%; save water by 25-30%;
2. 3-4 % in net crop field area
3. Improves crop stand and yield.

Direct seeded rice

DSR- an alternative to transplanted rice for saving labour& water. Rice can be sown directly on dry soil or on puddled soil (by broadcasting or drum seeder). It is a labour, fuel, time & water-saving technology. DSR can be practiced in different ecologies including upland, lowland, deep water & irrigated condition. DSR save 35-40% of irrigation water.

SUMMARY

Unsustainable and faulty adoption of agro-practices such as excessive tilling of the soil, removing all organic material and monoculture create diverse type of problems such as soil organic matter decline, soil structural degradation, water and wind erosion, reduced productivity, vulnerability of crop to certain pests and diseases, which ultimately reduces crop production potential of soils. Thus, CA,is a concept of resource saving in agricultural crop production system that strives to get acceptable profits together with high and sustained production level while, concurrently conserving all the natural resources and practices diversified crop rotation, crop residue management, bed planting, direct seeded rice, laser land leveling etc.

CA has gained significant importance toward agronomic, environmental and economic benefits for providing food security and agricultural sustainability.

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POLLUTED SOIL AND REMEDIATION

Heavy metals are serious environmental pollutants now a days. They are released as waste which pollutes the soil & ranges from solid organic and inorganic wastes, solvents and several other substances.The agricultural activities involving addition of nutrients, pesticides and sediments to soil also causes heavy metal pollution in agricultural fields. Dispersal of waste from its source can be through the atmosphere, through water bodies or directly into the soil itself. Pollutants are transported from soil to the water bodies where they contribute to further damage of the soil and water environment. Environmental pollution has become a serious public health concern as it causes several serious diseases throughout the world. In soil, heavy metals cause toxicological effects on soil microbes, which may lead to a decrease in their number and activities.

Heavy metals and their sources

Heavy metals are conventionally defined as elements with metallic properties having an atomic number >20 and a specific density of more than 5 gcm−3. Heavy metals enter the environment from natural and anthropogenic sources (Table no.1). Among the natural sources, heavy metals occur naturally in the soil environment from the pedogenetic processes of weathering of parent materials at levels that are regarded as trace (<1000mg·kg−1) and rarely toxic.On the other hand, among the anthropogenic sources, human activities(mining, smelting, electroplating, energy and fuel production, power transmission, intensive agriculture, sludge dumping and melting operations) are the main contributor of heavy metal contamination in soil and environment. Heavy metals in the soil from anthropogenic sources tend to be more mobile and bioavailable than other sources. The industry of mining and processing metals is a major source of heavy metal concentration in farmlands.

Remediation of soil

Remediation of heavy metals is necessary to protect the soil and environment from their toxic effects and to protect the environment for future generations. Numerous physicochemical and biological methods have been adopted to eliminate the heavy metals. Some of the important methods are discussed below:

1. Physical remediation

The physical remediation mainly includes soil replacement method and thermal desorption. The soil replacement means using clean soil to replace or partly replace the contaminated soil with the aim of diluting the pollutant concentration, increasing the soil environmental capacity, and thus remediating the soil. The soil replacement is

Table 1.Sources of selected heavy metals in the environment

Heavy Metals	Sources
As	Semiconductors, petroleum refining, wood preservatives, animal feed additives, coal power plants, herbicides, volcanoes, mining and smelting.
Cu	Electroplating industry, smelting and refining, mining biosolids
Cd	Geogenic sources, anthropogenic activities, metal smelting and refining, fossil fuel burning, application of phosphate fertilizers, sewage sludge.
Cr	Electroplating industry, sludge, solid waste, tanneries.
Pb	Mining and smelting of metalliferous ores, burning of leaded gasoline, municipal sewage, industrial wastes enriched in Pb, paints.
Hg	Volcano eruptions, forest fire, emissions from industries producing caustic soda, coal, peat and wood burning
Se	Coal mining, oil refining, combustion of fossil fuels, glass manufacturing industry, chemical synthesis (e.g., varnish, pigment formulation)
Ni	Volcanic eruptions, land fill, forest fire, bubble bursting and gas exchange in ocean, weathering of soils and geological materials
Zn	Electroplating industry, smelting and refining, mining, biosolids

also divided into three types, including soil replacement, soil spading and new soil importing. This method is suitable for contaminated soil in small areas. Besides the replaced soil should be treated. Soil spading is deep digging the contaminated soil, making the pollutant to spread into the deep sites and achieving the aim of diluting. New soil importing is adding lots of clean soil into the contaminated soil as cover over the surface or mixing to make the pollutant concentration decreasing.

2.Chemical remediation

2.1.Chemical leaching

Chemical leaching is washing the contaminated soil using fresh water, reagents, and others fluids or gas that can leach the pollutant from the soil. Through ion exchange, precipitation, adsorption and chelation, the heavy metals in soil are transformed from soil to liquid phase, and then recovered from the leachate. The leachate mainly include inorganic eluent, chelation agents and surfactant etc.

2.2. Chemical fixation

Chemical fixation is adding reagents or materials into the contaminated soil so that they react with heavy metals to form insoluble or hardly movable, low toxic matters, thus decreasing the migration of heavy metals to water, plant and other environmental media and achieving the remediation of soil. The soil conditioning materials used include clays, metallic oxides, biomaterials, etc. The ability of bonemeal (finely ground, poorly crystalline apatite, $Ca_{10}(PO_4)_6OH_2$) to immobilize pollutant metals in soils and reduce metal bioavailability through the formation of metal phosphates has been evaluated. The chemical fixation could remediate the soil with low concentration of Cu, Zn, Pb and Cd contaminant, however, the bioavailability of fixed heavy metals may be changed with the change in environmental condition.

2.3.Electro kinetic remediation

Electro kinetic remediation is a new remediation technology, which is mainly by applying voltage

at the two sides of soil thus forming electric field gradient. The pollutants are carried to the two poles treatment room via electromigration, electro-osmotic flow or electrophoresis and then treated further. It is suitable for low permeable soil, and has the following advantages (1) easy to install and operate (2)low cost and (3) do not destroy original nature of the environment. So this method can achieve environmental remediation and protect the original ecotope. The main improved methods include adding buffer solution in cathode and anode to control pH value, using ion exchange membrane to control pH value, adding complexant to improve migration, etc.

3. Biological remediation

The biological remediation includes phytoremediation, microbial remediation and animal remediation.

3.1 Phytoremediation

Phytoremediation is the use of living green plants to fix or adsorb contaminants and clean the contaminants or reduce their risk or make them disappear. Here are some important crops for the remediation of polluted sites with economic returns, because of their tolerant nature. *Cymbopogon flexuosus* (NeesexSteud.), Wats (lemon grass), *Vetiveria zizanioides* (Linn) Nash, *Ricinus communis* L. (castor bean), *Jatropha curcas* L., *Prosopis juliflora* (Sw) DC, *Ocimum basilicum* L. (sweet basil), Rosa damascena mill L., and Nelumbo nucifera (sacred lotus).

The phytostabilization, phytovolatilization and phytoextraction are the main three types of phytoremediation. Phytostabilization is fixing heavy metals by plants through the adsorption, precipitation and reduction of root; thus reducing their migration and bioavailability and preventing them from migrating into the groundwater and food chain. Phytoextraction is adsorbing the heavy metals using tolerant and accumulating plants, and then transferring, storing at the overground parts. Studying the adsorption characterization of different plants and screening high uptake plants is the key of this technology.

3.2 Microbial remediation

The microorganisms cannot degrade and destroy the heavy metals, but can affect the migration and transformation through changing their physical and chemical characterizations. The remediation mechanisms include extracellular complexation, precipitation, oxidation-reduction reaction and intracellular accumulation.

Microbial leaching is a simple and effective technology for extracting valuable metals from low-grade ores and mineral concentrates. Besides the industrial application for raw materials supply, microbial leaching has some potential for remediation of mining sites, treatment of mineral industrial waste products, detoxification of sewage sludge and for remediation of soils and sediments contaminated with heavy metals. The role of VA mycorrhizae as a biological agent in reducing the toxicity of heavy metals is worth mentioning. However, the vulnerability of biological remediation is affected by different kinds of factors, such as temperatures, oxygen, moisture, pH value etc. It is also limited in applications, such as some microorganisms can only degrade special contaminants, microbes/zymin may which incur secondary pollution.

3.3 Animal remediation

Animal remediation is based on the characterization of some lower animals adsorbing heavy metals, degrading, migrating the heavy metals and thus removing and inhibiting their toxity. The studies showed that, the treatment of the earthworm-straw mulching combinations enhanced plant Cu concentration, and the amount increased by it was lower than that of the earthworm treatment but higher than that of straw mulching treatment. The accumulation amount increased with the Pb concentrations also.

The research of remediation technologies in India is still in initial and experimental stage. The development strategy of future remediation technologies is researching green, environmental-friendly biological remediation, combining remediation, in-situ remediation, quick remediation, and supplying technical support for agricultural soil contamination, industrial enterprises, brownfield, mining sites, etc.

Hibiscus

An encyclopedia of medicinal value

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Hibiscus rosa-sinensis native to southeastern Asia (china), is commonly found in tropical region and seen as a common plant throughout the world. *Hibiscus rosa- sinensis* is commonly known as Hawaiian hibiscus or Chinese hibiscus. It is an evergreen, profusely flowering, perennial, woody ornamental shrub belonging to the family Malvaceae and distributed widely in the tropical regions. The edible flower is defined as non toxic, innocuous flowers with health benefits when consumed in human diet. Edible flowers impart unique and powerful color, flavor and aroma to the food, and therefore have gained popularity in the culinary world as an innovative ingredient. It also posses bioactive properties and is recommended to be used as a herbal alternative to cure many diseases.

Nutritional uses

Fresh flowers of *Hibiscus rosa- sinensis* contain 83% moisture. These flowers are rich in proteins, fat, carbohydrates, Beta carotene, Vitamin–C, calcium, potassium, Boron and zinc.

Leaves of *Hibiscus rosa- sinensis* have high fibre content and they are rich in carbohydrates, proteins, calcium and potassium

Domestic application

The uses of different part of hibiscus are many and varied both in food and traditional medicine. All parts of hibiscus including leaves, flowers and roots are used as food in different parts of the world. Fleshy red color flowers are used for the preparation of juice, wine, cake, chocolates etc. These are rich in carotene, riboflavin, anthocyanin, and ascorbic acid, Niacin, Calcium, Iron and Vitamin-C.

Traditional uses

The red coloured flowers was most preferred in medicines. Roots and leaves are used to regulate menstruation cycle and stimulate blood circulation. Leaves were also used as abortifacient and to stimulate expulsion of placenta after childbirth. Flowers were used for regulation of menstrual cycle, for liver disorders, high blood pressure as antitussive, for stomach pain, for eye problems, as abortifacient and as an aphrodisiac. The leaves of Hibiscus rosa-sinensis were used for the treatment of dysentery and diarrhoea

Therapeutic uses

a) Anti bacterial effect

Hibiscus is known for its antibacterial activity. Hibiscus plants can be sources of compounds that can potentiate the activity of antibiotics against resistant bacterial pathogens.

b) Anti ulcer

The acquires and alcohol extracts of *Hibiscus rosa- sinensis* roots possess significant antiulcer activity. It has been scientifically proven that these extracts posses enough potential as an anti-ulcerogenic agent.

c) Inflammation

Inflammation is a localized reaction that produces redness, warmth swelling and pain as result of infection. The treatment of affected area with extracts of flowers and leaf of white and red coloured *Hibiscus rosa- sinensis* helps to cure these problems.

d) Wound healing

The flower extract of hibiscus increases the cellular proliferation and collagen aynthesis at the wound site and significantly helps in wound healing.

e) Anti diabetic

H. rosa-sinensis could have great importance as a safe therapeutic agent in *Diabetes mellitus*. Aqueous extract and ethanolic extract of the flowers and leaves have anti diabetic effect. Phytochemical study reveals that alkaloids, tannins, saponins, triterpenoids, coumarins, steroids, flavonoids were present in the extract.

f) Hair growth

Hibiscus flowers are known as hair growth promoter in traditional and folklore medicines. Presence of active constituents like flavanoids and tannins are responsible for hair growth activity. The antidiabetic activity was performed by enzyme inhibition (α-glycosidase) in in-vitro method of extraction and the extract showed significant inhibition.

g) Antilithiatic

The aqueous extract of flowers of *Hibiscus rosa-sinensis* was evaluated for its antilithiatic potential in vitro. *Hibiscus rosa-sinensis* is a good remedy for leucorrhea, chronic cough, urinary diseases and psychiatric ailments without any side effects and is less expensive. The presence of calcium oxalate crystals was evaluated immediately and after 24 hrs of stone induction.The components present in the flower extract might be responsible

for its preventive action against kidney stone formation.

Other medicinal uses

- The extract of hibiscus flower has been used as anti solar agent by absorbing UV radiation
- The chemicals in hibiscus flowers help in the growth of hair. It reduces dandruff and keeps the hair black
- The oil of hibiscus flower can be used as contraceptive.
- The juice from the hibiscus leaves and flowers can regularize the menstrual cycle
- Ayurveda says the medicine made from its roots can be used for the prevention of venereal diseases
- If the buds of white hibiscus flowers are eaten in the early morning, it will help to improve digestion
- The roots of hibiscus are boiled in oil until the water gets evaporated, then the oil can be applied to the wounds caused by cancer. This is very useful in initial stage of cancer.
- Hibiscus flower is also used to increases the blood count in anemic people
- Oil extracted from red coloured hibiscus are used for cooling head and eliminate headache and to also remove dandruff
- Hibiscus decoction help to lose weight and to prevent cold and fever
- Flowers are home remedy to cure mouth ulcers.
- Flowers are boiled in water and drinking this water would be beneficial to control cholesterol and heart problems.
- Hibiscus is rich in vitamin-C that would help to boost immune system.

Conclusion

Hibiscus rosa sinensis is a common flower found in many parts of the world. Yet only a few people are aware of its health benefits. Indian Ayurvedic medicine has recognized the medicinal effects of this flower long ago and recommends its use in treating many ailments. People are moving towards ayurveda to cure ailments in order to reduce the side effects of English medicines. So hibiscus is one such plant for curing many ailments. So plant a hibiscus at your surroundings to keep you away from many of the above ailments.

LAB GROWN MEAT
HOW FAR IS THE REALITY..?

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In the usurping phase of CoVID- 19 pandemic, close calls are hovering, to ban the trade and consumption of wild animals that may cause zoonotic diseases. Such a sudden policy-induced ban on meat consumption will lead to food insecurity, reduced protein intake and malnutrition, especially in meat consuming nations worldwide. The use of animal source foods are essential for better nutrition especially in children, but overuse of certain types like red meat is related to excess greenhouse gas emissions, loss of biodiversity, freshwater use, antibiotic resistance and diet related diseases in the long run. In his recent book on "How to avoid climate change" Bill Gates, recommended the rich developed nations to use synthetic meat in their diets, thereby curbing greenhouse gas emissions.

The plant-based meat (PBM) and cell-based meat (CBM) are approaches meant for meat production based on non-animal sources. Products like tofu from soybean are traditionally known but the novel plant-based meat analogues that had been already commercialised have better sensory characteristics like appearance, flavour, texture and aroma. Cellular agriculture is an emerging field of science meant for developing meat from muscle or fat cells of cows, pigs, chicken, insects rather than whole animals. Cultured meat production needs 99 percent less land, 90% less water and 45% less energy. Besides, it's feasibility even in traditionally inhospitable areas of livestock production and minimal animal cruelty enunciates a valid strategy in mitigating climate change.

A nascent industry

The first lab grown meat or slaughter free hamburger was developed in 2013 by the company Mosa Meat in the Netherlands and worth 250000 US dollars. Mark Post, a vascular biologist at Maastricht University was the brain behind it and got a patent. Since then efforts has been taken by various private enterprises all around the world like Memphis food, Aleph farms, Cargill & Tyson in developing cultured meat meant for global population. Good Food Institute (GFI), a non-profit organisation based at Washington DC, working on

alternative meat sources offered 2.3 million US dollars since 2018 for almost 16 research teams working on cultured meat. In November 2020, a 4-year project- CUSTOMEAT got funding from government sources in Belgium for scientists at Ghent University & KU Leuven. Kate Kreuger, a Cambridge based cellular agriculture firm consultant states that as this multi disciplinary field, remains a no-man's land between biomedical research and agriculture research, reasonates the crunch from public funding sources.

Technical challenges

The source material i.e., the animal cells taken for biopsies or cell lines, protein as growth factors and the nutrient medium plays a crucial role in the success of final product. The proliferation of muscle cells and its differentiation to mature meat needs optimal growth medium which is still in experimental stage. An edible scaffolding material that shape up the meat is another technical hurdle. 3D printing option were used by some companies to mimic a steak from cultured meat. Muscle tissues are formed by the fusion of thousands of individual precursor cells known as myotubes. Cells need physical stimuli to mature into myofibres. Scaling up of the product in bioreactors under batch/ continuous/ stirred tank method is yet to standerdise.

Plant based mock meat

Plant based mock meat industry is in advanced stage with more customer acceptance and US companies like Beyond meat and Impossible foods had already been in business for a decade. First processes in PBM is extraction of targeted plant protein and improving it's properties like solubility by the chemical breaking down process known as hydrolysis. Secondly the protein extracted should be formulated to organise the texture and nutritional content as of meat by using food adhesives, fat or flour of plant origin. Finally it's the processing phase where all the ingredients should undergo reshaping process to get meat like texture. Compared to CBM, the retail cost of PBM is lower but in a retail set up the processing cost worths 94% of the final product price.

Indian scenario

Good food institute (GFI) made a MoU with the publicly funded Mumbai based research institute - Indian Chemical Technology (ICT) in 2019. The Centre for Cellular and Molecular Biology (CCMB) at Hyderabad, received a grant from Department of Biotechnology in 2019 for development of cell based meat, along with National Research Centre on Meat (NCRM). "Efforts are progressing in our lab on culturing sheep stem cells by optimising media and growth scaffolds for the expansion & differentiation to muscle cells" said Dr. Jyotsna Dhawan on behalf of Director, CCMB. Meanwhile NCRM conducted a survey on consumer acceptability aspects and now starting to isolate cells from muscle in their dedicated cell culture facility along with CCMB experts" Dr. Dhawan added.

At the private sector, India became a commercial hub even for foreign companies like California based-Beyond meat in plant based meat industry. A good number of Indian firms/ start ups like Gooddot, Vezley, Ahimsa foods are all conspicuous in urban cities and e- commerce platforms. These companies offers various meat products and ready to cook items at an affordable price. Wakao foods a Goa based firm is utilising jackfruit for plant based meat in ready to cook packs, thereby opens up a new trend to efficiently make use of the underutilised superfood.

According to Indian Council of Food & Agriculture (ICFA) report, in 2013 the per capita meat consumption in India was among the lowest among countries, at 5.6 kg against the global average of 33.2 kg. But 70% of population above the age of 15, consumed non-vegeterian diet in 2014, as per a 2016 survey report released by Registrar General of India.

The increasing population, demand for quality food, improved purchasing power of people, rapid urbanisation, changing consumer lifestyle including veganism all pinpoints a bright future both in India and globally for the alternative meat market. Considering the rich biodiversity of flora & fauna and rich animal or insect resources give an edge for India in the business by availing various technologies and strategies for alternative meat production.

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