Online ISSN 2582-368X

AGRIALLIS

SCIENCE FOR AGRICULTURE AND ALLIED SECTOR

A Monthly Magazine

VOLUME 4, ISSUE 9
SEPT. 2022

www.agriallis.com

Growing seed

Editorial Board

Contents

Article Id
AL04153

IMPACT OF COVID-19 ON INDIAN AGRICULTURE: CHALLENGES AND OPPORTUNITIES

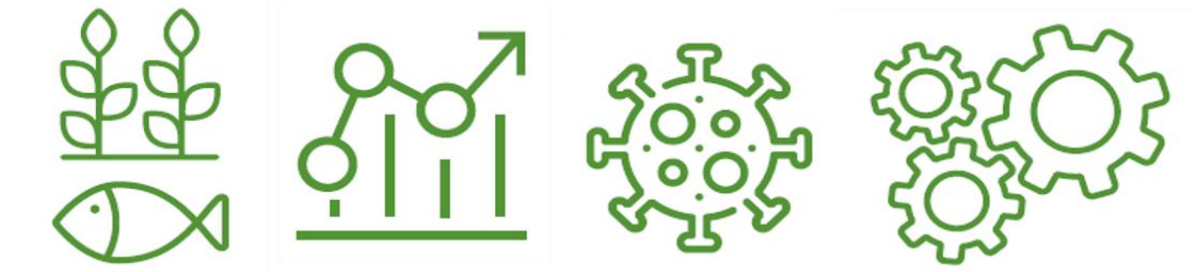
Sridhara M R

Email

agrisridhar72@gmail.com

Department of Agronomy, University of Agricultural Sciences, Raichur – 584104, Karnataka, India

The novel Coronavirus (COVID-19) epidemic has quickly spread over the world, wreaking havoc on millions of people's lives and livelihoods. India's first outbreak was detected on January 30, 2020, causing officials to take immediate action to halt the spread of the disease. Because the sickness is extremely contagious, a much-needed global lockdown was implemented on March 25, 2020, to prevent the spread of the COVID-19 pandemic.



The Novel Coronavirus Disease (COVID-19) epidemic, which began at a seafood market in Wuhan, Hubei Province, China, in mid-December 2019, has already spread to 214 countries, territories, and places throughout the world (Ministry of Health and Family Welfare, 2019). India's agriculture system has been devastated by the COVID-19 epidemic. Nonetheless, the most recent quarterly GDP predictions post-COVID scenario show that Indian agriculture is strong and resilient, since it is the only sector to grow at a positive rate of 3.4 percent in fiscal year 2020–21.

Meanwhile, growth for the most recent quarter is expected to be 5.9%, down 2.5 per cent points from the prior quarter. In this context, we'd want to gather preliminary data on COVID-19's impact on the Indian agriculture sector, including production, marketing, and consumption, as well as a set of potential recovery and post-pandemic strategies. According

to survey findings, the pandemic slowed production and marketing due to labour and logistical challenges, while the negative income shock reduced market access and elevated food commodity costs, influencing consumption habits. On a physical, social, economic, and emotional level, the virus wreaked devastation on all players in the Indian agriculture industry.

The agriculture and allied industry is extremely important to India's economy. It accounts for roughly a sixth of India's national GDP and employs nearly half of the country's workers. It is critical for the nation's food security and, through its forward and backward links, impacts the growth of the secondary and tertiary sectors of the economy. Agricultural development decreases poverty both directly and indirectly by increasing farm earnings and lowering food prices. To put it another way, a strong agricultural sector benefits almost every area of the Indian economy.

The influence of the Covid-19 on Indian agriculture may be divided into two categories: lockdown and post-lockdown.

During lockdown time	After lockdown time
✓ Labour shortage - due to imposition of largest lockdown of the in the world. ✓ Harvesting of *rabi* crop is delayed due to the labour shortage. ✓ Delay in sowing - summer and *kharif* crop due to the labour shortage. ✓ Change in the choice of crop and method of sowing due to the labour problem. ✓ Closing of market due to lockdown ✓ Farmers could not able to sell the produce. ✓ Huge drop in demand for perishable products like milk, fruits, vegetables, chicken meat. ✓ Assam swine fever - first time reported in India. ✓ Locust attack has been enhanced due to the lockdown. ✓ Disruption in the supply chain due non-availability in supply chain. ✓ Lack of access to warehouse, cold storage and processing facilities.	✓ Hike in fuel - increased machinery wages. ✓ Hike in food commodities price. ✓ Schools shutdown affecting education of children. ✓ Global zero hunger by 2030 could be delayed. ✓ Change in farm ordinances by the central government. ✓ Change in food habits. ✓ Tribal people following Indigenous methods to sustain. ✓ Poaching of wild animals increased. ✓ Lowering growth in agriculture. ✓ Less income per person in agriculture. ✓ Doubling the farmer's income by 2022 could be delayed. ✓ Proposal to discontinue free power supply to farmers. ✓ Impact on export and import (Sahoo and Samal, 2020).

Opportunities Allowed By the Covid-19 Pandemic in the Agricultural Field

1) Change in method of crop establishment.
2) Change in choice of crop.
3) Farm Mechanization.
4) Value addition mainly in horticultural crops.
5) Integrated Farming for small and marginal farmers.
6) Change in government policy.
7) Attract youth towards agriculture.
8) Restructuring food system/ Food distribution system.
9) Increase food production due to increase in area.
10) Strengthening e-NAM (Sahoo *et al*. 2020)
11) Hike in MSP - for promoting non-cereals production.
12) Strengthening of MGNREGA for rural development.

Conclusion

COVID-19 is the deadliest disaster in human history. The growth and development of all major countries in the globe has slowed. Due to the country's long-term lockdown, India is the most directly or indirectly afflicted country in the globe by this epidemic. Agriculture is the only sector with positive growth of 3.4 per cent, despite a 23.9 per cent drop in GDP. In agriculture, the benefits presented by this epidemic outnumber the risks. So, if we make appropriate use of these chances, we can certainly expect increased agricultural growth for the benefit of farmers.

References

Sahoo J P, Samal K C and Behera D. (2020). A Blueprint to Boost Indian Agriculture in the Era of Covid-19 Pandemic. *Biotica Research Today*. **2**: 780-782.

Singh A K, Singh L and Kumar S. (2020). Impact of COVID-19 on Agriculture and Allied Sectors. *Journal of Community Mobilization and Sustainable Development.* **15**: 8-16.

The Hindu e-newspaper Website: https://epaper.thehindu.com/.

World Health Organisation (WHO) Website: www.who.int/health-topics/coronavirus.

Article Id
AL04154

THE IMPACT OF MICROPLASTICS ON AGRICULTURAL SOILS

[1]Soniya Ashok Ranveer*, [2]Phool Singh Hindoriya, [3]Pooja Nivrutti Bhagat and [4]Sameer Bhagwat

Email

soniyaranveer11@gmail.com

[1]Dairy Microbiology Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India
[2]Agronomy Section, ICAR- National Dairy Research Institute, Karnal, Haryana, India
[3]Dairy Engineering Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India
[4]Dairy Technology Division, ICAR-National Dairy Research Institute, Karnal, Haryana, India

Agricultural soils that have been contaminated with microplastics have the potential to endanger food safety and human health. Microplastics are a growing environmental concern around the world. The main sources of microplastics entering agricultural soils were outlined in this review paper with an emphasis on their various characterizations and environmental fate. The transformation and movement of microplastics within agricultural soil systems were examined, with a focus on the impacts of UV radiation and mechanical abrasion from soil life and agricultural operations. In addition, a summary of microplastics' direct and indirect effects on soil flora and fauna in agricultural soils was provided. Finally, future research directions were suggested based on the knowledge gaps in three areas: standardization techniques for different types of microplastics, interactions between microplastics and other pollutants, and the long-term effects of microplastics in agricultural soils on human health risks.

Recent news states that the amount of plastic made around the world has reached 368 million tonnes. Many plastics get into the environment because they are not thrown away properly, and 79 percent of all plastic waste ends up in landfills. Plastics stay in the environment because they are strong and don't break down easily. Plastics can break up into microplastics (particles smaller than 5 mm) because of photo degradation, mechanical abrasion, and bioturbation. Also, cosmetics and products made in factories can directly release microplastics. Researchers have looked at where microplastics come from, where they end up, what happens to them, and what effects they have on living things. Concerns about microplastic pollution in land systems have been growing recently. There are rumours that

the amount of microplastics on land could be 4-23 times higher than in the ocean. As the source of food, the agroecosystem is the basis of human life. Microplastics are likely to pollute it because people use it so much. Soil pollution from microplastics in agricultural areas can't be ignored. Microplastics in farm soils could have effects on farm ecosystems and food security that we don't yet know about. Due to the risks that microplastics pose to the ecosystem through the food chain, it is important to know how they behave in agricultural soil systems. This review will help us learn more about how microplastics behave in the environment by summarising studies on their sources, effects, and what happens to them in agricultural soil systems.

What are the Sources of Microplastic Pollution in Agricultural Soils?

Plastic products were widely used in agricultural techniques, such as cultivation, fertilization, and plastic mulching, as modern agricultural systems developed. These polymers provided a significant amount of microplastics to soils and even accumulated in crops when they degraded in agricultural soils. Plastic mulch films make up a significant fraction of those sources and are frequently utilized in arid and cold climates to maintain the proper temperature and increase crop output. They broke up into microplastics after being exposed to light and mechanical forces like tillage procedures, and they then migrated into agricultural soils, especially in regions with a poor rate of mulch film recovery. Consumption of mulching films and microplastic concentrations are positively correlated. Although it has been disregarded for the past few years, atmospheric deposition is another possible route for the contamination of terrestrial systems with microplastics. The weather has an impact on the inputs of microplastics from atmospheric deposition. The fallout of microplastics from the atmosphere to soil systems may be considerably influenced by precipitation and snowfall, as described in earlier research, and wind/atmosphere circulation significantly influenced the remote transport to various places (Mohajerani and Karabatak, 2020). Agricultural soils and human health may be at risk from airborne microplastics from cities that travel to rural areas and deposit on fields and even plant leaves, even if the direct negative effects of these particles on agricultural soils have not been well-documented. Compost is also frequently used to increase soil fertility, in addition to mulch films. A significant channel for microplastics entering agricultural soils was suggested by the high proportion of plastics found in the compost. The rapid fragmentation of larger plastics into smaller pieces and the microbial activity that occurs during the composting processes accelerate the concentration of microplastics added to agricultural soils. According to Yang et al.,3.50 ± 1.71million

particles/ha/year could be the typical rate of microplastic deposition in agricultural soils with long-term, repetitive application of organic mature. Additionally, microplastics have been discovered by Weithmann *et al.*, in a variety of commercial bio wastes from household, energy crops, mature compost, and nonmatured fertilizer. These compost-derived organic fertilizers are underutilized sources of microplastics in farmland soil. The microplastics in sludge and wastewater are primarily obtained from the effluent of residential washing machines and discharged from personal care items, synthetic textile fibres, and microbeads, in contrast to the input from plastic usage inside agricultural systems. Due to the varying compositions, characteristics, and additions of these microplastics, there may be a variety of ecological threats to both agricultural soils and human life (Lwanga*et al.*, 2016).

The degradation, transport, and consequent ecological consequences of these microplastics from various sources are directly influenced by their form, type, and additive content in agricultural soils. Future research should focus on the dangers of microplastics made from various sources because those dangers have not yet been fully understood. Agricultural soils have been discovered to include all of the common polymer types PE, polypropylene, polystyrene, and polyvinyl chloride with varying detection frequencies in various sampling locations. Additionally, various additives were added into various types of plastic products for various purposes. Plasticizers were added to soften plastics, primarily in polyvinyl chloride, flame retardants were widely used in consumer products ranging from household items to polystyrene insulation foams, and antioxidants were used in many polymers, including PE and polypropylene, to stop the ageing process in outdoor settings (Tian*et al.*, 2022).

Microplastics' Transformation and Movement in Agricultural Soils

Plastics are transformed in the environment by chemical, physical, and biological processes, including fragmentation and degradation. The chemical degradation caused by ultraviolet (UV) radiation is the most important and frequently predominates the early degradation processes of plastic waste among these three forms of transformation. Due to UV exposure at an appropriate temperature and oxygen usage, microplastics in topsoil undergo phototransformation. Chemical reactions such chain scission, cross-linking, the creation of functional groups containing oxygen, and even mineralization into CO2 are all involved in the phototransformation of microplastics. Smaller microplastics and even Nano plastics may be produced during these processes. Additionally, the fragmentation of microplastics is

accelerated by the combined impacts of UV radiation and mechanical abrasion caused by the turbulence of agricultural operations and soil organisms. Microplastics tend to aggregate with soil particles by electrostatic forces, which were facilitated by root exudates in the rhizosphere or during feeding and excretion by soil animals, in contrast to the way that microplastics break down into smaller particles. Aggregates may contain microplastics that are resistant to UV radiation and other types of mechanical abrasion. Microplastics in soil may not completely degrade, which could lead to an accumulation of plastic at the submicron scale and unknown environmental concerns.

In addition to degrading, the movement of microplastics through the soil's porous matrix alters their distribution. According to studies, the transport of microplastics in saturated porous media, such as soils, may be improved by the reduction in size and increase in surface functional groups of microplastics. Additionally, soil characteristics like ionic strength and cation type, as well as heterogeneity, soil organic matter, and surface coating, had an impact on the mobility of microplastics in soils. Through borrowing, ingestion, and egestion as well as epidermal adherence, soil organisms, notably earthworms, considerably facilitated the transport of microplastics in soil. This resulted in the transport of microplastics from the topsoil to deeper soil and finally to the groundwater (Kumar and Sharma, 2021).

The Effects of Microplastics on Agricultural Soil Systems

There are a number of factors that contribute to the effects of microplastics on agricultural soil systems. According to a number of studies, ingesting microplastics may slow down earthworm growth and induce weight loss, reduce nematode survival and body length, and slow down collembolan growth. The potential causes may be attributed to digestive tract obstructions created by microplastics in faunal guts that reduced food intake and nutrient absorption, or even injuries to the skin and digestive system brought on by some sharp microplastics. While other studies have reported a variety of effects of microplastics on soil fauna, the results have shown a decrease in nematode reproduction rates, an increase in the diversity of gut bacteria in collembolan, and no appreciable effects on the reproduction of epigeic earthworms. Although the causes of these variations have not yet been determined, it has been hypothesized that they may be linked to animal dietary preferences as well as the characteristics and microplastic exposure concentration. Additionally, researchershave provided evidence that microplastics may migrate along with a terrestrial food chain, going

from soil through earthworm casts and chicken faeces (with increased microplastic concentration.

Recent studies have documented how microplastics affect terrestrial plants in addition to soil animals. Wheat plants have reportedly experienced severe detrimental impacts from microplastic PE residues both throughout the vegetative and reproductive growth phases. Additionally, PS microplastics of various sizes could reduce the photosynthetic rate while increasing the weight of Chinese cabbage by changing the microbial metabolism and the relationships between microorganisms. Spring onion leaves and overall plant biomass may grow substantially more quickly when PA microbeads are used. Additionally, microplastics may build up by the roots of wheat and lettuce plants before moving to the shoots and leaves and in the roots of cucumber plants before moving to the leaves, flowers, and fruits. The consequences of microplastics varied depending on the plant species and degree of contamination, and they included changes to soil structure, water holding capacity, nutritional content, and microbial population (Kumar *et al.*, 2020).

Microplastics can alter soil parameters, such as soil bulk density, soil aggregate size fraction, and evapotranspiration, in addition to their direct effects on soil animals and crops. These changes can then have an indirect impact on plant performance. By expanding the routes for water movement, microplastics may hasten soil water evaporation and alter the soil microbial population, especially with regard to root colonization microorganisms. Additionally, microplastics have been shown to lessen the detrimental effects of sulfamethazine on plant growth by modifying microbial populations. Microplastics interact with other pollutants such polycyclic aromatic hydrocarbons, organochlorine insecticides, and heavy metals (Cd, Zn, and Pb) in agricultural soil due to their large specific surface area, which in turn affects their environmental consequences. Microplastics may cause the adsorption and attachment of sorbed organic contaminants as they move vertically through the soil profile via bioturbation, surface runoff, and water penetration, or through irrigation canals, overland runoff, and even into the atmosphere. Microplastics and their co-existing contaminants provide significant environmental dangers in agricultural soil systems and act as vectors for other contaminants. These risks need to be thoroughly researched.

Crops and Plants Can Be Affected By Microplastic Pollution

Sludge from sewage and wastewater treatment plants has been discovered to contain microplastics. According to reports, around 50% of sewage sludge in developed countries

was eventually applied to farmlands as commercial fertilizers, resulting in up to 870 tonnes of microplastics per million inhabitants entering European agricultural soils. The figure could be greater in places where plastic is widely used. When agricultural plastic films are used for mulching, microplastics are released into the soil when the films disintegrate. There is currently very few research on the effects of microplastics on crops. According to one study, fluorescent polystyrene nanobeads (100 nm) entered tobacco cells via endocytosis. Li et al. revealed that crop tissue cultures can ingest and store polystyrene microplastics (0.2 m), implying that the microplastics could be transferred to humans via the food chain. Moving beyond the cellular level, it has been found that biodegradable and polyethylene microplastics can interfere with wheat growth, with biodegradable microplastics having a greater negative impact. The presence of earthworms partially mitigated the harmful effects of biodegradable microplastics on fruit biomass, according to the study. This study raised a new worry about biodegradable polymers, which have been promoted as a replacement for conventional plastics in order to reduce environmental microplastics. Knowing that microplastics modify soil biophysical properties, researchers hypothesized that by lowering soil bulk density, microplastics could promote plant root penetration, soil aeration, and root growth. On the other hand, experimentally added plastic film pieces to soil created channels that promoted water movement and evaporation, resulting in water loss from soil that could impact plant health. Plant health is also influenced by changes in soil microbial populations caused by microplastics, and the impact is likely to be detrimental if root symbionts like mycorrhiza and nitrogen fixers are harmed. The slow breakdown of microplastics has been connected to microbial immobilization, while empirical proof for immobilization is currently lacking. Furthermore, microplastics may act as a medium for the introduction of phytotoxic chemicals into soil, thereby damaging plant roots and health (Tang, 2020).

Conclusions and Potential Outcomes

Agricultural soil systems serve as major microplastics reservoirs and are exposed to them in a variety of ways. Different environmental conditions may have an impact on how these microplastics behave. Agriculture methods, input from irrigation and fertilizer, and atmospheric deposition are the main causes. Microplastics are fragmented and degraded in agricultural soils by photo-oxidation, mechanical abrasion, and UV irradiation, with UV irradiation dominating the early phases of the process. Because of the nature of the soil, agricultural practises, and the qualities of the microplastics, microplastics may also move through soil systems in physical and biological ways. Through direct consumption or

accumulation by organisms as well as indirect changes to soil characteristics or the soil microbial population, microplastics have a variety of effects on agricultural soils.

References

Huerta Lwanga, E., Gertsen, H., Gooren, H., Peters, P., Salánki, T., Van Der Ploeg, M., &Geissen, V. (2016). Microplastics in the terrestrial ecosystem: implications for Lumbricus terrestris (*Oligochaeta, Lumbricidae*). *Environmental science & technology*, 50(5), 2685-2691.

Kumar, M., Xiong, X., He, M., Tsang, D. C., Gupta, J., Khan, E., & Bolan, N. S. (2020). Microplastics as pollutants in agricultural soils. *Environmental Pollution*, 265, 114980.

Kumar, R., & Sharma, P. (2021). Recent developments in extraction, identification, and quantification of microplastics from agricultural soil and groundwater. *Fate and transport of subsurface pollutants*, 125-143.

Mohajerani, A., & Karabatak, B. (2020). Microplastics and pollutants in bio solids have contaminated agricultural soils: An analytical study and a proposal to cease the use of bio solids in farmlands and utilize them in sustainable bricks. *Waste Management*, 107, 252-265.

Tang, K. H. D. (2020). Effects of microplastics on agriculture: A mini-review. *Asian Journal of Environment & Ecology*, 13(1), 1-9.

Tian, L., Jinjin, C., Ji, R., Ma, Y., & Yu, X. (2022). Microplastics in agricultural soils: sources, effects, and their fate. *Current Opinion in Environmental Science & Health*, 25, 100311.

Weithmann, N., Möller, J. N., Löder, M. G., Piehl, S., Laforsch, C., & Freitag, R. (2018). Organic fertilizer as a vehicle for the entry of microplastic into the environment. *Science advances*, 4(4), 8060.

Yang, J., Li, R., Zhou, Q., Li, L., Li, Y., Tu, C.,& Luo, Y. (2021). Abundance and morphology of microplastics in an agricultural soil following long-term repeated application of pig manure. *Environmental Pollution*, 272, 116028.

Article Id
AL04155

MYCOREMEDIATION

[1]Dumpapenchala Vijayreddy, [1]Hans Austin K. H.*, [1]Krishti Rekha Puzari and [1]Ngawang Namgey

Email

hansaustine@gmail.com

[1]Department of Plant Pathology, School of Crop Protection, College of Post Graduate Studies in Agricultural Sciences, CAU(Imphal), Umiam, Meghalaya-793103, India

Time, it has been the most influencing factor entangled in the secret spool of the universe. Right from the expansion of the universe to this day we commemorate every milestone of our journey with time. Before the Jurassic era the planet was colonized by humongous achlorophyllous mushrooms. They utilized the matter that were available during that time converting to energy for growth and reproduction, thereby indirectly conditioning the earth for organisms to thrive.

Fig. 1: Bacons made of fungal mycelia

Courtesy: Ecovative Designs

Armillaria spp. fungi is known to be the largest organism living on earth surface, covering hectors of forest land. The fungi knew the concept and principles of internet even before we discovered. Those intricating networks exchanging vast amount of information between the higher organisms is still unknown to our humble intelligence. The one and only organism on earth that is purely selfish in nature whose satiety and hunger are never be quenched by any supernatural force even if existed are humans. Our actions took a huge toll on mother nature. Air, water, soil, everything around us is being contaminated and we are unaware of the fact that we our self is contaminated.

Hike in cancer cases around the world and the emergence of pandemics claiming the lives of many are indications that we have already crossed the limit. Just as fire was a great discovery for prehistoric men, plastic was a game changing discovery of modern man. From

the tip of your toes to the root of your hair we are dependent on various plastic products. The impact of chemicals, petroleum products, heavy metals and non-degradable materials are devastating to the environment. It was there where the concepts of Mycoremediation was born.

Mycoremediation is when fungi and its products are used to break down pollutants in environment. Myco is derived from the Greek word *mykes* meaning fungus and remediation from Latin word *remedium* meaning to restore balance. Fungi forms network of hyphae called mycelium in the soil to derive nutrients. They produce enzymes to degrade harmful contaminants in the soil. These contaminants get accumulated in the fungi and are easily degraded preventing further damage to the environment. Thus, fungi are gateway species that opens the world for other biological communities. New York based company called the Ecovative designs found substitute for Styrofoam, leather and many other plastic products. Modulating the mycelium of fungi to produce airy, soft and elastic material called aero mycelium is used as replacements for many goods. This aero mycelium can be sliced thin to make vegan bacon or can be compressed and dried to form leather revolutionizing fashion industry. Styrofoam used for packaging electronic and fragile products takes long time to decompose and they are hazardous to the environment.

Fig. 2: Air mycelium technology
Courtesy: Ecovative Designs

Similar packaging materials can be made using mushrooms and suitable substrate which is a perfect substitutefor Styrofoam. The mycelium of different mushrooms has different properties. Some are hardy and some others are soft and stretchy.

Mycelium as Building Material-Mycelium Brick

We have to consider the following steps for its formation. For this purpose, we need to:

1. Take a mushroom sample. Allow it to dry in the open until the tissues are visible.

2. Prepare the agar, which is a gelatinous substance made from seaweed. Put it in a pot of water and bring it to a boil. When finished, pour it into a container.

3. Put the tissue from the mushroom in the agar-filled container. One can observe how mushroom tissue collects on the surface and gradually grows into fibres that resemble hair. A semi-liquid mass of mushroom tissue should form after some time.

4. Prepare the substrate (item or food source) to encourage the growth of mushroom tissue. It might include sugars, pet food, agricultural waste, and even energy drinks. Put it in a container after filling it.

5. When the mushroom mass is prepared, put it in the container with the substrate mixture. Permit the mass to settle, increase in volume and occupy the substrate. Shake the container after closing it to evenly distribute the mass. This could take 3–7 days, depending on the quantity and kind of substrate.

6. Once the mushroom mass is prepared, take it out of the container, cut it into smaller pieces, and then put the pieces in a tray or mould to give the mass a particular shape. Allow it to stabilize and grow stronger under ideal circumstances.

7. Remove the completed brick block or form from the mould and store it for 7 days in ideal conditions. The block will become stronger and have dried out all of the moisture within 7 days.

8. The brick develops a white powdery coating on top as it dries. To eliminate any undesirable organisms that may have absorbed moisture, place the block in an oven. Once baked, the mycelium block is finished.

It is advantageous because it is completely biodegradable, less time consuming, temporary setups and depending on usage, installations can be quickly built and taken down. More heat can be trapped by mycelium tissue than fibreglass insulation and is also non-toxic and fireproof. It becomes lighter after drying despite developing porosity, it is still more powerful than a concrete pound for pound. It is a quick, low-cost, and simple to produce material. It has a lifespan of about 20 years.

The mycelium bricks' ability to hold water decreases over time, making them more vulnerable to mould and humidity. Mycelium bricks cannot be used for long-term structures due to their decreasing resistance to moisture, humidity, and mould growth. Mycelium bricks

expand, contract, and relax in response to the weather and when they are left untouched by the ground, so no coating is typically needed under normal environmental conditions.

Oil Degradation by Oyster Mushrooms

Some oyster mushroom strains have the ability to clean up oil-contaminated land. The most prominent study to prove this was led by Paul Stamens, and it is described in his book "Mycelium Running: How Mushrooms Can Help Save the World." Oyster mushrooms were utilized to solve diesel oil-contaminated soil. 95% of the oil was converted into non-toxic compounds by mushroom. *Pleurotus ostreatus* can also grow on and degrade oxo-biodegradable plastic bags; it can also aid in the degradation of green polyethylene.

The discovery of oil-eating mushrooms has numerous applications in industry, health, and environmental rehabilitation. Dispersants, which can increase oil toxicity, are now used in methods for cleaning land and shoreline oil spills. The lush and verdant pile of rehabilitated soil that was reduced from 20,000 ppm to 200 ppm of TAHs is

Fig. 3: Oil degradation by Oyster mushroom

Source: Fungi Imperfect i

An indication of the Oyster mushroom's efficiency and effectiveness. Even bacteria and enzymes used in Paul Stamets' experiment did not degrade the oil as well as the *P. ostreatus* culture. This discovery could have the same impact as fungi used in bread and beer; fungus is an important application in our everyday lives. It is clear that corporate and industry executives are ignorant of the possibilities for oyster oil-eating mushrooms. Oyster mushrooms have an advantage over the less hospitable settings of the bacterium and enzyme piles, as evidenced by the breakdown of oil and development of a functioning ecosystem on the infected dirt pile within a 6-week time frame. The potential efficiency and effectiveness of future GMO mushrooms are only made more hopeful by the discovery by researchers of the detoxifying characteristics of mushrooms (peroxidase). It won't take long for companies to start making money off of this finding. *Pleurotus ostreatus*, an oil-eating oyster mushroom strain, is the best candidate for removing land oil contamination. The mushroom absorbs the

oil and re-manufactures it to produce energy by breaking hydrogen-carbon bonds. The mushroom, in addition to catabolically dissipating the oil, creates a habitable environment for native species much faster than any other known method of oil dissipation. This discovery has not been fully utilized by industry and business sectors.

Mycofiltration

Mycofiltration is a technique that removes microorganisms and toxic waste from soil water using fungal mycelia. Decomposition is one of the primary roles of fungi in the ecosystem which is done by its mycelium. Extracellular enzymes and acids are secreted by the mycelium

Fig. 4: Mycofiltration of River water that breaks down lignin and cellulose, the two main building blocks of plant fibre.

Source: Tesla Nova

These are organic substances that resemble many organic pollutants structurally and have lengthy carbon and hydrogen chains. The key to Mycoremediation is identifying the best fungal species to target a particular pollutant.

Fungi have enzymes that break down woody materials such as ligninase and cellulase. This allows fungi to obtain the necessary carbon and energy for growth.These enzymes are non-specific, which means they can act on a variety of substrates, including environmental pollutants. Fungi can use hyphae to increase their surface area, making it easier to contact the pollutant. Extracellular enzymes can then be activated and they work on it.

Mycopackaging

Mycelium is the root network of a fungus which is found below ground. The branching network which are interconnected and can grow into any shape of delicate structure to tightly packed structures. The advantage of mycelium is that it can grow to very large area and is ecologically

Fig. 5: Mycopackaging of beauty products

Source: Ecovative Designs friendly.

The mycelium can be manipulated according to the human intention in order to form a definite shape as it can be used as a binder together with agricultural byproducts such as straw for the manufacture of protective packaging. Mycelium grows literally to fill the moulds; hence it can be molded into different shapes. A New York based company called Ecovative Design is the market leader of the mycelium packing technology and produces two packaging material solution- Myco Composite, which is the rigid composite material and Mycoflex, which is the mycelium flexible foam.

The advantages of mycelium are as follows – it is completely natural with no toxic effects plus, easy to grow and needs very less water to grow at an industrial level, making it almost perfect as a substitute to styro form in packaging material. The only drawback which can be seen is that, as a part of the fungus it actually utilizes oxygen and releases carbon dioxide which if produced in a large scale might trigger increased amount of carbon dioxide in the atmosphere.

Cellular Intelligence

A slime mold called *Physarum polycephalum* which is known to have baffled scientists by its ability to find food for itself when it is placed at one end and the food material is kept somewhere inside the maze. That, is called the nutrient maze. Now, the slime mold has special preference towards oat kernels as their food source so, what the scientists did was that they tried to mimic the map of Japan and took oats kernels and placed it all over an environment favourable for the slime mold similar to grow.

What we have to know is that each of the kernel represented a major city of Japan and Tokyo at the centre, was represented by the kernel with the slime mold inoculated on it. At

first the slime mold expanded in an exploratory manner, searching for more food i.e. oat kernels. But as the time passed, after 28 hours or so, the slime mold reorganized itself in the most efficient manner forming a network between those kernels which now represented each city in Japan connected to the source of slime mold i.e. Tokyo.

The question which arose was, how a unicellular organism was able to form a network that efficient? The engineers who worked around the clock for years, trying to find the most efficient way of connecting those cities were amazed by how a slime mold can do the exact same work in a matter of hours that too more efficiently than them. This was the demonstration of the cellular intelligence at its best, which teaches us how less we know about our own earthly organisms and us humans are searching for life beyond our earth.

Conclusion

Global warming along with water crisis is drawing attention of various scientists as well as the researchers. Acid rain is an another burning issue that is hampering the beautiful white marble structure of Taj Mahal since 1970s, even causing havoc in the Agricultural fields. For these consequences, sole reason that is to be blamed is the destructive use of plastics or polyethylene derived products mostly in packaging materials for various kind of commodities that results in variants of sources of pollution. There is a high need of finding an alternative to the use of plastics or it's derived products. For this, Mycoremediation can be considered the best remedy as well as can be utilized to replace at least 40% of the plastics. There is still a wide gap in mass production and commercialization of fungi-derived products and its awareness among the farmers as well as the common people. A pre-established stereotypic thought among people i.e., fungi are poisonous... still persist. Thereby, these drawbacks should be wiped off in order to promote Mycoremediation and save our planet earth from sinking deeper day by day.

References

Pini, A., and Geddes, P. (2020). Fungi are capable of Mycoremediation of river water contaminated by *E. coli*. Water, Air & Soil Pollution, 231:83.

Happhoadmin7. (2022). Happho. https://hapho.com/an-emerging-sustainable-construction-material-mycelium-bricks/.

Mclntyre, G. (2007) Ecovative Designs: The Mycelium Technology Company[online]. Available at: https://www.ecovative.com [Accessed 22nd August 2022]

Article Id
AL04156

NON-BEE INSECTS: VISITORS AND POLLINATORS OF CROPS

[1]Hissay Cheday Bhutia*, [1]Sabina Rai, [1]Ansh Raj and [1]Sutanu Majumdar

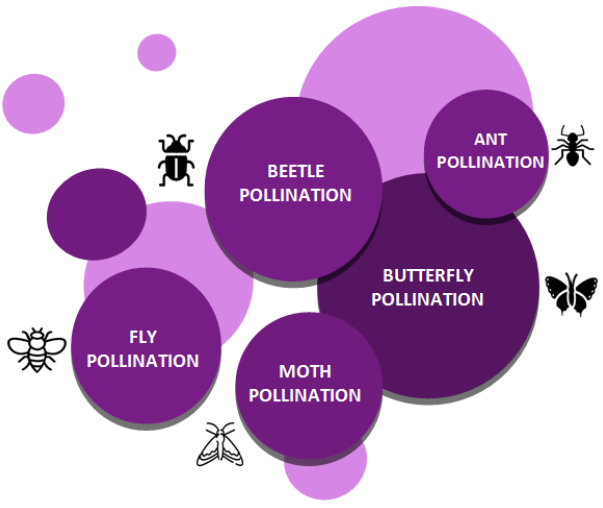
Email

hisnamz@gmail.com

[1]School of Crop Protection, CPGS-AS, CAU(I), Umiam, Meghalaya-793103, India

Pollination is the transfer of pollen grains from anther of male flower to stigma of the female flower. The agents (living & non-living) which carry out pollination is called as pollinators. Non-living pollinators includes wind, water, etc., while living pollinators includes animals, insects, etc. It is estimated that worldwide around 35% of crops grown and one-third of food we eat relies on pollination by insects. Insect pollinators provides substantial crop pollination services. Often, bees are considered as the most essential crop pollinators as they are effective pollinators and are easy to manage. Both managed and wild bees are responsible for crop pollination services in most of the crops. However, other than bees, there are other insect pollinators that provide significant pollination services. With the growing human population and thereby increasing global food demand, there is therefore a need to recognize the aspects that affect the world crop yield for sustainable crop production.

Non-bee insects consist of insect pollinators like flies, beetles, wasps, moths, butterflies, etc. These non-bee insects can help in protecting agriculture and promote sustainable crop pollination. The following are the non-bee insect pollinators:



NON-BEE INSECT POLLINATORS

1. **Flies**: Flies are considered as important pollinators of various vegetable and fruit crops. Among flies, hoverflies or flower flies is the most acknowledged and important group of pollinators. These flies hover in air while flying, hence the name hoverflies. They resemble bees except they have a single pair of wings whereas bees have two pairs of wings. Also, it does not possess sting unlike bees. Hoverflies provide double benefits for human beings as the immature stages (larva) act as predators of aphids and other soft-bodied insects and the adults act as pollinators of various crops.

   Other flies like blowflies are pollinators of vegetable crops. Houseflies are recognized as pollinators of mango flower. Tiny flies are responsible for pollination of cocoa plant which are used to produce chocolate.

Fig 1: Fly pollinators: left to right, top - thick headed fly, dagger fly, flesh fly; middle - hover fly, blowfly, blowfly; bottom -horsefly, mosquito, bee-like fly

Courtesy: Sean McCann

2. **Wasps**: Wasps looks like bees, but their body has less hairs than bees. They mostly visit flowers for nectar. As their tongues are short, they select flowers with readily available nectar droplets. Among wasps, fig wasp pollinates several species of figs. The fig and fig wasp have a mutualistic interaction i.e., one cannot live and breed without the other.

Fig 2: Potter wasps (Vespidae)

Source: Wikipedia

Fig 3: wasps (Agaonidae)

Courtesy: Wang Gang

3. **Beetles and Weevils**: They are considered as one of the primitive insects to visit flowers. They tend to visit flowers for feeding on pollen, petals, anthers, or stigmatic secretions. Some of them use flowers as a place to stay so that they can prey on other insects e.g., ladybird beetles. Oil palm, a plant which produces edible vegetable oil, is pollinated by oil palm weevil. Pollination by this weevil has shown to increase fruit set and bunch weight of oil palm.

Fig 4: Locust Borer beetle

Courtesy: Bonnie Ott.

Fig 5: Long horned beetle on *Magnolia grandiflora*

Courtesy: D. Hill

4. **Moths**: They are pollinators which are mostly active during nighttime. They visit flowers for nectar. While walking around flower in search of nectar, their body picks up pollen and thus transfers it to another flower. Moths visit many flowers and fly long distances; thus, they can act as effective pollinators.

Fig 6: Armyworm mothon an apple flower

Courtesy: Stephen Robertson

5. **Butterflies**: They pollinate various flowers during the daytime and often prefer large, brightly coloured flowers having flat surfaces to land upon it. They visit flowers for

sugary nectar and sit or rest on flowers, thereby collecting pollen on their body and legs while searching for food.

Fig 7: Monarch Butterfly
Courtesy: Patrice Thrives

Non-bee insects have several advantages like:

i) They play dual role as predators/parasites and pollinators, for e.g., hoverflies, parasitic wasps, etc.
ii) They respond less negatively than bees to land use changes.
iii) Some of them like flies, beetles and butterflies can fly long distances in comparison to bees.
iv) They can act as pollination insurance incase of bee decline.

However, it is also important to note that for making decisions and strategies for promoting non-bee insect pollinators, it requires careful planning as some of these pollinators (like flies, etc.) can spread diseases in crops and livestock. Also, the immature stages of certain insects (moths, etc.) are pests of crops. Recognizing practical management choices are thus required under such circumstances.

In recent years, populations of pollinators have been decreasing around the world. Pollinator decline is due to causes like

i) Anthropogenic (man-made) causes such as deforestation, habitat fragmentation (i.e., large tracts of land are fragmented into smaller fragments due to road construction, agriculture, etc.),
ii) Climate changes which include high temperature, flood, drought, other extreme climatic conditions, and changes of flowering time which hinders pollination by desynchronizing the blooming of flowers with the supply of pollinators,
iii) Use of pesticides, fungicides and herbicides which are harmful to the pollinators and,

iv) Introduction of parasites & diseases (e.g., Varroa mite in honeybees)

There is an increasing need to conserve these pollinators by adopting methods like

i) Planting native or wildflower strips – plants that supports wellbeing of pollinators by providing them with a place to live, eat and lay eggs.
ii) Using less toxic pesticides or alternative pest management practices.
iii) Providing nesting sites and artificial food supplements in dearth period.

Conclusion

Although non-bee insects are essential contributors to world crop production, many of them are still insufficiently studied and often overlooked. From the perspective of maintaining biodiversity, we should not solely depend upon a single pollinator species especially since the health of managed honeybee colonies are currently threatened. Therefore, research studies and proper exploration of these pollinators should be conducted for determining their effectiveness and efficiency as pollinators and people should be made aware about the importance of these pollinators.

References

Radar, R., Bartomeus, I., Garibaldi, L.A., Garatt, M.P., Howlett, P.G., Winfree, R and Cunnigham S.A. (2016). Non-bee insects are important contributors to global crop pollination. *National Academy of Sciences*, 113: 146-151.

Mitra, B., Banerjee, D. (2007). Fly pollinators: Assessing their value in Biodiversity Conservation and Food Security in India. *Zoological Survey of India.* 107: 33-48

Usha, Shyam, R., Srivastava, M., Rajput, B.S. (2017). Insect Pollinators and sustainable Agriculture. *Rashtriya Krishi*. 12(1): 11-14

Article Id
AL04157

SWOT ANALYSIS: A SITUATION ANALYSIS TOOL FOR AGRIPRENUERSHIP

[1]Sharmistha Swayamprava*, [1]Puja Debnath, [1]Ritesh Debnath and [1]Dering Phawa

Email

sharmisthas493@gmail.com

[1]School of Social Sciences, CPGS-AS, CAU (I), Umiam, Meghalaya – 793103, India

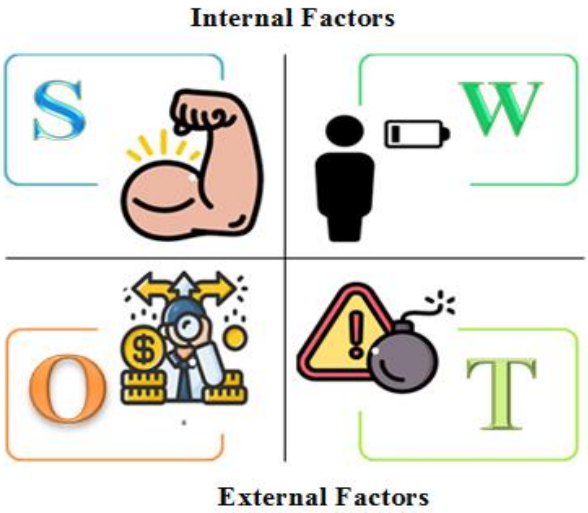
Everything in this world strives for growth. Be it an individual or an enterprise, everyone needs a strategic planning for obtaining goals which can contribute to their desired development and growth. SWOT Analysis is one such tool which can help in strategic planning. SWOT Analysis is a strategic management tool primarily used to analyze the situation which provide inputs to formulate strategies for a particular situation or context.

Development of the concept of SWOT Analysis is often credited to Mr.Albert Humphrey, an American management consultant, initially named as SOFT Analysis. It was developed around the 1960s – 1970s.

Components of SWOT

SWOT is an acronym for Strengths, Weaknesses, Opportunities and Threats. These four constitute the components.

Strengths and weaknesses are internal factors and attributes of the enterprise, opportunities and threats are external factors and attributes of the environment. SWOT Examination is regularly drawn out in a four-quadrant box that permits for a rundown that's organized according to the four area titles. The following table is a SWOT analysis with its four elements in a 2x2 matrix.



Source: Edited by Author

In SWOT Analysis, the strong and weak angles of an enterprise are recognized by looking at its internal environment whereas opportunities and threats are decided by looking at the external environment. It gives data that helps in coordinating the enterprise assets and capabilities to the competitive environment in which it operates.

Strength

Strength is an internal and helpful character that can help the enterprise to reach its full potential. These are variables for which the organization is recognized and which provides it an edge over its competitors. These are uncommon positive characteristics, such as a solid brand picture, a steadfast client base, or a one of a kind innovation that gives a clear advantage to the enterprise compared to rivals. A SWOT examination can be instrumental in recognizing an enterprise's unique suggestion that shapes the premise for the quality and keeps the commerce ahead of its competitors within the market.

Weakness

Weakness is an internal and harmful factor. It stays inside until mitigated or corrected. Recognizing these can offer us insights on zones where change is required. Doing this lets an enterprise plan measures to amend and control their frail focuses, which in turn makes a difference in the company growth. Like strengths, shortcomings such as low brand esteem, unused turnover, or need of capital are solid traits that affect and impact future course of action.

Opportunity

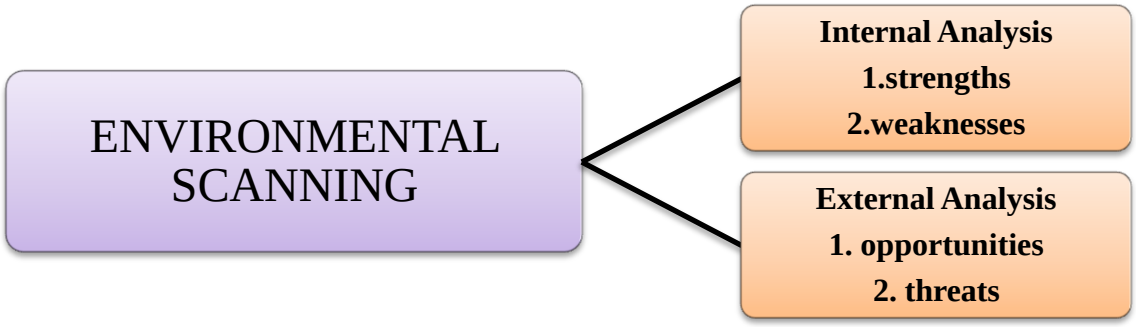
These are external variables that are open and should be utilized by the enterprise for its advantage. Enterprise must have a great eye to distinguish and analyze winning opportunities within the showcase to be able to proactively use them. Utilizing opportunities to draw growth strategy can help the enterprise to realize its future development trajectory.

Threat

Like opportunities, these are outside or external components that adversely affect business. Dangers can come in numerous shapes — money related downturns, supply chain issues,

rigid government directions or shifts in showcase prerequisites, etc. which are outside the control of an enterprise. Hence, it is significant to expect dangers in development and take essential safeguards to maintain a strategic distance from falling casualty to such outside occasions

SWOT Framework



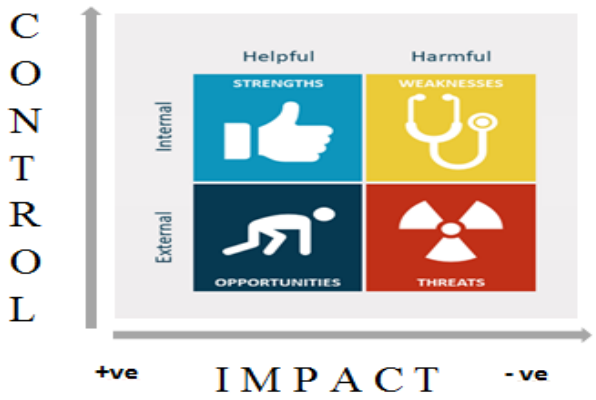
Source: Edited by Author

Strength, Weakness, Opportunity and Threat are the 4 quadrants. In each quadrant, we put the various factors to be analyzed. For selecting the factors, we have to start with scanning our environment. After internal analysis, we get our Strengths and Weaknesses and analysis of external environment gives Opportunities and Threats. While putting the factors, we have to be very vigilant and keep the context in mind as depending on the context the same factor can be put under any of the quadrants.

The next important thing is the 2 axes: 1. Control axis (Y- axis)

2. Impact axis (X- axis)

As we move from top to bottom on control axis, our control on the factors decrease and as we move from left to right on impact axis, the factors go from becoming more helpful to more harmful.



Source- https://www.presentationgo.com/presentation/

Advantages and Disadvantages of SWOT Analysis

ADVANTAGES	DISADVANTAGES
• It is easy to use • As it in Pictorial form, it is more attractive and can be comunicated easily • It has a general perspective and presents general solutions • SWOT Analysis can be applied at different analytical levels - individual level, organizational level etc • It has low cost	• It doesnt provide solutions or offer alternative decisions • It is more of a subjective analysis • It can generate too many ideas but not help choose the best one

Application

SWOT Analysis is mostly used in the field of business and commerce. As in this article we are focussing on agriculture, SWOT Analysis can help our farmer entrepreneurs in the following ways:

- In deciding which enterprise or crop to take up
- For strategic planning
- To set up clear goals and direction
- To tap available opportunities and mitigate any looming threat
- To choose profitable markets
- To select new arenas while expanding the farm business
- Can use SWOT Analysis before any big investment, especially to check any risks associated with it
- Can use it to keep focus on important areas and remove unnecessary diversions

Case Study

Mushroom also known as "Vegetarian's meat", a conspicuous umbrella, shaped fleshy fruiting body of some certain fungi, are one of those most loved food in Northeast Indian region not only for its exotic taste but also for the various benefits it brings in with it. It is

usually consumed in different forms like fresh, pickled, dried, powdered, canned etc. in this region. In recent years Mushroom cultivation has picked up a rapid growth among many agricultural entrepreneurs for its medicinal and nutritional benefits and low cost input with high output. The SWOT analysis of Mushroom cultivation in the NEH region is discussed below-

Strength	**Weakness**
• The climatic condition of Northeast India is favourable for mushroom cultivation • Cheap manpower • Short growing cycle • Develop self-reliance to rural woman	• Less availability of packing material • Poor quality of raw materials • Mushroom is a highly perishable product • Prone to diseases and pests
Opportunity	**Threat**
• Well adapted modern techniques for production • Increasing awareness among customers about nutrition in domestic market • It generates employment for rural people	• High cost of mushroom spawn • Irregular supply of spawn • Mushroom supply from other regions of the country

Conclusion

SWOT has been an important analytical tool for strategy development over the years. It helps us to make use of what we have to generate the highest possible profit by tapping into suitable opportunities. It makes us aware of our lacunas and hence nudges us to find solutions to fill them up; otherwise we may get fatal blows which can make our survival in the market very difficult. Before starting and while conducting a SWOT Analysis, we have to keep the context in mind. At last, SWOT is not alone a sufficient tool to develop strategies but can be a starting point.

References

Mind tools. (2001, December). SWOT Analysis: Understanding Your Business, Informing Your Strategy. Retrieved July 10 2022,

PrachiJuneja (n.d.) Management Study Guide. SWOT Analysis - Definition, Advantages and Limitations. Retrieved July 25 2022,

Sarsby, A. (2012, November). A Useful Guide to SWOT Analysis. Pansophix Limited, available at https://www.cii.co.uk/media/6158020/a-useful-guide-to-swot-analysis.pdf

Article Id
AL04158

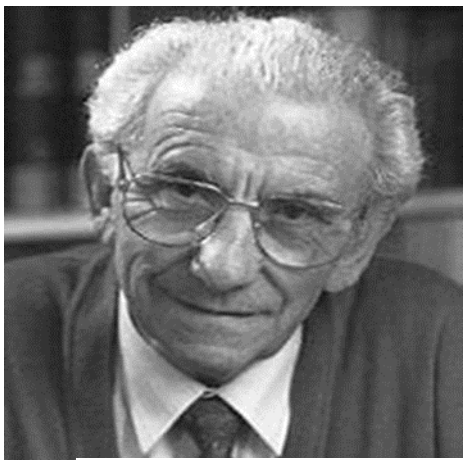
DNA INSECTICIDES: AN EMERGING TOOL IN PEST MANAGEMENT

[1]Manju Mathew*, [1]V. Nirosha, [1]Thokchom Tullika and [1]Gracy Mankhanniang

Email

sharmisthas493@gmail.com

[1]CPGS-AS/CAU, Umiam, Meghalaya, India



V.V OBEREMOK

Insecticides are chemicals which kill insects. Considering the rapid growth of global population, annual reduction in cultivated lands, and considerable loss due to pests, the need for insecticides cannot be questioned but many of them cause great harm to the environment. This demands further research aimed at production of safer insecticides. The most marketable insecticides are those combine the best properties of existing insecticides. This condition is met by DNA insecticides, preparations based on nucleic acids. This concept was formulated and expanded by V. V Oberemok. They have unique features like use of ssDNA molecules, cost effective, target specific, fast action, topical application and the use of viral anti-apoptotic genes, can even replace organophosphates as reported by Useinov*et al.*, 2020. The action is similar to methods of blocking expression of genes using the mechanisms of RNA interference (Wang *et al*., 2011), DNA interference (Kawai-Toyooka *et al*., 2004) and application of antisense technologies. These features make DNA insecticides distinct from the other post-genomic means of crop protection. But this technique is still in its infant stage. Researches provide on how to rearrange current attempts and supplement for the production of such insecticides and make them available for common man.

DNA insecticides are known as intellectual insecticides because they act target specific. It is a technology based on application of single stranded viral DNA fragments possessing insecticidal activity. These are introduced exogenously which can act in a manner similar to antisense molecules. It combines the techniques of RNA interference (RNAi), DNA interference (DNAi) and antisense oligo nucleotides (ASOs).

RNA Interference

RNAi is a biological process involving double stranded RNA which can suppress gene expression through translational or transcriptional repression. It was first documented in animals in 1996 by Gou and Kemphues in *Caenorhabditis elegans.* This includes two components, namely, micro RNA (miRNA) and small interfering RNA (siRNA).

The RNAi can occur in a cell due to the presence of antisense RNA. The complementarity of antisense RNA and cellular mRNA cause them to bind with each other. The antisense RNA can be introduced into a cell through different ways such as, by a researcher for any research purpose or a virus when they multiply within a cell.

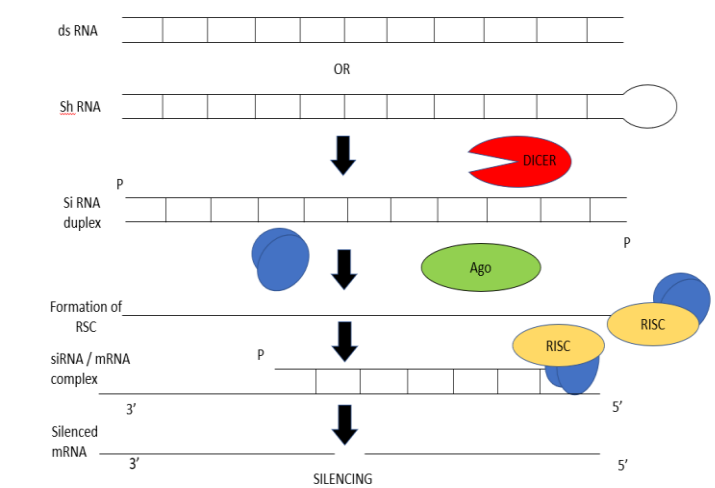


Fig 1: RNA interference

Source: Clipart edited by authors

RNAi involves two steps:

- Creation of RISC (RNA Induced Silencing Complex)
- Degradation of cellular RNA by RISC

An endonuclease known as "dicer" identifies dsRNA in a cell. It cuts the dsRNA into pieces of 21-23 nucleotide long. The antisense RNA associated with proteins like Argonaute proteins forms RISC.

RISC associate with cellular mRNA which has a sequence homologous with RNA fragment in RISC. The RISC attaches and thus degrades the cellular RNA. Thus, the gene expression is blocked.

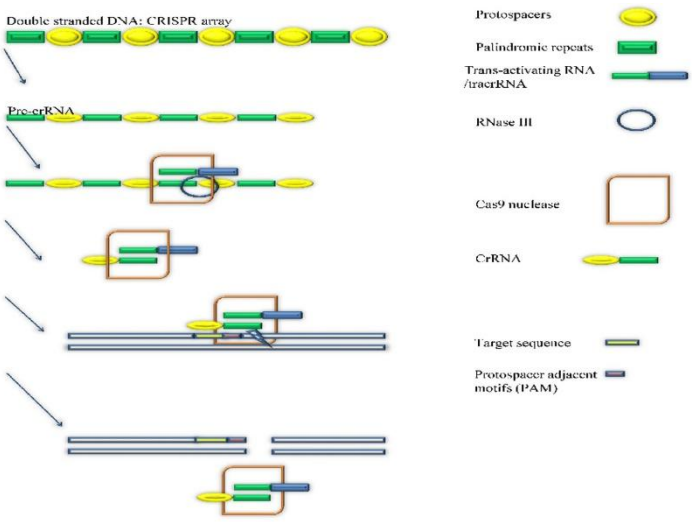


Fig 2: DNA interference

Source: Shengfu Shen *et al.*, 2016

DNA interference

The DNAi can be best explained by the help of CRISPR/Cas9 technique. It

works on dsDNA. The components of CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) are mainly an endonuclease called Cas9 and a guide RNA. Guide RNA has two components, they are tracrRNA and crRNA. The tracrRNA binds to one of the palindromic sequences and the ribonuclease 3 will cut the tracrRNA. This is called the crRNA. The crRNA, tracrRNA and the Cas9 enzyme forms a complex. The crRNA is complementary to a DNA sequence of the target. So, crRNA guide Cas9 nuclease to the target. PAM (Protospacer Adjacent Motifs) acts as an initiator of attaching crRNA to its complementary strand. The complex will thus cut the target DNA and blocks its genetic expression.

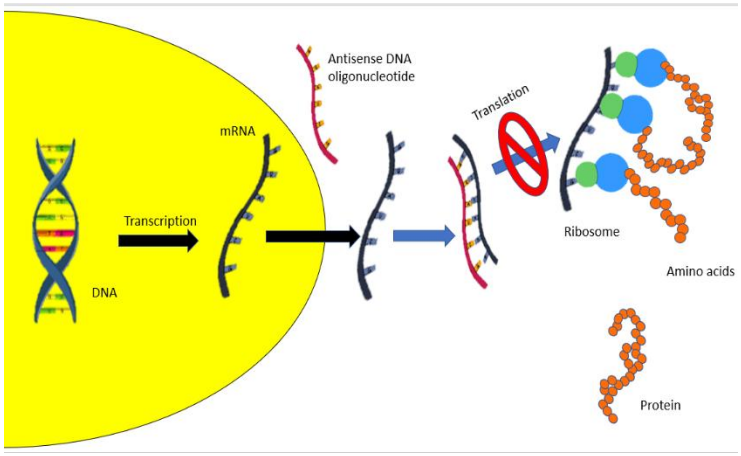


Fig: Antisense Oligo nucleotide Technique

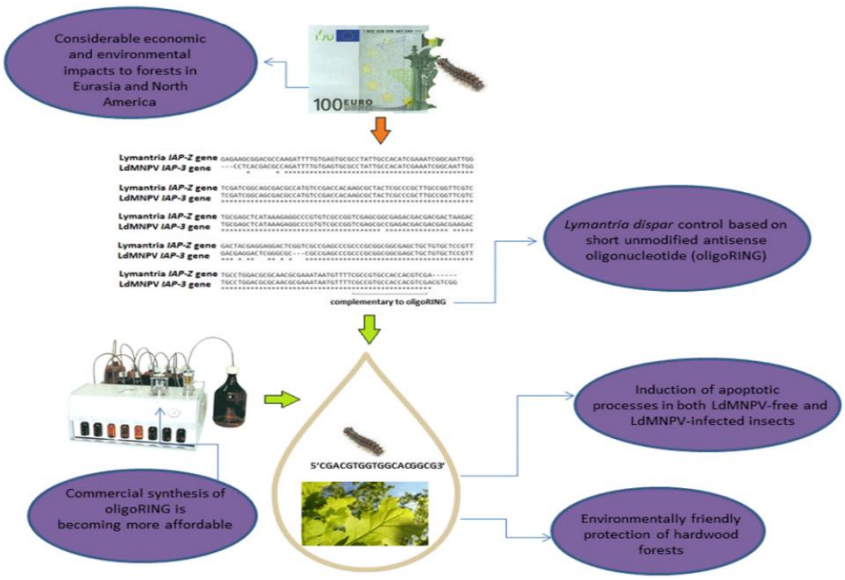
Source: Clipart edited by authors

Antisense oligo nucleotides

Antisense oligo nucleotides are short strands of nucleotides which are complimentary to the mRNA and can bind with each other.

Mode of Action

The DNA insecticides have been studied only with the anti apoptosis gene. The anti apoptosis gene is found in Baculo viruses. The Baculo viruses have IAP gene 1-5, among which the IAP3 is the most effective against insects. The IAP3 gene is extracted from the baculo viruses. They contain two domains namely, BIR (baculo viruses IAP repeats) and RING (Really Interesting New Genes). RING is the most effective and act homologous to the target site in insects. The insects also possess anti apoptosis gene. When IAP3 is introduced into insects as ssDNA fragments, they act complementary to the anti apoptosis site of insects. Thus, bind together and blocks the expression of anti apoptosis gene in insects which lead apoptosis in them. Thus, the insect dies. Most of the studies are done in Gypsy moth, *Lymantria dispar,* this is because it is a major pest in Russian forest which have a capacity to feed upon $1m^2$/larvae area in its caterpillar stage. This also have more than 80 host plants including agricultural crops.



(Source: V. V. Oberemok*et al.*, 2018*)*

The DNA insecticides are basically single stranded DNA fragments in water solution which can be applied topically. Cold fog generators are used for topical application or spraying of these insecticides. The cold fog generators are mainly used in the application because the atomization of the insecticide particles is more which help in more penetration into insects. These act like hand sprayers. The carriers mostly used are poly-L-lysine, polyethyleneimine, poly[(organo) phosphazenes], etc**.** The better the carriers are, the more the penetration and absorption of the insecticides applied.

The symptoms are shown by caterpillars within three to seven days of application. The caterpillars infected stop eating, move slowly, appear dehydrated and appear to be smaller than the healthy ones.

The Advantages of Using DNA Insecticides

They are very selective in action and cost effective, no long term negative effects are shown on host plants. They are very suitable for lepidopteran pests in caterpillar stage specially second instar. They resolve the problem of developing insecticide resistance in insect pests. They work at lower concentration (in picomolar concentration). It is more natural containing water dissolved with antisense oligonucleotides.

The Disadvantages of using DNA Insecticides

They are hard to penetrate cryptic feeding insects and adult beetles due to hard elytra. They may not be successful in controlling insect pests in an emergency situation like pest outbreak. The carriers used are very expensive.

Challenges of DNA Insecticides

This approach must be made profitable and marketable. This can be made marketable only by creating a product composed of multiple treatments such as a solution containing several ASOs that target different genes. Optimal delivery is critical for achieving maximum potency. We must ensure more penetrability of DNA insecticides with the use of suitable carriers. DNA insecticides can only be produced if we know about the gene sequences of agricultural pests. So the sequencing of all insect genomes, especially that of pest is necessary. As of 2019, the genomes of only 28 species have been sequenced. One of the most pressing challenges while creating DNA insecticides is the need to increase insect mortality as compared to the present insecticides.

Future Prospects

Investigation in the field of post genomic approach deserve attention and detailed study. Researches provide on how to rearrange current attempts and supplement for the production of such insecticides. Further improvement for establishing more precise mechanism of their action. Researches for extending use to controlling other serious insect pests

Conclusion

` The DNA insecticides can combine the best properties of modern insecticides; the low cost and the fast action of chemical preparations on one hand and the selectivity of biological preparations on the other. Considering the rapid growth of the global population, annual reduction of cultivated lands, and considerable agricultural losses due to pests, more feasible alternatives to insecticides are to be discovered. The new insecticides must be selective, feasible and eco-friendly. Such requirements are fulfilled by DNA insecticides, arising as a new promising insecticide group. So, the studies in this area have to be more encouraged and supported for a better tomorrow.

References

Oberemok. V. V. *et al.,* (2013). DNA Insecticides: Application of the Iap-2 Gene Single-stranded Fragments from Three Different Nucleopolyhedroviruses against Second Instar Gypsy Moth Larva. *Universal Journal of Applied Science.* 1(2): 33-37.

Oberemok. V. V., Zaitsev. A. S., Levchenko. N. N., and Nyadar. P. M., (2015). A Brief Review of Most Widely Used Modern Insecticides and Prospects for the Creation of DNA Insecticides. *Entomological Review.* 95(7): 824-831.

Chan. H. P. Jasmine, Shuhui Lim and WS Fred Wong. (2006). Antisense Oligonucleotides: From Design to Therapeutic Application. *Clinical and Experimental Pharmacology and Physiology*. 33: 533–540.

Nyadar. M. Palmah, Shyatesa Razo. (2019). DNA insecticides as an emerging tool for plant protection and food security strategies. *Journal of Agronomy and Animal Industries*. 14(2):105—113.

Nikita Gal'chinsky. *et al.,* (2020). A breakthrough in the efficiency of contact DNA insecticides: rapid high mortality rates in the sap-sucking insects *Dynaspidiotusbritannicus*Comstock and Unaspiseuonymi Newstead. *Journal of Plant Protection Research.* 60(2): 220–223.

Oberemok. V. V. *et al.,* (2019).Insecticidal activity of three 10–12 nucleotides long antisense sequences from 5.8S ribosomal RNA gene of gypsy moth *Lymantriadispar*L. against its larvae. *Journal of Plant Protection Research.* 59(4): 561–564.

UsenovZhevdetovichRefat.*et al.,* (2020). To bee or not to bee: creating DNA insecticides to replace non-selective organophosphate insecticides for use against the soft scale insect *Ceroplastesjaponicus*Green. *Journal of Plant Protection Research.* 60(4): 406–409.

Kawai-Toyooka, H., Kuramoto, C., Orui, K., Motoyama, K., Kikuchi, K., Kanegae, T., and Wada, M.(2004). DNA interference: a simple and efficient gene-silencing system for high-throughput functional analysis in the fern Adiantum. Plant and Cell Physiology, 45(11):1648-1657.

Wang, Y., Zhang, H., Li, H., and Miao, X. (2011). Second generation sequencing supply an effective way to screen RNAi targets in large scale for potential application in pest insect control. PLoSONE. 6 (4): e18644.

Article Id
AL04159

RECENT DEVELOPMENT OF NANOFERTILIZERS AND SUSTAINABLE AGRICULTURE

[1]Pradeep Jat*, [1]Shagolsem Chinglembi Chanu and [1]Sunny Raj Konsam

Email

pradeepjat1007@gmail.com

[1]School of Crop Improvement, CPGS-AS, CAU (Imphal), Umiam, Meghalaya-793103, India

Agriculture is a major economic sector related to the production and provision of a wide range of crops for food, feed, and ornamental purposes, and services to majority of the population of the world. The growing human population, with limited land and water resources put an immense pressure in agriculture sector for greater agriculture production. Chemical, natural or synthetic fertilizers have been an important input in agriculture for better plant growth and development boosting their yield and productivity. Since a very long time ago, farmers have been using agrochemicals continuously to provide macro- as well as micro-nutrients to crop plants. In soil these nutrients are present in an inadequate amount, so the existing production practices cannot fulfil the ever growing demand of food without relying on the extensive use of commercial fertilizers.

Nutrient use efficiency of conventional fertilizers by plants is very low. Not all applied fertilizers are used up by plants efficiently. Crop usage is generally less than half of the applied amount of fertilizer, some are lost in leaching, some by runoff and they will get accumulated in water bodies causing water pollution affecting the water and ultimately to land ecosystem; it also causes soil quality degradation, and hence causing imbalance in the environment. Higher cost input due to intensive use of fertilizers leads to increase in production cost and hence the market price of agricultural products. Numerous human diseases have also been reported due to consumption of excess N-compounds in the food we eat. Hence a number of environmentalists, consumers and scientists have developed great interest in the science and technology of fertilizers for their efficient utilisation with minimum negative effects. In order to maximize production of agriculture products with minimal fertilizer input while balancing the ecosystem and the environment, nano fertilizers come into light. A correct application of nano fertilizers can give nutrients to plants gradually in a controlled manner. Nano fertilizers are nutrients encapsulated/coated with nanomaterial

for the control and slow delivery of one or more nutrients in order to fulfil the essential nutrient requirements of plants. These, in several cases, are being considered to be the preferred form of fertilizers over the conventional ones at present. Nanomaterials, being highly reactive,interact with fertilizers resulting in an increased and effective absorption of nutrients by plants.

How are the Nanofertilizers Developed?

Nano fertilizers are prepared by methods such as adsorption, attachment on nanoparticles, entrapment of polymeric nanoparticles and encapsulation in nanoparticulate matters.The use of nano sized materials (1-100nm) for coating the fertilizer particles has various advantages like having large surface area, higher adsorption capacity, extra infiltration capacity, and its appropriate and controlled kinetics to deliver nutrients at targeted sites causing minimum loss of nutrients. To obtain the desirable effects from nano fertilizers, its formulations and delivery methods should be proper so as to facilitate the proper uptake of nutrients (Boehm *et al*. 2003). The nanoparticles such as carbon-based, metal oxides, and other nanoporous materials are used as the composition of nano fetilizers depending upon the combinational and compositional properties.

Nanofertilizers can be prepared by methods like biological, chemical(bottom-up), or physical(top-down) approaches. Non-hazardous, environmentally friendly procedure, such as green nanotechnology or bio-fabrication, can also be employed for preparation of nanofertilizers. The bottom-up method employs at the atomic or molecular scale to build up nanoparticles using chemical reactions. This method controls the particle size better and reduces impurities as it is a chemically controlled synthetic process. The top-down method is basically the reduction of size to nanoscale well organised assemblies from bulk materials. There are some natural sources for the biological synthesis approach, viz., plants, fungi and bacteria. The biological approach has greater control of the toxicity. The most effective approach used nowadays for nanofertilizer production is the chemical method. The use of different nanofertilizers including N, P, K, Fe, Cu, Zn, Mn, Moand carbon nano tubules have shown agreat controlled release for a targeted delivery. The nanoparticles used for encapsulating the chemical fertilizers are made from organic and inorganic nanomaterials. The inorganic nanomaterials include ZnO, TiO_2, MgO and AgO, and organic nanomaterials including lipids, polymers, and carbon nano tubules are used according to the chemical or physical methods to be employed. The nanofertilizers are classified based on the type of

nutrient present; micronutrient nanofertilizers and macronutrient nanofertilizers. The different types of nanofertilizers having different compositions of nutrients help improving the nutrient solubility, dispersal of insoluble nutrients, phyto-availability to the targeted plants minimizing the nutrient losses and high nutrient uptake efficiency.

Application in Agriculture

The nanofertilizers can be utilised in various ways in agriculture according to their properties including their efficiency, timely-controlled release, solubility, targeted delivery, stability, and less toxicity. The effectiveness of nanofertilizer is very much influenced by the mode of application. Nanofertilizers can be absorbed by crops through the roots or leaves. Two commonly used are, *in-vitro* and *in-vivo* methods. In *in-vitro* methods, the nanofertilizer application is done in aeroponics and hydroponics which are both soil less methods. In aeroponic solution containing nanofertilizers are sprayed in the form of mist to make it available near the floating root in air. The roots absorb the mist containing nanfoertilizers. In hydroponics, nutrient solutions are used for culture, and nanofertilizers are mixed in the nutrient solution to make it available to the plants through roots. *In-vivo* methods are of two types, foliar application and soil application. In foliar application, the nanofetilizers containing micronutrients are sprayed directly to the leaves, nutrients are uptake by the plants immediately after application. In soil application, the uptake of nanofertilizers at root level are influenced by various constraints such as nanoparticle size, acquaintance situations, plant structure, rhizospheric activities, and crop phenology. Soil applied nanofertilizers enter the roots through their surface and pass through a series of barriers before reaching the plant's vascular system. The size of nanofertilizers should be small enough to penetrate into the plant cells so that plants can get the nutrients sufficiently. Generallythe pore size of plant cell wall ranges from 3-8nm, the nanoparticles should be smaller than 8nm.

Among the essential plant nutrients, N, P, Mg, and K are the most crucial components required by the plant. They cannot be absorbed directly from the atmosphere, but they can be absorbed by plants through their roots. As a result, nanofertilizers has emerged as a solution to this problem.

Other applications of nanotechnology in the agriculture sectors include uses of nano-based herbicides, insecticides, pesticides, and fungicides also play a role in sustainable agriculture.

Risks associated with Nanofertilizers

As being a recently developed technology, the ethical and safety issues surrounding the use of nanoparticles in plant productivity are limitless and must be very carefully evaluated before adapting the use of the nanofertilizers in agricultural fields.Huge concerns were reported by researchers regarding the ill effects associated with the inappropriate use of nanofertilizers.

The extensive release of nanomaterials into the environment and food chain may pose a risk to human health. Although nanofertilizers use in agriculture is offering great opportunities to improve plant nutrition and stress tolerance to achieve higher yields with regards to climate change, not all nanomaterials will be equally safe for all applications. For sustainable crop production, nanofertilizers having potential of releasing nutrients as per plant requirements in temporal and spatial dimensions must be formulated. The risks of nanofertilizers should be carefully examined before use, and further biotechnological advances are required for a correct and safe application of nanomaterials in agriculture.

Conclusion

Inappropriate use of agrochemicals in agriculture causes soil fertility degradation, which in turn affects the plants and ultimately causing imbalance in ecosystem, *flora* and *fauna*. There have been environmental issues pertaining to rapid accumulation of agrochemicals in rivers, lakes and other fresh water bodies. A strategy to utilize fertilizers in an environment friendly way to improve agricultural production is to make use of nanotechnological tools and techniques. As we all know, nanofertilizers play an important role in crop protection as well as increasing their productivity in a sustainable way, use of organic manures and other organic farming methods with integrated use of nanofertilizers is still recommended. Numerous advantages of using nanofertilizers in crop production have been reported like the stability of crop growth, lesser fertilizer application hence lesser input cost, reduced nutrient loss through leaching or runoff, etc. Different nanomaterials have different impacts on plants viz., increase in germination rate, plant height, root development, antioxidants and chlorophyll content in leaves. Nanofertilizers have the advantage of controlled and timely release of nutrients to plants throughout their growth period over other forms of fertilizers. Nanomaterials are highly reactive as well as dispersive that they are easily absorbed through the cuticles in the leaves. But certain toxic impacts of nanotechnology in food industries and the environment need to be looked upon by future

researchers. Researchers also need to look for improving further technological advances in synchronizing the uptake of nutrients with their release according to plants requirement. Safety and ethical issues of using nanofertilizers, alongside their importance and advantages in agriculture need to be addressed during awareness programmes held at farmers' level.

References

Faisal Zulfiqar, Míriam Navarro, Muhammad Ashraf, Nudrat Aisha Akram, SergiMunné-Bosch, Nanofertilizer use for sustainable agriculture: Advantages and limitations, Plant Science, Volume 289,2019,110270. ISSN 0168-9452

Mathur, Sharmistha, ShaliniPareek, and DivyaShrivastava. "Nanofertilizers for Development of Sustainable Agriculture." *Communications in Soil Science and Plant Analysis* (2022): 1-18.

Kumar, Y. O. G. E. N. D. R. A., K. N. Tiwari, T. Singh, and R. Raliya. (2021). "Nanofertilizers and their role in sustainable agriculture." *Annals of Plant and Soil Research* 23, no. 3: 238-255.

Thavaseelan, Dinesha, and Gayan Priyadarshana, (2021). "Nanofertilizer use for sustainable agriculture." *J Res TechnolEng* 2, no. 1: 41-59.

Article Id
AL04160

INTEGRATED NEMATODE MANAGEMENT OF ROOT-KNOT NEMATODE

[1]Bablu Hrangkhawl, [1]Chingsubam Elvis Singh* and [1]Nungoileima Thoudam

Email

elvisch717@gmail.com

[1]College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University, Imphal, Umiam-793104, India

Integrated Nematode Management may be defined as the integration of management methodologies for all economically important nematodes of the agrosystem, with the objective of optimizing productivity, net returns, stability and environmental quality. It is widely accepted that a management strategy in which a variety of physical, mechanical, cultural, biological and chemical management measures are combined to give a stable, long term nematode management. The concept of integrated nematode control was proposed as early as 1933 by Tyler. The combination of two or more control strategies into an overall management programme is the only sound, sustainable approach to controlling root-knot nematodes effectively

Implementation of INM (Integrated Nematode Management) programme is based on the principles of nematode exclusion, population modifications and tolerance (Bird, 1981). The aim of INM is i) to utilize several compatible control techniques in combination, ii) to maximize natural environmental resistance to plant parasitic nematodes, iii) to apply specific and drastic control measures only as and when necessary, and iv) to maximize profit of the grower with location and resource specific recommendations. The requirements for integrated nematode management are the research, development, transfer of technology for implementation of combining different nematode management options in most effective manner (Bird, 1981). Therefore, the components of INM system includes (a) biological and environmental monitoring (b) agricultural production system, (c) pest crop ecosystem models and system design and implementation (Bird, 1981).

Host Range

M. graminicola, M. naasi, M. oryzae, M. salasi, M. triticoryzae etc. generally prefer cereal hosts but can also infect some dicotyledonous plants (Birchfield, 1965; Yik and

Birchfield, 1979; MacGowan and Langdon, 1989; Gaur and Sharma, 1999; Sabir and Gaur, 2005). The root-knot nematode, *Meloidogyne graminicola* prevalent in most of the rice growing areas of India. *Meloidogyne arenaria* and *M. javanica* are the most constraints to groundnut damage in Gujarat, India (P. Parvatha Reddy). *M. incognita* and *M. javanica* also known to infect in tobacco plants, grapevine. *M. incognita* also known to infect on cotton plants, banana, pomegranate, potato, tomato, brinjal, chilli, okra, French bean, cowpea, peas, carrot, biter gourd, pointed gourd, watermelon, crossandra, tuberose, patchouli, davana, cymbopogon, carnation, gerbera, Coleus forskohlii, Plumbago rosea, kacholam, colocasia, menthol mint, cardamom, betelvine, ginger, turmeric, coriander, cumin, fennel, black pepper (INM, P. Parthava Reddy). *Meloidogyne exigua* and *M. coffeicola* infect on *Coffea arabica*.

Management Strategies

1. Prevention

Preventing nematode problem is far better than trying to treat one after it is established because once a plant is parasitized it is impossible to kill the nematode without destroying the host.

Nematodes which occur throughout the state, may not occur in every site of the area, and it will be worth the effort to avoid bringing any pest into a previously uninfested field. For example, if peanut root knot nematode (*Meloidogyne arenaria*, *M. hapla*, *M. javanica*) is in one of the fields but not in the neighbouring field, we can avoid that serious pest problem into the uninfested field.

This strategy should be the first line of defense. Prevention is the practice of keeping a population of nematodes away from infesting a site and specific tactics include:

- Sampling of soils and plant parts of the suspected field or site to determine the population of existing nematode.
- Use of nematode free transplants or planting materials. Eg. Ornamental cuttings to be rooted should be taken only from uninfested plants or portions of plants above ground, which have never been rooted in a potentially contaminated soil. This prevents propagating populations of root-knot nematodes that might cause serious economic losses.
- Weed control as means of eliminating nematode access to alternate hosts

- Sanitation practices such as cleaning of equipment between sites of operation.

2. Avoidance

It is practiced when nematode populations exist in a site, but their impact can be avoided or lessened through some cultural practice. It includes

- Sampling to determine nematode species and population levels
- Choosing plant materials that are poor hosts.
- Practice crop rotations that include non-host, resistant, and susceptible crops when feasible.

3. Cultural Practices

- Crop Rotation with non-host crops(e.g., for rice rotate with crops like ragi, maize, sugarcane, pulses, castor, cowpea, sweet potato etc. at least for one year). For root-knot nematodes, a resistant cultivar of a susceptible crop can be used in rotation with a susceptible cultivar of the same or different crop in the same way as a non-host crop. Cotton may be used to reduce *M. javanica*, *M. arenaria*, *M. hapla* whereas alfalfa is used to reduce *M. incognita* and *M. arenaria* populations.

Table 1: List of some non/poor hosts of Root-knot nematode that can be included in croprotation (Plant Nematology, N.G. Ravichandra, Chapter 17)

Sl. No.	Target nematode	Non/poor hosts
1.	*Meloidogyne hapla*	Cotton, maize
2.	*M. incognita, M. javanica*	Peanut, mustard, marigold, onion, lucerne, garlic
3.	*M. nasi*	Potato
4.	*M. graminicola*	Potato, groundnut, black gram, wheat, sunflower, soyabean, onion, cauliflower, cowpea

- Summer ploughing 2-3 ploughings at 15-day interval could cause more than 70% reduction in nematode population density. The efficiency of summer ploughing is improved by polythene mulching that trap and retains solar heat for longer period, thereby reducing the population. Root-knot can be effectively control by this method.

- Rabbing is another method to raise root knot nematode free seedlings. After ploughing the nursery area to a fine tilth, a 15-20 cm thick layer of rice husk (20kg/sq.m) can be spread on the surface and burnt. The practice of rabbing tobacco seedbed with paddy husk reduces the root-knot nematode population.
- Flooding has long been practiced for the control of root knot nematodes; this practice may be uneconomical but effective against root knot nematodes on vegetables.
- Organic manuring-Incorporation of rice straw into the soil resulted in a significant decrease in the population density of root knot nematodes and improve the yield. Growing mungbean and ploughing back the green crop after picking pods significantly reduced the infestation in subsequent rice crop. Green manuring by growing and ploughing back *Sesbania aculeate* or *Sesbania rostrata* also reduced the population. Chopped pineapple leaves, *Sorghum vulgare*, Neem leaves, water hyacinth, decaffeinated tea waste, chrysanthemum can also be used.
- Adjustment of sowing/planting dates and season- The planting of winter annual crops, usually in autumn, can be delayed until soil temperature has declined, to avoid nematode activity. Thus if a host crop of *M. incognita* is planted after the soil temperature has declined below 18ºC, the plants will escape the infection**.**

4. Trap Crops/ Antagonistic Crops

In plants like Crotolaria, the root knot nematodes invade but fail to reach maturity. Such plants can be used to trap the nematode juveniles before planting the actual crop.

On the other hand, antagonistic crops (enemy crops) which contains some chemicals or alkaloids can be used to repel or suppress the nematode.

Table 2: Important plant possessing nematicidal effect on Root-knot nematodes. (Plant Nematology, N.G. Ravichandra, Chapter 17)

Sl. No.	Scientific name	Common name	Plant part
1	*Tagetes* spp.	Marigold	Root
2	*Azadirachta indica*	Neem	Seed, leaf
3	*Brassica* spp.	Mustard	Seeds
4	*Lantana camara*	Lantana	leaves

5. Host-Resistance

Some root knot nematode resistant lines/cultivars reported from India

- **Tomato**: Karnataka hybrid, Hisar-1, Hisar-N-2 &3, Mangla Hybrid, Hisar Lalit
- **Pea**: C-50, A-70, B-58
- **French bean**: Banat, Blue Lake, Brown beauty, Cambridge
- **Rice**: Badami, Neela, Bhanja, KAU-28-1-1,
- **Groundnut**: Ambali 4018
- **Coffee**: Coffea robusta, C. arabica
- **Potato**: Kufri Deva
- **Chilli**: Pusa jwala, Pusa sadabahar, ca-63
- **Okra**: Arka Anamika
- **Tobacco**- Motihari, Bitri, Hepti

6. Biological Control

Organic amendment of root knot nematode infested soil is highly effective due to their nematoxicity, imparting tolerance to plants and encouraging build-up of natural antagonists. However, requirement of very high dosages and cost considerations deter their use at field scale. Nevertheless, products like Neem cake, Neem seed extract, Lemon grass oil etc can be used for nursery bed treatment, spot application and basin area treatments in different crops.

Oviparasitic fungi, *Paecilomyces lilacinus* and *Pochonia chlamydosporia*; and a bacterial parasite, *Pasteuria penetrans* are promising biocontrol agents. Bacterium *Pseudomonas fluorescens, Bacillus thuringiensis* and fungi like *Trichoderma harzianum* and *T. viridae* have also been found effective.

7. Chemical Control

Nematicides are generally not recommended, particularly in vegetables crops, in view of their high cost and residue problem in fruits. However, intensive cultivation of high value susceptible crops makes their use unavoidable. The following methods are recommended for judicious use of nematicides

- Treatment of nursery bed alone with carbofuran @3kg a.i. per hectare in case of transplanted vegetable crops at sowing.
- In case of bold-seeded crops like okra cucurbits, cowpea etc, seed dressing with carbosulfan @ 2-3% W/W
- Seedling root dip treatment of vegetables crops in thionazin 500 ppm for 15 mins or carbosulfan 1000 ppm for one hour.
- All these practices are very effective to give initial protection to the young vulnerable stage of crop.
- In case of grapevine, application of carbofuran @4kg a.i. perhectare just before pruning is highly effective.
- For *M. graminicola* infecting rice, nursery bed treatment with carbofuran @ 0.1 g a.i per sq.m and field application of carbofuran @1kg a.i per ha 40 days after transplanting rice helps in checking the disease. Soaking of rice seeds in 0.1 percent solution of carbosulfan 25 EC is also effective.

Conclusion

Once an area has been infested with root knot nematode systemic adoption of INM is necessary. The great challenge is to control the nematodes in soil and root tissues. Therefore, no single method maybe sufficient to avoid significant damage due to root knot nematode. Depending upon the crop, a combination of two or more practices can be employed to raise successful crops in infested areas. Developing resistant cultivars, they can be incorporated in the rotation/succession are highly encourage especially for *M. incognita*. Also, the search for nematicides with greater control efficiency is needed. New registration for safer nematicides have increased in the recent years, and this trend will increase in view of the worldwide for less toxic pesticide. In addition, the use of biocontrol fits perfectly in INM, which further favours the scenario of root-knot nematodes in the coming years.

Reference

"P. Parvatha Reddy, Ganguly et al.INM in vegetable crops"

"P. Parthava Reddy. Introductory Plant Nematology"

"N.G. Ravichandra. Plant Nematology"

"Raman K. Walia and Harish K. Bajaj. Textbook of Introductory Plant Nematology"

"Pedro Luiz Martins Soares and Daniel Dalvan Nascimento.*Integrated Nematode Management of root lesion and root-knot nematodes in soybean in Brazil*"

"Abhijit Chetia, Priyanka Gogoi, Pallabi Roy and Madhumita Goswami. *Antagonistic plants as a tool of nematode management*"

"Tushar K. Dutta*, Ajoy K. Ganguly and Hari S. Gaur. Global status of rice root-knot nematode, *Meloidogyne graminicola*."

Article Id
AL04161

MYCOMEDICATION

[1]Ranjan Kumar, [1]Shruti Sinha, [1]Om Prakash* and [1]Abhipsa Subhadarsini

Email

omprakash.nayaganj@gmail.com

[1]Department of Plant Pathology, School of Crop Protection, College of Post Graduate Studies in Agricultural Sciences, CAU (Imphal), Umiam, Meghalaya-793103, India

Mycomedication means "use of fungus as medicine" which is also known as myco medicine. Mycomedicine is a special class of medicine, which is used mainly in Asian countries for many years. It is composed of spores, fruiting bodies, or other tissues as well as biochemical compounds like polysaccharides, and triterpenoids extracted from medicinal fungi.

In the late 19th century, the discovery of penicillin by Alexander Fleming from *Penicillium notatum* focused on the use of fungi and their extracts as a medicinal value in front of the world. There is a huge potential in medicinal fungi to enhance the immune responses of an individual with various mechanisms like inducing apoptosis, autophagy, and reduction of metastatic potential.

There are lots of fungi that are used for medicinal properties such as *Auricularia delicata, Ganoderma sp., Pleurotus tuber-region, Lentinus velutinus, Pycnoporus sanguineus, Schizophyllum commune, Daldinia eschscholtzii, Inonotus obliquus, Piptoporus betulinus, Trametes versicolor, Fomes fomentarius, Fomitopsis pinicola, Trichaptum pergamenum, Stereum subtomentosum, Grifola frondosa, etc.*, possess wide range bioactivities, e.g., antiviral, antifungal, antibiotic, anticancerous, anti bacterial, anti-inflammatory, and in cardiovascular disorders.

Antiviral Activities by Medicinal Mushrooms

- Laccase (LAC) is a low molecular substance extracted from the medicinal mushroom *Tricholoma giganteum* which inhibits the RT activity of HIV-1. LAC is

Fig1:-*Ganoderma lucida*

extracted from lots of other mushrooms like the dried fruiting body of *Hericium erinaceus*, and the fruiting body of *Pleurotus eryngii*, *Ganoderma lucidum*, and *Lentinus edods.*

- The lectin extracted from the toxic *Pholiota adiposa* and *Inocybe umbrinella*, *The Schizolysin*, a hemolysin extracted from *Schizophyllum commune*, and hemagglutinin extracts from *Cordyceps militaris*,are known to inhibit the inhibitory activity of HIV-RT.

Fig2:-*Fomes fomentarius*

- Lake Sinaivirus (LSV)and Deformed Wing Virus are the diseases of honey bees and these diseases are controlled by the use of extracts from both medicinal mushrooms like *Fomes fomentarious* and *Ganoderma lucida.*

Anti Bacterial Activity of Medicinal Mushrooms

Ganoderma mushroom species show antibacterial effects on both Gram Positive as well as Gram Negative bacteria. The mycelial extracts of this fungi possess antibiotic activity against different strains of bacteria such as *Bacillus subtilis*, *Bacillus cereus, Staphylococcus aureus, E. coli, Salmonella spp*. The extracts of *Ganoderma lucidum* in combination with 4 Antibiotics i.e. ampicillin, cefazolin, chloramphenicol, and oxytetracycline shows combine effects on bacteria and are found more effective to decrease the growth of bacterial cells.

Anti protozoal Activities of Medicinal Mushroom

Protozoa are unicellular, nucleated organisms generally associated with animal cells. It is responsible for causing Malaria disease in human beings. It has many species (*P. vivax, P. falciparum, and P. malaria*e) which affects the animal cells and leads to sickness. Interestingly, extracts from Ganoderma lucidum show inhibitory effects against *Plasmodium falciparum*as well.

Fig3:- *Cordyceps mortierella*

Fig4:-*Armillaria mellea*

Anti-Inflammatory Activities of Medicinal Mushrooms

Inflammation is the complex biological response of the immune system to harmful stimuli, from infection, damaged cells, or irritation. Macrophages play a crucial role

during the inflammatory process by engulfing apoptotic cells and pathogens and secreting immune effector molecules. The control of the overproduction of inflammatory molecules by macrophages should greatly facilitate the treatment of inflammatory diseases such as rheumatoid arthritis, septic shock, and autoimmune diabetes. There has recently been increased interest globally in identifying anti-inflammatory components/compounds that are pharmacologically potent and have few or no side effects for use in preventive medicine. Medicinal mushrooms, most of which belong to higher Basidiomycetes, are species used or studied as possible treatments for disease. The anti-inflammatory compounds like chloroform, ethyl acetate, methanol, and n-hexane are extracted from the mycelium of five important medicinal mushrooms *Cordyceps mortierella, Armillaria mellea*, *Cephalosporium sinensis*, *Ganoderma lucidum*, and *Hericium erinaceus* are being used widely. The chloroform extracted from *H. erinaceus*and *Armillaria mellea*, Ethyl acetate extracted from *A. mellea*, n-hexone, ethyl acetate, chloroform, and methanol extract from *C. sinensis*, *G. lucidum*, and *Cordyceps mortierella*. The chloroform among all is the most effective inhibitor of inflammatory substances.

Antioxidant Activity of Medicinal Mushrooms

Fig5:-*Inonotus obliquus*

Fig 6:-*Piptoporus betulinus*

Nowadays, biologically active substance is a major issue in the pharmaceutical industry. Although higher fungi have a wide range of secondary metabolic pathways, they have been less studied as a potential source of BAS than plants. The Chaga mushroom (*Inonotus obliquus*), is traditionally used as medicine in Russia. It has been used for a long as an anti-inflammatory and anti tumor agent and has also proven pronounced anti cancer and immunomodulatory effects. In China and Japan, the reishi (also known as lingzhi) mushroom (*Ganoderma lucidum* (Curtis) P. Karst) is widely used for medical treatment. It has been shown that fruiting bodies of Ganoderma contain high concentrations of steroids and triterpenes (triterpenic acids and alcohols), which have a pronounced anticancer effect. A report from Japan shows that extracts of glycoprotein from biotechnologically cultivated Trametes versicolor (L.) Lloyd has got anticancerous properties. Extracts from P. betulinus fruiting bodies were rich in free amino acids and showed high antiradical and antioxidant activity.

The xylotrophic fungi species growing on birch are potential natural sources of antioxidants and free amino acids.

Anticancer Activity of Medicinal Mushrooms

Naturally obtained products are playing a major role not only in health promotion and disease treatment but also in drug discovery and development these days, especially in the area of cancer and infectious diseases. Medicinal mushrooms are a large group of organisms that are extensively used as antiviral, antimicrobial, anti-inflammatory, antihyperglycemic, and anti cancer compounds. Ganoderma lucidum, as already been discussed in the last section, has been used in traditional Chinese medicine as a medicinal mushroom for many years for the prevention and treatment of various human diseases, including chronic bronchitis, hepatitis, hypertension, hypercholesterolemia, immunological disorders, and cancers. The major bioactive ingredients in Ganoderma lucidum are polysaccharides, ganoderic acid (triterpene), and adenosine. Ganoderma lucidum possesses biological activity and is of therapeutic application, while ganoderic acid possesses anti-tumor and anti-HIV-1 activities, in addition to other biological activities including facilitating histamine release, cytokine production, and immunomodulatory activity. Ganoderma lucidum is the most well-studied member of the Ganodermataceae family. Amauroderma is another member of the same family, widespread in tropical areas, and contains about 30 species. Among them, Amauroderma rude is a newly described fungus in 2007. This mushroom is brown with concentric zones of varying shades on the cap and possessed the highest activity in inducing cancer cell death.

Conclusion

Medicinal uses of traditional and natural products have long been applied in Asian countries but have been primarily dependent on ancient experience and evidence. Ever since the development of the famous fungal extract, penicillin, and the notable 2015 Nobel Prize for the discovery of artemisinin from traditional Chinese herbs, a growing body of research has acknowledged the potential pharmacological and beneficial effects of these natural-based products. Mycomedicine, which consists of all macroscopic fungi, medicinal mushrooms, and their extracts or powders, contributes an enormous source of food and health supplements for humans, with presents numerous benefits, including anti-cancer, antibacterial, and anti-inflammatory properties. Despite promising advantages, several obvious limitations need to be resolved. First, aside from the widely documented anti-cancer components of myco

medicine, the exact structures and anti-neoplastic functions of numerous bioactive have not been extensively explored. More importantly, the amount of these pharmaceutically active compounds isolated from Mycomedicine is usually extremely low, with extraction procedures being costly and time-consuming. Thus, in this regard, improving the extraction methods and purification protocols could be a practical strategy to enhance production. Lastly, although medicinal mushrooms are superior in terms of their safe application and less severe side effects to humans, their efficacy is usually lower than that of synthetic agents. This vital weakness leads to the phenomenon that Mycomedicine is consistently regarded as an adjuvant rather than a main therapeutic approach for treating diseases, including cancers. Having a tremendous reservoir of pharmacologically active chemical compounds, Mycomedicine deserves further development, and in-depth studies should be conducted to reveal the mechanisms of action of this "superfood" in treating various diseases.

References

Aoki, M., Tan, M., Fukushima, A., Hieda, T., Kubo, S., Takabayashi, M., Ono, K., Mikami, Y.(1992). Antiviral Substances with Systemic Effects Produced by Basidiomycetes such as *Fomes fomentarius*. *BiosciBiotechnol Biochem*.,57(2):278-82.

Geng, Y., Zhu, S., Lu, Z., Xu, H., Shi, JS., Xu, ZH. (2014). Anti-inflammatory activity of mycelial extracts from medicinal mushrooms. *Int J Med Mushrooms*. 2014:16(4):319-25.

Jiao, C., Xie, Y.Z., Yang, X., Li, H., Li, X.M., Pan, H.H., Cai, M.H., Zhong H.M, Yang, B.B. (2013). Anticancer activity of *Amauroderma rude*. *PLoS One*., 20:8(6):e66504.

Article Id
AL04162

NUTRITION SENSITIVE AGRICULTURE

[1]Vaishnu Rai* and [1]Sharmistha Swayamprava

Email

vaishnurai96@gmail.com

[1]School of Social Sciences,
CPGS-AS, CAU (I), Umiam, Meghalaya-793103, India

Malnutrition is a serious concern which we are facing all over the world.It includes stunting, underweight and wasting. The data released by Joint Child Malnutrition Estimates in 2021 shows us that around the globe, 149 million children under five are affected by stunting, while 39 million children under 5 are overweight, and 45 million children are affected by wasting. According to the Global Hunger Index (2021), India ranks 101 out of 116 countries which pushes India into the 'serious' category. Based on the National Health Survey (2019-2021),59.1% of women and 31.1% of men between the age of 15-19 years are anaemic in India. The Women and Child Development Ministry estimates that there are 17.76 lakh severely acute malnourished children and 15.46 lakh moderately acute malnourished children across the country.

How to Combat Malnutrition and to Promote Good Health Among People?

Nutrition Sensitive Agriculture (NSA) is one such approach which is focused on growing crops which are rich in nutrition in order to support good health, and eradicate hidden hunger and malnutrition. Proper nutrition has an important role in health and development. For achieving their full potential, a person needs to consume a diet which is healthy and diverse in nature (legumes, tuber crops, nuts, vegetables, fruits, meat, etc.).Agriculture is the source for all meals we enjoy at our dinner table. Food, agriculture, nutrition and health go hand in hand. Therefore, exploring NSA will help us to meet the dietary needs of the population of all age groups. NSA includes:

1. **Diversification of crop and diet** -- In simple terms, it means growing various kinds of crops in our fields. Each and every crop provides us with different micronutrients, for example, leafy green

Courtesy: pngkey.com

vegetables are a rich source of calcium and iron. Likewise, Cole crops like cabbage and cauliflower are rich in vitamin A, C and K. Diversifying our crops will help us to put nutrient rich food on our tables.

Courtesy: clipground.com

2. **Cultivation of Biofortified crops**--It is the process of enriching the micronutrient content of food crop through genetic modification or selective breeding. These crops have more micronutrients when compared with the traditional varieties of the crop. An initiative by ICAR-CTCRI Kerala under the name 'The Rainbow Campaign' was started to scale up biofortified sweet potato to combat nutrition deficiency (vitamin A) in North Eastern region of India. The main aim of the campaign was to promote tuber crop-based rainbow diet. In Maharashtra, school children were given Iron-rich Pearl Millet which led to a reduction in Iron deficiency in less than 6 months.

Courtesy: Clipground.com

3. **Livestock rearing and fish farming**-- Micronutrients like vitamin A,B_{12}, D and minerals are abundant in milk, eggs, meat, etc., consumption of which will lead to a reduction in hidden hunger.

4. **Establishing Nutri-gardens**-- It involves growing nutrient-rich crops in order to make sure that there is year-round availability of diverse and healthy crops. These crops are grown organically and promote good health.

Courtesy: Foodandhealth.com

Nutrition Sensitive Agriculture aims at uplifting poor households by providing them with proper nourishment, encourages gender equity and also imparts nutrition education. An awareness and understanding on nutrition can increase the production of nutrition rich crops. As people become more aware and nutrition sensitive, the demand for these crops will increase too which will in turn lead to an increase in income of rural households. In India and also in most parts of the world, women are seen as the homemaker and the caregiver in a household, therefore, their participation in agriculture activities and their empowerment is an absolute necessity. Women empowerment can be done by supporting them with credit and providing income-generating opportunities. Through this, they will be able to look after their own nutrition requirement as well as their child's

requirement. While going for Nutrition Sensitive Agriculture, several activities must be taken into consideration like upgrading storage facilities for harvested crops. Also, processing and preservation techniques should be scientific and improved in order to preserve the nutritional benefit. Efforts should also be directed towards how to decrease post-harvest losses and food safety measures must be taken into consideration. There are several schemes which encourage Nutrition Sensitive Agriculture. These include National Food Security Mission, National Nutrition Mission, Poshan Abhiyan, Mid-Day Meal Scheme, Integrated Child Development Scheme, Food for Work programmes and many more.

Conclusion

Many advancements have taken place in the field of Agriculture and nutrition over the past several years. Applying the accumulated knowledge in the field level is an important challenge as well as a necessity if, we want to further develop Nutrition Sensitive Agriculture. Overcoming malnutrition and nutrition deficiency is possible only if we focus on growing crops which are rich in nutrition. Both 'quantity' and 'quality' should be given equal priority and attention while producing food for the population. Only eradicating hunger is not sufficient but hidden hunger must also be addressed and steps must be taken to overcome malnutrition deficiency. Policies must be favourable towards Nutrition Sensitive Agriculture if we want to achieve sustainable goals in the near future.

References

Global Hunger Index- Peer reviewed annual publication2021.

DLG-Verlag GmbHFrankfurt, Germany (2016). Nutrition Sensitive Agriculture. *Rural 21 – The International Journal for Rural Development.***50:**1866-8011.

Ruel, Quisumbing, Balagamwala. (2017). Nutrition-Sensitive Agriculture What Have We Learned and Where Do We Go from Here?.*International Food Policy Research Institute*.

Tafesse K. *ALIVE & THRIVE.ORG*. Retrieved June 27, 2022,

Paramasivan,S.S., Kumar, H.K., Immanuel, S. (2020). RAINBOW DIET CAMPAIGN: An Extension Strategy for Scaling up Biofortified Tuber Crops Varieties. *ICAR – Central Tuber Crops Research Institute.*

Article Id
AL04163

A GUIDE TO MILKY MUSHROOM CULTIVATION

Dumpapenchala Vijayreddy

Email

dpvijayreddy@gmail.com

School of Crop Protection, College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal), Umiam, Meghalaya, India

Agri-business solutions that are commercially, technically, and economically viable must be adopted by the agriculture sector in India. This is because of the recent changes in consumer behaviour, which have increased demand for high-quality niche products(Shirur *et al.,* 2016). Mushroom cultivation is one of the most profitable Agri-business industries. Mushrooms are increasingly being regarded as a future vegeta ble due to their medicinal and nutritional properties, and consumer demand also increased significantly in recent years. Because they are so easily digestible, mushrooms are being considered as a possible alternative to muscle protein(Pavel, 2009) and are a great source of vitamin-D, which is not available in other food supplements (Pehrsson *et al.,* 2003). The large-scale recycling of agricultural waste in India may benefit from microbial technology. Milky mushroom (*Calocybe indica*) is becoming more popular due to its strong, fleshy, and milky white sporophore. It gives people access to an additional high-quality vegetable and enriches their diet (Vijaykumar *et al.,* 2014).

Milky Mushroom

Classification	
Kingdom	Fungi
Division	Basidiomycota
Class	Agaricomycetes
Order	Agaricales
Family	Lyophyllaceae
Genus	*Calocybe*
Species	*indica*

Milky Mushroom

Scientifically it is known as *Calocybe indica* and belongs to the family Lyophyllaceae. It is also called as swetha mushroom due to its pure white in appearance. It was formally described in 1974 based on the data gathered in Calcutta. Botanists R. P. Purkayastha and Aindrila Chandra observed it to be a popular mushroom in West Bengal markets. It has a firm consistency. It grows well in hot and humid climates. It can be grown

throughout the year when conditions are favourable. It is an excellent edible mushroom with high fibre content.

Status of Mushroom Production

- There are mainly 5 mushroom species are grown in India, they are milky mushroom (*Calocybe indica*), oyster mushroom(*Pleurotus spp*), white button mushroom(*Agaricus bisporus*), paddy straw mushroom(*Volvariella volvaceae*), shiitake mushroom(*Lentinula edodes*) (sharma *et al.,* 2017).
- Milky mushroom is indigenous tropical mushroom of our country (Kumar *et al.*, 2017). However, their production is commercially restricted to south Indian states and contributing up to 3% to the total mushroom production (Sharma *et al.,* 2017).

Scope and Importance

Milky Mushroom has excellent medicinal properties. They are high in nutrients and a source of revenue for Indian markets. It can be used for treating diabetes and joint pain. It has high fibre content and used by constipation patients to promote free bowel movement. It is also high in protein and amino acids. It also offers numerous job opportunities. After paddy straw, the milky mushroom is the second most common tropical mushroom.

Nutritional value (on dry weight basis)	
Carbohydrates	64.26%
Protein	17.2%
Fat	4.1%
Vitamins	Vit-A, Vit-C, Vit-E and Vit-D
Minerals	Ca, K, Mg, Na, P, Cu, Fe, Mn and Zn
Crude fibre	3.4%
Soluble sugars	4%
Starch	2.9%

Source: Kumar *et al.*, 2017

Cultivation of Milky Mushroom

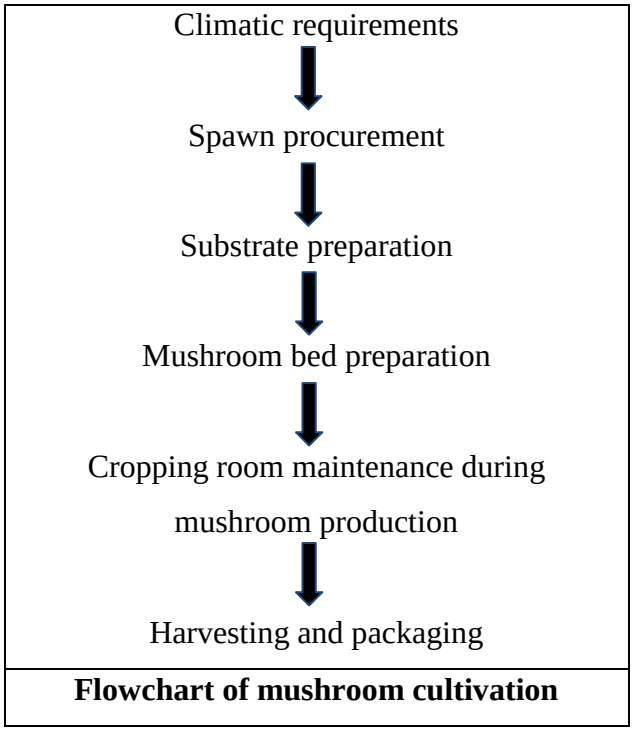
The cultivation of milky mushroom includes following steps:

1) Climatic requirements

They mainly gives good yield at mild hot and humid climatic areas.The most suitable temperature for growing mushrooms is25^0-35^0 C and the relative humidity of 85-90%. Total life cycle completes in between 40-45 days under ideal conditions when the climatic conditions are not favourable, then there is a delay of 5-10 days.

2) Spawn Procurement

Spawn is the basic most seed material for growing mushroom. Elite spawn should be selected for mushroom cultivation. Good quality spawn will give good yield and care should be taken that the spawn is not contaminated. Spawn should be milky white in color with uniform appeal. Discoloured or dull coloured spawn should be avoided and not to be used for cultivation. Spawn can also be produced from the mother spawn under controlled conditions.



Flowchart of mushroom cultivation

3) Substrate Preparation

- **Chaffing**

For chaffing, the substrates used are paddy straw and wheat straw, mainly paddy straw is used. Paddy straw of less than 1 year age should be selected for cultivation because as it is fresh with good amount of storage materials. The selected paddy straw should be of good quality and it should be devoid of any type of weeds. Chaff cutter can be used for chaffing of paddy straw into fine and uniform pieces of 5-6 cm.

- **Straw Sterilization**

After chopping of paddy straw, it should be sterilized and it is done by two methods.

I. Chemical Method

In this method nearly 125 ml Formalin and 8 g Bavistin diluted in 100 lit water containing drum to sterilize 15 kg of paddy straw. Straw should be soaked in this solution for about 24 hrs or soaked overnight. After soaking water should be drained and the paddy straw is spread on tarpaulin sheet for drying under sunlight. The straw should be dried to retain 30-50% moisture for filling the bags.

II. Autoclaving

Substrate is filled in polypropylene bags and sterilized in an autoclave at 121^0 C at 15lbspsi for 15-20 minutes. Once it is completed then bags containing straw are shifted to spawning room for cooling, bag filling and spawning.

- **Draining and Drying**

Straw has to be taken out from the drums and drained for removal of excess water. Then straw has to be allowed to dry up till to get required moisture for bed preparation.

4) Mushroom bed preparation

Spawn filling should be done in polythene bags of 12x22, 14x20, 16x20 inches. Size is based on availability and with a thickness of 120 gauge. Open end of the bags is closed by Rubber band after its proper packing small holes were made for aeration.

A layer of spawn should be filled in polybag and is covered by 2^{nd} layer of paddy straw. Another layer of spawn is placed on paddy straw which is again followed by layer of paddy straw in the process of bedding 5–6 layers of paddy straw and spawn was filled in polythene bag and the thickness of paddy straw should be around 5-7 cm. Label the mushroom beds and place them in incubation chamber (dark room) and should be monitored regularly.

5) Cropping Room Maintenance during Mushroom Production

- **Incubation in the dark room**

The inoculated labelled beds were kept in a dark room over a period of 20-25 days. The average temperature has to be maintained at28^0-35°C and optimum humidity of 80% to get good yields.

- **Casing**

After 21 days, when the mycelial growth developed fully then the beds have to be shifted into the light room for casing.The beds used for casing has to made into two equal halves. Casing can be laid by using black or red soil and they have to be sterilized with either formaldehyde or solar sterilization. The layer thickness of the black or red soil has to be around 2-3cm.

- **Incubation in light room**

The beds will be then shifted to light room after casing for the further growth of mushrooms. Proper lighting facilities and aeration has to be provided. If there is no proper light facilities available then artificial light has to be provided.

- **Watering**

The beds are sprinkled with water every day in order to avoid drying. Care should be taken while watering, excess watering should be prevented as it allows the growth of contaminants/disease causing organisms. Poor moisture content leads to cracking of mushroom caps.

- **Fruiting**

After 12-14 days of casing, mushroom starts attaining pin head stage and the formed small pin head sized fruiting bodies will attain the harvestable size within 4-7 days.

6) Harvesting and Packaging

Mushrooms with 6-8 cm diameter caps are harvested by gently twisting them in clockwise direction with hand. Harvested mushrooms should be neatly packed. Fresh mushrooms should never be kept in plastic bags, as this accelerates deterioration.

Mushrooms can be stored for 2-3 days under normal conditions and under refrigerated conditions it can be stored for 4-7 days.

Pre-Requisitesin Mushroom Cultivation

- Hygienic conditions should be maintained.
- Maintaining the incubation rooms with optimum humidity and regular sprinkling of water on beds to avoid drying.
- Hand gloves and face masks should be used while preparing beds or any other type of activity in mushroom unit andfoot dip should be done before entering into mushroom unit.
- Paddy straw should be soaked in water which is mixed with Bavistin and formalin and it should not be dried on the ground, it should be dried on the tarpaulin sheet.
- Entire mushroom unit should be sprayed with insecticide Malathion and some disinfectants and the unit should be sterilized properly.

Conclusion

Mushroom cultivation can be a highly profitable source of income with little investment. They can be commercially cultivated round the yearin humid tropical and subtropical regions of the world with average temperatures between 25^0C and 35^0 C and these conditions are highly suited for their production (Navathe *et al.*, 2014). It can also be cultivated in the backyard of house by maintaining even in a small room. They aremore popular on the global market because of its morphological appearance, longer shelf life, higher productivity, white colour, and low production cost. The mushroom resembles the button mushroom, which might once more aid in increasing global demand for this particular mushroom.Besides being commercially viable, it can also help in maintaining good health being endowed with proteins, vitamins and minerals. Owing to its numerous benefits, profitability and easy cultivation, milky mushroom cultivation can be a potential source of income generation cultivation.

References

Kumar, S., Sharma, V.P., Shirur, M., and Kamal, S. (2017). Status of milky mushroom (*Calocybe indica*) in India – a review. *Mushroom Research*, 26(1): 21-39.

Navathe, S., Borkar, P.G., and Kadam, J.J. (2014). Cultivation of *Calocybe indica* (P & C) in Konkan region of Maharashtra, India. *World Journal of Agricultural Research*, 2(4): 187-191.

Pavel, K. (2009). Chemical composition and nutritional value of european species of wild growing mushrooms: a review. *Food Chemistry*, 113(1): 9-16.

Pehrsson, P.R., Haytowitz, D.B., and Holden, J.M. (2003). The USDA's national food and nutrient analysis program: update 2002. *Journal of Food Composition and Analysis*, 16: 331-341.

Sharma, V.P., Annepu, S.K., Gautam, Y., Singh, M., and Kamal, S. (2017). Status of mushroom production in India. *Mushroom Research*, 26(2): 111-120.

Shirur, M., Shivalingegowda, N.S., Chandregowda, M.J., and Rana, R.K. (2016). Technological adoption and constraint analysis of mushroom entrepreneurship in Karnataka. *Economic Affairs*, 61(3): 427-436.

Vijaykumar, G., John, P., and Ganesh, G. (2014). Selection of different substrates for the cultivation of milky mushroom (*Calocybe indica* P & C). *Indian Journal of Traditional Knowledge*, 13(2): 434-436.

Article Id
AL04164

CATALYZING INDIA'S AGRICULTURE THROUGH DIGITALIZATION

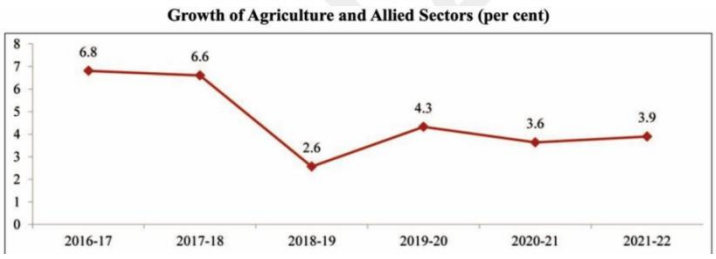
[1]Ashrini Borah* and [1]Bhabna Talukdar

Email

borah.mxn222@gmail.com

[1]CAU(I), CPGS-AS, SSS, Umiam, Meghalaya, India

As digital awakening sets in, India is touching heights for different courses of opportunities and challenges in progress towards digitalization. Digital India week 2022 programme has clearly demonstrated the importance of digital platforms which have sorted ease of life to citizens. Digital India aims to provide the much needed push in the field, namely agriculture, highways, e-governance, broadband, public interest access programme etc. The agriculture and allied sectors grew at a positive rate of 3.6 per cent during 2020-21 and 3.9 per cent in 2021-22 with GVA in agriculture 18.8 in 2021-22.



Source: First Advance Estimates of National Income, 2021-22

A considerable amount of progress can be seen in agriculture sector due to intervention of government policies, strategies and improved farming technology and recent incorporation of digital technology in farming has led to acceleration in the growth of agriculture.

The Ministry of Agriculture & Farmers Welfare aims to improve **awareness**, **knowledge** and **efficiency** of farmers. The former Information Technology Division was reoriented to become the Digital Agriculture Division with the overarching objective of raising farmers' incomes in mind and in accordance with the suggestions of the Doubling of Farmers Income (DFI) committee.

Further Steps Taken by Government are as Follows

1. Kisan Drones
2. Remote sensing
3. IDEA concept
4. KCC
5. Farmer's Portal
6. Mobile Apps
7. M kisan

1. Kisan Drones

Kisan Drones will be **used to boost the agricultural sector** in the country which use of will be promoted for crop assessment, digitization of land records and spraying of insecticides and nutrients. However, the Kisan Drone Suvidha has added a new chapter in the farming sector and it will prove to be a milestone for drone technology. Prime minister in the budget 2022 introduced off "Drone Kisan Yatra" to promote chemical-free farming in India to ensure inclusive drone improvement. This year guidelines of the "Sub-Mission on Agricultural Mechanization" (SMAM) scheme was incorporated in a move aimed at making drones more accessible to the farmers.The Kisan drone will have an unmanned tank filled with insecticides and nutrients. They are expected to have a high capacity of 5 to 10 kg. The drone will spray the same amount of pesticide on about one acre of land in just 15 minutes. Time will be saved, less work will be needed, and spraying will be done consistently. They will also be utilized to transport produce from farms, such as fruits, fish, and vegetables, to markets. Farmers and fishermen will make more money because these products will be delivered directly to the market with little to no harm and in a shorter amount of time. Thus this initiative under digital India will increase the efficiency of production in the agricultural sector in India.

Recent example: Drones are being used in India to combat locust infestations, which have been regularly assaulting and ruining sizable portions of the country's crops since the winter of 2019–20. Drones are being used by the agriculture ministry's at both the federal and state levels to spray for locusts. In an otherwise difficult situation when India faces significant crop losses in the states of Rajasthan, Gujarat, Madhya Pradesh, and Uttar Pradesh, they are proving to be an efficient answer.

2. Remote Sensing Application in Agriculture

The remote sensing technique is used in Crop production forecasting, Assessment of crop damage and crop progress in the field of Horticulture, Cropping Systems Analysis, to know the Non-point source of pollution, to study the Impact of Climate Change on Agricultural System, to study Biophysical parameter retrieval and process modelling and in Demonstration of technique for forewarning Pests and Diseases. However, remote-sensing technology provides many advantages over the traditional methods in agricultural resources survey In crop classification, crop monitoring and yield assessment of crops. Remote sensing plays a role in Assessment of vegetation cover, in nutrient use and requirement of water status, especially in semi arid and arid areas, identification of weed and its management, crop-evapotranspiration status, pest and disease infestation status. Thus , with the help of digitalization in India we are able to reinforce the technology of remote sensing in future analysis of agricultural sciences. The Ministry of Agriculture and Farmers' Welfare (MoA&FW) effectively uses satellite remote sensing to gather crop statistics data required for the planning and decision-making of agricultural inputs. In comparison to conventional methods, remote sensing data has a number of benefits, including quicker decision-making processes, better coverage, and economic gains. Numerous crucial parts of crop production use space data.

For the best crop cutting experiment (CCE) plan and improved yield estimates using high-resolution remote sensing photos from satellites and UAVs, the MNCFC launched the "KISAN" (Farmer) project in 2015. A number of variables, including the sowing date, NDVI (Normalized Difference Vegetation Index), Biomass, and Leaf Area Index (LAI) collected by remote sensing, were used to determine the sites of CCEs.

3. IDEA Concept

IDEA(IndEA Digital Ecosystem of Agriculture) concept is the Adoption of a holistic ecosystem approach to address the multiple challenges faced by the agriculture sector in regard to growth to fulfil the goals like Doubling Farmers Income and achieving the SDG’s, Millennium development goal, achieving new climate target on renewable energy expansion, its target for nationally determined contribution (NDC) commit of 40 percent non fossil based.

The following are the goals of the National Digital Agriculture Ecosystem;

- To help farmers increase their income and profitability by giving them access to the correct information at the right time and through cutting-edge services.
- To make it possible for the Central and State governments, the corporate sector, and Farmers Producer Organizations to develop and carry out their policies, plans, and schemes more effectively (FPOs)
- To increase productivity in the use of resources, such as land, water, seeds, fertilizers, pesticides, and farm mechanization, by making information more easily accessible.
- Specific and customized extension services across the farm lifecycle are available, and personal data privacy is also protected.
- To increase capabilities across the spectrum of precision agriculture and digital agriculture
- To encourage the adoption of standards for ecosystem-wide information exchange and interoperability while maintaining effective management of digital rights.
- Encourage agricultural R&D and innovation by providing access to high-quality data.
- To work with the states and union territories to realize the IDEA's vision while embracing the best cooperative federalism principles.
- To develop PPP frameworks and use them to realize the "power of the digital"

4. Kisan Credit Card

The Kisan Credit Card has evolved as a cutting-edge credit delivery method to quickly and easily meet the farmers' needs for production credit. The programme is being implemented throughout the entire nation via a broad institutional credit structure made up of Commercial Banks, RRBs, and Cooperatives, and it has earned widespread support from both bankers and farmers. Studies carried out by NABARD and recommendations made by several Committees that the GOI formed also support this assertion. Therefore, it was thought important to review the current KCC Scheme in order to make it truly straightforward and hassle-free for both farmers and bankers. A Working Group was subsequently established by the then-Ministry GOI's of Finance to evaluate the KCC Scheme.

The Kisan Credit Card Scheme seeks to provide timely and adequate credit support from the banking industry. system with a single point of contact for the farmers' cultivation and other requirements as listed below:

- To fulfill the short-term finance needs for agricultural farming
- costs following harvest
- Loan for Produce Marketing
- consumption needs for a household of farmers
- Working capital for agriculturally related operations, such as maintaining farm equipment and dairy products, inshore fisheries, etc.
- The need for investment loans in agricultural and related businesses, such as pump sets, dairy animals, sprayers, etc.

The programme was launched in 1998 to give farmers access to sufficient and timely credit support from the banking system through a single window with a flexible and streamlined process for their farming operations as well as other needs like the purchase of agricultural inputs like seeds, fertilizer, pesticides, etc. and cash withdrawals for their production requirements. In 2004, the program's scope was expanded to include farmers' needs for investment loans for ancillary and non-farm operations. The extension of the Kisan Credit Card (KCC) programme to farmers engaged in fisheries and animal husbandry was announced by the government as a way to assist them in meeting their working capital needs in the Budget 2018–19. Around 25 lakh applications had been approved for Nationwide Fishery KCC as of June 2020. The government has declared that as part of the Atma Nirbhar Bharat Package, 2.5 crore farmers will be covered by the Kisan Credit Card (KCC) scheme with a credit boost of Rs. 2 lakh crores thanks to a special saturation effort.

A significant milestone goal of covering more than 1.5 crore farmers under KCC with a sanctioned loan ceiling of Rs. 1.35 lakh crore has been reached as a consequence of coordinated efforts. Thus digital India is helping India to achieve milestones.

5. Farmers Portal

Farmers' Portal is an attempt in the direction of creating one stop shop for meeting all information relating to Agriculture, Animal Husbandry and Fisheries sectors production, sale/storage of an Indian farmer. Farmers portal, a place where the farmers will be able to get all relevant information regarding specific subjects around his village/block /district or state. This is the backbone of all mobile apps and SMS advisories. This information can also be explored in more detail by using the visual version of the India map that is displayed on the homepage. An important feature of this web based portal is that one can drill up to the block

level and get information for each block. Information regarding all stages of crop management right from sowing of seeds till post harvesting, is also provided in the portal.

Source: farmer.gov.in

6. Mobile Apps

It is clear that information and communication technologies (ICTs) have the potential to make it easier for farmers to access and share information. Mobile phone use has increased among ICTs, which is altering the way that agriculture communicates. New services and applications have emerged as a result of the adoption of mobile phones. These include access to market information, weather information, plant health monitoring, education and e-trading

Different mobile applications in use are as follows Kisan Suvidha, Pusa Krishi, Soil Health Card mobile app, Crop cutting Experiments-Agri Mobile App, Bhuvan Hailstorm App, Crop insurance, Krishi Video Advice Mobile app, Plantix, IFFCO Kisan Agriculture, APEDA Farmer Connect, Shetkari Malik Android App, Krishi Vigyan, Haaamana Krishi , e-NAM Mobile App, AgriMarket, Digital Mandi India, Loop, riceXpert, expert system for various crops and allied sector apps include Pashu Poshan, Cattle expert systems, mKrishi Fisheries app, avimitra, Ag. MachineryRent Calculator, e-kalpa, Kheti Sewa, Kheti-Gyan, Gene bank app etc.

7. M kisan-Use of Mobile Telephony

M Kisan portal was launched by the President of India in 2013 and more than 2462 crore SMS's have been sent till date. It is a portal where the farmers get connected to officials and scientists who can send targeted text and voice based on advisories for issues related to agriculture and allied sectors. Though there is a penetration of smartphones with internet in rural areas but the best option is mobile telephony for the dissemination of information to farmers. A portal has been developed by the department m kisan (mkisan.gov.in), where around 5.2crore farmers are registered and experts and scientists from different departments

like India Meteorological Department (IMD), Indian Council of Agricultural Research (ICAR), State Government, State Agriculture Universities which send information to farmers on regualar basis in 12 different languages. Based on the State, District, Block and the Crops/Activities selected by respective farmers, they are grouped accordingly. The portal provides with information related to weather such as rainfall, temperature etc which helps the farmer to make decisions regarding the choice of seed varieties, time of sowing, when to harvest etc. It also provides information regarding market which enables the farmers to stay updated with prevailing market prices, the quantity demanded in the market and better informed regarding selling their produce at right place and right time and also helps to save the farmers from distress sale. Some web services have been already registered with SMS Portal such as Kisan Call Centre, market prices, fertilizer testing, Buyer Seller Interface etc and many more are yet to be.

Source: mkisan.gov.in

Conclusion

Government Proposes digital India act, which is anticipated to replace the Information Technology Act of 2000. The IT Ministry is debating whether to make doxing a crime under the new Act. New and emerging technologies like blockchain and artificial intelligence will be regulated under the new Act. The planned Digital India Act will be responsible for regulating e-commerce and cybercrime legislation. The replacement of the IT Act, 2000 with the Digital India Act is a measure that will boost the nation's digital ecosystem and cyber-security environment. However, it is urgently necessary to implement laws in a timely manner while also efficiently resolving any problems that arise during the legislative process.

References

Annual Report 2020-21: Department of Agriculture, Cooperation & Farmers' Welfare, retrieved on 23rd August 2022 from www.agricoop.nic.in.

Anonymous, December,2021., India Digital Ecosystem of Agriculture (IDEA) framework, *Journals of india,* https://journalsofindia.com/agristack/ retrieved on 26th august 2022.

Indian Council of Agricultural Research (Ministry of Agriculture and Farmers Welfare)., https://icar.org.in/mobileapp , retrieved on 26th august 2022.