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## EFFECT OF PLASTIC MULCHING IN AGRICULTURE

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**Introduction:** Rapid population growth poses a major challenge for both efficient and sustainable agricultural practices given the limited availability of arable land. In order to meet the increasing food demand, plastic mulching has become a widely used technique for its instant economic benefits such as higher yields and improved crop quality. Plastic mulch also acts as a barrier to keep methyl bromide, both a powerful fumigant and ozone depleter, in the soil. In plastic mulching crops grow through slits or holes in thin plastic sheeting. Plastic mulch is also used in drip irrigation to increase water use efficiency. Nowadays use of plastic mulch becomes standard practice for all vegetable farmers. Polyethylene film was first used as mulch in the late 1950's in USA for high value crops. It conserves moisture efficiently because water that evaporates from the soil under the plastic film condenses on the lower surface of the film and falls back to the soil as droplets. It accelerates plant growth by increasing the soil temperature and stabilizing soil moisture. Furthermore, the application of plastic covers is known to reduce weed and pest pressure, minimisation of the development time for seed and fruit, yield increase, the prevention of soil erosion, reduction of herbicide and fertiliser use.

**Mulching add organic matter to the soil:** Soil that is high in organic matter is very much alive. In just one pinch of soil, there are about a billion individual living organisms, perhaps ten thousand distinct species of microbes. As these microbes decompose organic matter, it supplies nutrients needed by growing plants. The beauty of this natural nutrient cycle is that nutrients are released in harmony with the needs of the plants. When environmental conditions are favorable for rapid plant growth, the same conditions favor a rapid release of nutrients from the organic matter.



Fig.1. Vegetable production under plastic mulching

**The use of plastic mulches along with the use of drip irrigation has many benefits such as:** Earlier planting dates: The use of plastic mulch alters soil temperature. Dark mulches and clear mulches applied to the soil intercept sunlight warming the soil allowing earlier planting as well as encouraging faster growth early in the growing season.

**Soil moisture retention:** Plastic mulches reduce the amount of water lost from the soil due to evaporation. This means less water will be needed for irrigation. Plastic mulches also aid in evenly distributing moisture to the soil which reduces plant stress.

**Weed management:** Plastic mulches prevent sunlight from reaching the soil which can inhibit most annual and perennial weeds. Clear plastics do not prevent weed growth. Holes in the mulch for plants tend to be the only pathway for weeds to grow.

**Reduction in the leaching of fertilizer:** The use of drip irrigation in conjunction with plastic mulch allows one to reduce leaching of fertilizers. Using drip irrigation eliminates the use of flood and furrow irrigation that applies large quantities of water to the soil which in turn tends to leach nitrogen and other nutrients to depths below the root zone. Drip irrigation applies lower amounts of water with fertilizers injected and thus these fertilizers are applied to the root zone as needed. This also reduces the amount of fertilizer needed for adequate plant growth when compared to broadcast fertilization.

**Improved crop quality:** Plastic mulches keep ripening fruits off of the soil. This reduced contact with the soil decreases fruit rot as well as keeps the fruit and vegetables clean.

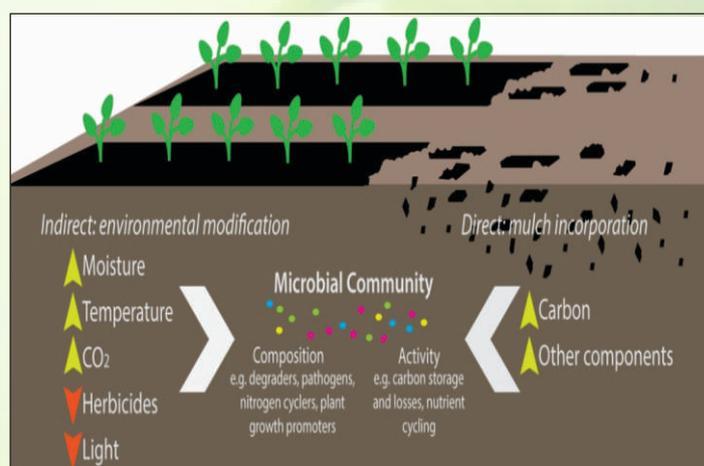


Fig. 2: Beneficial effects of plastic mulching in soil.

**Reduction in soil compaction:** The plastic mulch covering the soil decreases the crusting effect of rain and sunlight. The reduction in weed quantity means a decreased need for mechanical cultivation. Weed control between beds of plastic can be done using directly applied herbicides and through mechanical means. The soil underneath the plastic mulch stays loose and well aerated. This increases the amount of oxygen in the soil and aids in microbial activity.

**Reduction in root damage:** The use of plastic mulch creates a practically weed free area around the plant, removing the need for cultivation except between the rows of plastic. Root damage associated with cultivation is therefore eliminated. Due to these factors, the use of plastic mulch can lead to an improvement in the overall growth of the plant.

Table.1: Comparison of various characteristics between organic and plastic mulching

Subject	Organic mulching	Plastic mulching
Materials type	Bio-based cellulose, chips, leaf, paper	Acetate, polyethylene, polymeric material
Durability	Temporary and decay over time	Long-lasting, 2–3 crop seasons
Thickness	3–5 cm, controlled by application rates	15–20 $\mu\text{m}$ ; 15 $\mu\text{m}$ is most effective
Colors	Natural	Black, silver, white, red, blue, yellow
Weed control	Effective but grass material grows weed	High weed competition except the transparent color
Solarization	Not effective in most of the cases	Most effective by boosting soil temperature
Pest management	Reduces thrips and fungal disease	Reduces thrips, spider mites, and whiteflies
Fragments	Degradable to soil	Problematic and contaminated after 1-2 seasons
Availability	Locally available	Not locally available
Priority mulch	Straw (rice and wheat)	Black plastic
Costing	Cheap	Expensive
Labor	Not laborious	Laborious during setting and removing
Degradability	Naturally decompose and add nutrients	Discarded and buried that polluted soil
Plant growth	Moderate growth	Fast growth and earlier harvesting

**Disadvantages:** There are disadvantages to using plastic mulches in crop production as well.

**Cost:** The benefits from using plastic mulch come at a higher cost than planting in bare soil. These costs include equipment, the plastic film used as the mulch, transplanters designed for plastic beds, and additional labor during installation and removal of mulch films.

**Specialized Mulch:** Application equipment must be used to install plastic mulch beds into a field. These machines shape the soil and apply the plastic to the prepared soil. Transplanters designed for plastic mulch can be used to plant the desired crop. Hand transplanting is an option but this is rather inefficient. The removal of plastic mulch also contributes to a higher cost

through additional labor and equipment needed. Specialized designed undercutting equipment can be used to remove the plastic from the field after harvest.

**Conclusion:** Under plastic mulch, soil properties like soil temperature, moisture content, bulk density, aggregate stability and nutrient availability improved. Plant growth and yield are also positively influenced by the plastic mulch due to the modification of soil microclimate. Even though it has many advantages, high initial cost, removal and disposal of plastic materials are some of the limitations experienced by the farmers. To overcome these limitations photo and biodegradable plastic mulches can be effectively used for sustaining the productivity as well as controlling environmental pollution due to the use of plastics.

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### **APPEAL TO LIFE MEMBERS**

NESA Life Members are requested to submit short articles for the NESA e-Newsletter that are consistent with NESA's objectives to improve environment. The articles should focus on topics related to environment and facilitate communication and discussion among researchers, academicians and students. The articles for September edition can be submitted to [nesapublications@gmail.com](mailto:nesapublications@gmail.com) before **25<sup>th</sup> December 2019**.

**Dr. R.S.S. Tomar**, Editor, NESA E-newsletter

## ARSENIC CONTAMINATION OF GROUNDWATER AND ITS HEALTH EFFECTS

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Arsenic and arsenic compounds are human carcinogens. Exposure to arsenic may occur through several anthropogenic sources, including mining, pesticides, pharmaceuticals, glass and microelectronics, and most commonly, natural sources. Exposure to arsenic occurs via ingestion, inhalation, dermal contact and the parenteral route to some extent. Drinking water contaminated with arsenic is a major public health problem. Acute and chronic arsenic exposure via drinking water has been reported in many countries of the world, where a large proportion of the drinking water is contaminated with high concentrations of arsenic. General health effects associated with arsenic exposure include cardiovascular and peripheral vascular disease, developmental anomalies, neurologic and neurobehavioural disorders, diabetes, hearing loss, portal fibrosis, hematologic disorders (anemia, leukopenia and eosinophilia) and cancers. Significantly higher standardized mortality rates and cumulative mortality rates for cancers of the skin, lung, liver, urinary bladder, kidney, and colon occur in many areas polluted with arsenic.

In Bangladesh, India, China, Taiwan, Vietnam, Mexico, and elsewhere, high levels of arsenic in drinking water have caused serious health problems for many millions of people. Geoscientists from several countries are working with public health officials to seek solutions to these problems. By studying the geological and hydrological environment, geoscientists are trying to determine the source rocks from which the arsenic is being leached into the ground water. They are also trying to determine the conditions under which the arsenic is being mobilized. For example, the arsenic might be desorbed and dissolved from iron oxide minerals by anaerobic (oxygen-deficient) groundwater, or it might be derived from the dissolution of arsenic-bearing sulfide minerals such as pyrite by oxygenated waters. Understanding the mechanisms by which arsenic is mobilized will permit the public health officials around the world to identify aquifers that may pose a threat to their communities.

Undetectable in its early stages, arsenic poisoning takes between 8 and 14 years to impact on health, depending on the amount of arsenic ingested, nutritional status, and immune response of the individual. Arsenic is toxic substance to human health and toxicity depends on the amount of arsenic intake, which is classified into acute, sub-acute and chronic toxicity respectively. It is a silent killer. It is 4 times as poisonous as mercury and its lethal dose (LD) for human is 125 milligram. Drinking water contamination causes the last variety of toxicity. Inhalation, ingestion and skin contact are the primary routes of human exposure to the arsenic. Chronic arsenic ingestion from drinking water is known to cause skin cancer, and there is substantial evidence that it increases risk for cancers of the bladder, lung, kidney, liver, colon, and prostate. Recent studies have



**Figure 1:** Signs of Arsenicosis: spots on the hands.



**Figure 2:** Squamous cell carcinoma on heel. The patient was from the village of Singergdanga (police station Gaighata), North 24-Paraganas District.



**Figure 3:** Hyperkeratosis on sole. The patient died of lung cancer. The patient was from the village of Chandpur North 24-Paraganas District.

also shown that arsenic is associated with a number of non-neoplastic diseases, including cardiac disease, cerebrovascular disease, pulmonary disease, diabetes mellitus and diseases of the arteries, arterioles, and capillaries. Individuals with chronic Hepatitis B infection, protein deficiency or malnutrition may be more sensitive to the effects of arsenic. Children and older adults may be other groups at special risk. Observable symptom to the arsenic poisoning can be thickening and discoloration of skin, stomach pain, nausea, vomiting, diarrhea, numbness in hand and feet, partial paralysis, blindness (Fig:1,2,3). Arsenic toxicity is dose dependent, and particularly on the rate of ingestion of arsenic compounds and their excretion from the body but it also accumulate into the body and passes slowly out through hair and nail. Most of the ingested arsenic is excreted from the body through urine, stool, skin, hair, nail and breath. In excessive intake, some amount of arsenic is accumulated in tissues and inhibits cellular enzyme activities.

The worst affected people in Bangladesh are poor women and children. In poor rural households, it is the adult female who is generally the most undernourished and most vulnerable to disease. When the husband discovers symptoms of arsenicosis on her body, he often refuses to keep her under the same roof. If the woman is fortunate, the husband simply sends her back to her parents for treatment. In most case, however, the husband finds it too risky to maintain the marital relationship and seeks divorce. Women are unable to get married and wives have been abandoned by their husband. As a result, the divorced women find no place in the society and, with their children, become destitute. In villages, it becomes a problem for parents to get their affected daughters married. Arsenicosis also affects the productivity of victims who are often so incapacitated that they are unable to work and become liabilities for their families. The children of the poor have been drinking contaminated water since their birth. They, too, may eventually suffer arsenicosis. It will be very difficult, perhaps impossible, for the parents of an affected young woman to find a groom for her without offering a huge dowry. The provision of dowry is already a difficult, social problem, but will be further compounded by the arsenic problem.

## UNLOCKING THE MYSTERY OF BASTAR: THE KAILASH CAVE

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Bastar is a mysterious land with dense forests, medicinal plants, greenery, lush green mountains, deep valleys, rivers, waterfalls, caves, streams, natural parks, monuments, natural resources, exuberant festivity, peaceful solitude and other tourist attractions. Bastar, being a plateau region, serves as the home of some of the most incredibly beautiful valleys namely Bastarnaar valley, Darbha valley and Keshkaal valley. Among these, one of the most beautiful valley is the Kanger valley national park. This park is the most awaited projects of Chhattisgarh and is proposed to be the “Bio-Diversity Heritage site” as it not only comprises of the rarest species of flora and fauna but also have some of the most exotic natural caves namely Dandak cave, Kutumsar cave and Kailash cave. The Kailash cave is the oldest cave in this area which is formed nearly 40 m above towards the hill. The cave was discovered on march 22, 1993. The known length of this cave is 1000 ft with a depth of 120 ft. The cave is situated at a distance of about 40 km from Jagdalpur. The Kailash cave has the earliest limestone formations with stalactites and stalagmites within the cave due to which it forms a shapes like “Shivlinga” so called as Kailash cave. These dripstone structures are worshiped by the local inhabiting communities during the monsoon season. The Kailash cave is closed for tourists every year and

hanging from the roof of cave develops. Such a deposit is called “Stalactite”. Similar deposit also grows from the floor of the caves where the limewater drops. Such inverted conical pillar like structure is called “Stalagmite”. When a stalactite and a stalagmite meet the dripstone is formed. The ground water deposits crystals of quartz, calcite or other minerals. This deposit is called Geode. Going few meters ahead, there is change in shape and size of the caves as the chamber turns into 25 ft wide and 35 ft long hall, where one can observe greater colonies of budding and developed structures of stalactites and stalagmites (Fig. 1).

The inner environment of Kailash cave is mysterious and unexplored with special reference to the microbiological prospects. Sunlight neither reaches nor can pass through any pore inside the cave. The absence of sunlight and presence of moisture and humidity confers a different environmental habitat inside the cave which is favorable for the growth and rich diversity of several microorganisms viz., bacteria, fungi and actinomycetes which are the key source of various industrially useful metabolites yet to be explored. Due to the absent of sunlight and lack of oxygen towards the deeper areas into the cave, the tourists are restricted beyond a certain point to visit inside the cave. The altered environment within the cave might have developed a different metabolism among microbes to metabolise limestone inside the cave and the microbial colonies deposited on the surface of cave confers different type of color on the inner lining of the cave. The age of Kailash cave is not known till date but it is believed to be the origin of very ancient and primitive civilization.

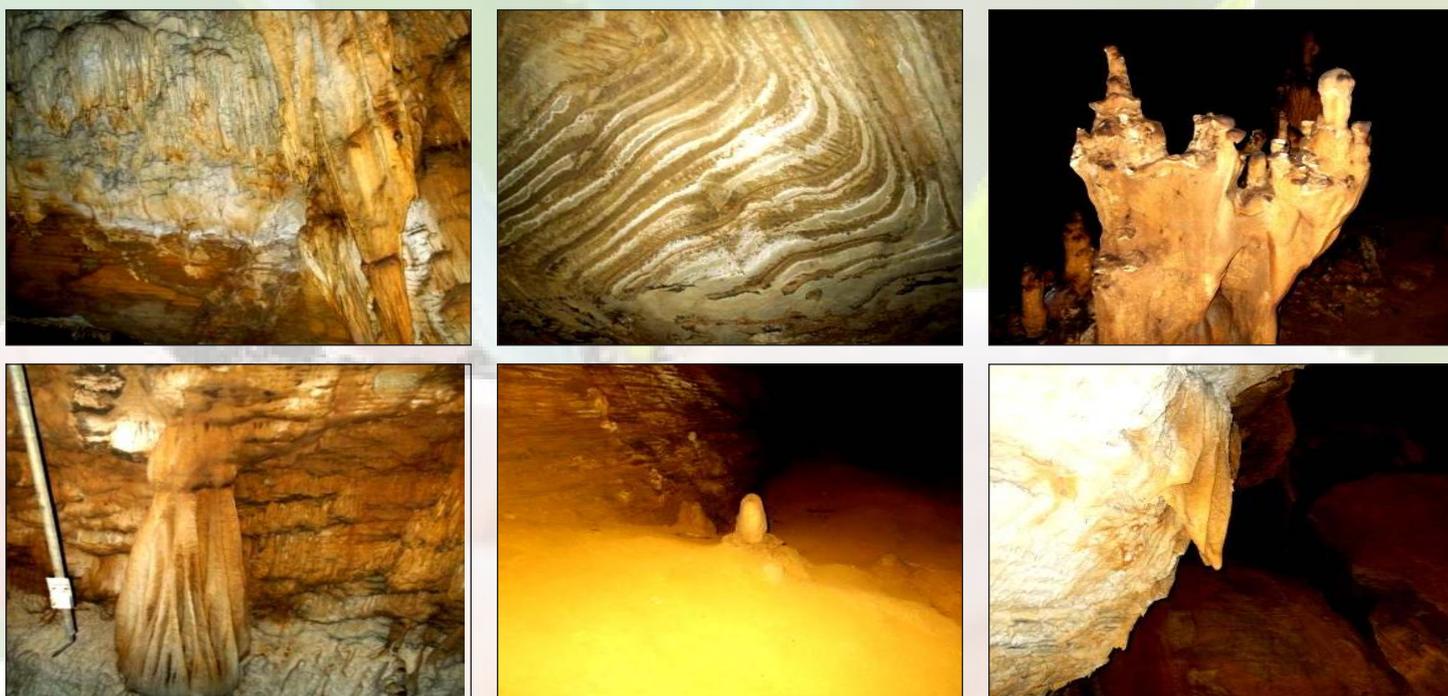


Fig. 1: Photographs of the Kailash Cave.

reopens from 16th October to 15th June. Now, gypsy safari is also available for tourists to explore the beauty of this area.

The Kailash cave is reachable just after travelling 28 km on NH-16, there is a check-post of forest department for the entrance of Kanger valley national park. After some distance there is the guest house of Kanger valley national park. From there, just after travelling 3 km to the way of famous Kutumsar caves, to the left of it, there lies a 12 km long road which directly takes us to Koleng forest range no.75. There lies a series of small hills. Among one of this hill, there lies the beautiful Kailash cave. These stalactites and stalagmites are generally formed inside the caves. As water drips from the roof of a cave, evaporation leaves a small deposit of calcium carbonate behind. Gradually a cone shaped pillar of calcium carbonate,

There is a very likely chance for the occurrence of primitive microbes like archebacteria, primitive fungal association and high environmental stress tolerant strains of microbes and novel unidentified strains of microorganisms can also be isolated, identified and characterized. The future perspectives for research are to explore the varied diversity of flora and fauna inside the cave. The detailed investigation of cave microorganisms, including isolation, characterization and molecular identification using advanced molecular techniques such as r-RNA sequencing for the discovery of novel microbial strains conferring several industrially useful products would be highly rewarding in the arena of research and development and will open new avenues for future research.

## ICT IN EXTENDING THE TECHNOLOGY: PROSPECTS & BENEFITS

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In an era driven by advancements in the field of information and communication technology for livelihood and lifestyle privileges, vistas of its application are ubiquitous and welfare of any country and its livelihood depends on the thought processes led actions executed at policy and implementation levels. More often than not the advantageous features of ICT transform the structure and function of the organizations for their mandated services. Approach to use of ICT evolves from a specific vision of improvising the existing practices accounting the drawbacks associated with them. Leveraging individual and integrated services of agriculture to the farmers ensuring their efficiency, transparency and reliability at affordable costs is possible through use of ICT. In agricultural research and development, the role of ICT is enormous from down to earth to the limit of the sky, and localized to global scales of space and time offering information with security along with the value addition of data preservation for a single to manifold components of any given subject. ICT has brought enormous changes in the lives of a common man and the society has gained multiple benefits of the technology.

**1. Economic prosperity:** ICT is an important enabler of innovation and development and is one of the fastest growing industries which is directly or indirectly creating millions of job opportunities. In this new environment, the competitiveness of economy depends on the ability to leverage new technology. ICT for economic prosperity indicates using it in an effective way to stream line administration, improve productivity in industry which in the long run will influence the performance of the economy.

**2. Social change:** Communication today is the key element in the development and implementation of policies and programmes aimed at the well being and welfare of people everywhere. The role is particularly important in relation to the social changes occurring in the modern world as socio-economic, environmental and developments in active components of society like family, women and young people.

**3. IT and poverty alleviation:** IT enriches the society with information about market prices, social services as health, knowledge, education, jobs, investment opportunities and reduction in poverty level. It is strongly believed that ICT may be the panacea to problems of accessing variety of information sources that are affordable, relevant and reliable by farmers. ICT facilitates the timeliness of extension delivery, leveraging or the electronic speed of processing, covering, transmitting, storing and retrieving information and protecting data.

**4. Rural Development and food security:** New ICTs have the potential for getting vast amounts of information to rural population in a more timely, comprehensive and cost effective manner. The greater tasks like food security and rural development will be achieved in the long run if used together with traditional media ICT is most effective in providing farmers with useful information such as weather reports and crop prices, as well as in educating them about new farming techniques.

Information and knowledge is most essential for facilitating the development of rural and bringing out economic and social change. The knowledge is least expensive input for rural development. Information on supply of inputs, new technologies, early warning systems Credit, Market prices and their competitors are required by the Rural communities.

**5. e-Governance:** e-Governance can improve and facilitate direct connections between citizens

and government and encourages their participation in governance also can help in alleviation of poverty. It can also enhance democratic processes and citizen empowerment and can open up avenues for direct participation of woman in various governmental schemes and decision making processes.

**6. ICTs for improving linkages:** The weaker linkage between researchers, front line workers and farmers have been a major constraint that has resulted in research findings not being applied by poor rural farmers. ICTs can improve and strengthen these linkages can ensure knowledge and information, which are essential for an effective collaboration.

**7. Empowering rural communities:** The rural community can acquire the capability to improve their living conditions with new ICTs techniques. ICTs can empower rural communities and give them a courage that permits them to contribute to the development process. Giving a courage means giving them seat at the table to express their views and opinions and become part of the decision making process. The approach should be participatory and could lead to improved policy formulation and execution.

**8. ICT as an aid:** The information services have to cater to the needs of common man in the areas like natural resources, energy, health and sanitation and employment. The services have to be directed towards promoting information to the extension agencies who in the transfer chain works as a middle man in meeting the needs of the actual user.

**9. Targeting marginalized groups:** Most rural people lack the power to access information. ICTs could benefit all stake holders including the civil society, in particular youth and women. Other disadvantaged groups that could be targeted include the disabled and subsistence peasants.

**10. Creating employment:** Information and Communication technology can create the employment opportunities by establishing the information centre's in rural areas and working as subject matter specialists. Such centre's can help in providing the trainings to the rural people to improve their skills which would help to training to the bridge the gap between urban and rural communities and reduce the rural-urban migration problem.

**11. ICT a group work:** Group work is widely practiced by Government, business and other social organizations.

**12. ICT for planning:** The National Natural Resource Management System (NNRMS) has been drawn up by the nodal agency of the Government's Department of space in cooperation with several other agencies and organizations. The NNRMS scheme is now being linked with the natural Resource Data Management System (NRDMS) to help districts in formulating district plans.



**13. ICT for national development:** There is a need for identification of different categories of users, their information searching behavior patterns, capability of utilization of information. To serve the community and to improve its overall quality of life, ICT modules should be designed.

**14. Artificial intelligence for risk assessment:** It is the ability of computers to make human like judgments. In the near term, the goal of keeping AI's impact on society beneficial motivates research in many areas from economics and law to technical topics such as verification, validity, security and control

**15. Expert system for various fields:** To solve problems in the specified areas using various inference systems and technical knowledge, Expert system are designed which can be defined as a man made software tool to collect technical knowledge related to specified areas and accumulate it in a knowledge base and ultimately used by the specific group when an expert is not available.

**16. Computers for productive rural banking:** ICT can be effectively used to reduce the work load as a large percentage of the bank branches are located in the rural areas.

**17. Distance education in computers:** The computer Mediated Communications (CMC) services include electronic mail, conferencing, assignment submission and feedback and continual updation of the course material. The role of central computing facilities has shifted during the last three years toward the provision of services to support teacher-student communication.

**18. Geographical Information System (GIS):** GIS are being used for mapping, analyzing, planning and interpreting massive amount of natural

resources, topographic and demographic data- making this one of the most potential tools for planners.

**19. On line auction:** The site will provide information on the quality, availability of products on daily basis and details about growers, traders and exporters.

**20. Agri portal:** This portal provides the complete information related to agriculture for each region in each district of each state in India. A special website that adjusts dynamically to present targeted information according to a person's specific requirements.

**21. ICT use in animal husbandry research:** In addition to data management and analysis use in agricultural research has been in supporting multidisciplinary and multi-location research in Latin America and several Asian countries.

**22. Gyan vani Radio network:** It is the mile stone activity of the TNAU under TOT efforts along with IGNOU, New Delhi to produce technical programmes for all kinds of learners.

**Prospects of The Technology:**

It can increase the efficiency in utilizing the development resources as the information is more widely accessible.

- The new media have features that enable bottom-up articulation and sharing of information on needs and local knowledge, where accessible.
- New range of additional media that can be part of the communication for development 'mix' of traditional and/or appropriate media.

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**Plastics give a helpful hand, but they are polluting our land!**

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**D**urable instead of disposables

**P**lastic, avoid it as much as you can

**D**onate old furniture and clothes instead of throwing them away

**P**lants. Put a beautiful potted plant in you balcony

*Save our planet Earth! Save the Environment and you will Save the Life and Future. Save the Environment, Save the World. Taking care of environment is not an obligation – Our environment is our life.*

**No Water, No Life**

**Our Bodies Need Clean Bodies of Water**

**We're All Equal in Our Need for Water**

**Without Water, Everything Withers**

**When You Save Water, It Saves You Back**

## LOSSES IN AGRICULTURE: LACK OF ADEQUATE INFORMATION ABOUT IPM

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Despite of all its achievements, Indian Agriculture is still struggling with lots of challenges. The challenges of unpredictable weather patterns, high monsoon dependency, reduction in arable land, low per hectare yield, increase in pest attacks, lower farmer incomes, lack of irrigation facilities, decreasing level of water table, fragmentation of land and lack of scientific knowledge in farmers. An important part of farmers income is lost due to attack of pests and weeds. Even though India has doubled it's per hectare yield in the past decades it continues to be lower than the peer economies. One of the modern approach i.e. Integrated Pest Management (IPM) to increase farmer income while protecting the environment provides a framework to undertake a step-by-step method in ensuring good health of the crop and higher productivity.

The one by fourth of the global crop output is damaged due to attacks by pests, weeds and diseases where agrochemicals have an increasing role to play in increasing the productivity and production of the crop. Many organizations and start-ups in the agriculture domain are working towards addressing the issues faced by Indian agriculture. Government of India is primitively working towards raising the unmet needs of the farmers across the Agri-value chain through various initiatives like National Agriculture Market (NAM), Soil Health card scheme, Paramparagat Krishi Vikas Yojana, National e-Governance Plan (NeGP), Pradhan Mantri Fasal Bima Yojana etc. IPM ensures the reliable quality of crop, lesser pest infestations, reduced potential for problems of pest resistance or resurgence and increased consumer confidence leading to fair price of the yield. It is the approach that reduce exposure to pesticides and improve long-term sustainability and stability of the agricultural system which can hence help to lower production costs. Information regarding these technologies reaches farmers through several diffusion mechanisms, including farmer field schools (FFSs), field days, exposure to other farmers, and written media (e.g. pamphlets). Given only limited involvement of the public sector in technology transfer, decision makers need to understand the relative cost effectiveness of information dissemination methods. Lack of appropriate information about farmers



Fig. 1: IPM program.

Knowledge, Perceptions and Practices (KPP) in pest management is one of the major constraints in establishing an IPM programme.

To recognize farmer's constraints and their existing technical knowledge, the researchers have to work with farmers which would further improve crop production and crop protection strategies. Knowledge of pests varies between farmers working in similar or different agro-ecosystems.

Pest recognition is a major problem in some cases while in others knowledge about pest ecology is the major constraint. However there may be difference in the opinion and observation of the farmers and researcher of a particular pest to which farmers attribute substantial yield losses and subsequently target their sprays against these organisms but generally, farmers have good knowledge about easily observable and important objects. The short term benefit can be seen to manage the insect pests by the use of pesticides but this can adversely affect the co-existing natural enemies in the crop ecosystem. An attempt must be made to understand the role of natural enemies and evaluate the safer molecules in managing the different pests of the particular crop. The Quantitative information on crop losses and a better understanding of their drivers have been mentioned as essential to

- (i) evaluate the efficacy of crop protection practices.
- (ii) compute system sustainability and stability.
- (iii) make decisions for IPM
- (iv) evaluate the effectiveness of pest and disease regulation as an ecosystem service.

The losses however can be avoided by implementing crop rotation or chemical treatments. Widespread adoption entails applying this sustainable pest management approach to a great diversity of biophysical and socio-economic farming situations. IPM practitioners contend with the intricacies of agronomic and ecological processes that are taken into account when reducing reliance on pesticides, In addition to the diversity of farming situations. The search for single universal platform, in the face of such diversities is important. Developing a pest management approach in terms of general principles makes sense and applying the set of principles via an outcomes-based approach rather than enforcing intermediate goals may have the added benefit of encouraging adaptation and creativity while generating environmental and health benefits. The important issue is create the conditions that enable farmers to move along the IPM continuum over the long-term is the view of policy makers.

Different countries are adopting different strategies to promote IPM and several countries are developing crop-specific IPM approach. For the success of IPM as a sustainable management practice, what matters in the implementation approach is to allow the expression of the dynamic, multi-actor, systemic, and knowledge-intensive nature of IPM. Many of the IPM levers operate at a multi-year scale within a process of coordination among multiple actors and institutions. With climate change and the acceleration of global trade, uncertainties and the frequency of emergence of existing and new pests will rise. Increasing our ability to quickly adapt to disturbance and climatic change will therefore become all the more important. The efforts in research and extension therefore will provide results a certain lag time in an environment where more effective types of funding and educational initiatives are tailored to the needs of IPM. IPM, if understood as the dynamic application of principles to local situations rather than short-term single tactics, can generate the capacity to adapt and achieve the levels of resilience needed. We hope it will help identify those research, education, and extension efforts that will make the mainstreaming of flexible, locally adapted and practical IPM a more widespread reality.

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## MELIPONICULTURE IN THE MAYAN COMMUNITIES OF MEXICO: CURRENT CHALLENGES

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Meliponiculture is the breeding and management of native stingless bees (NSB), which is practiced in tropical and subtropical regions of the world. In Mexico, a total of 46 species are registered in 11 genera, of these species, 17 are present in the Yucatan Peninsula (Campeche, Quintana and Yucatan states, YP). The NSB have

been producing honey since the time of the Mayan civilization, however, with the arrival of the Africanized bee (*Apis mellifera* L.) and the increase in anthropogenic activities (livestock and sugarcane cultivation), their wild populations have been reduced. The Mayan people of the YP developed meliponiculture at a level similar to the management of honey bees in medieval times in Europe, with densities of up to 500 colonies. The honey and wax produced by the Maya was marketed from the limits of Campeche and Tabasco in Mexico to Guatemala and Honduras. During the Spanish conquest, PY honey was one of the main products offered in the Tenochtitlan market in the Aztec culture. After the Spanish conquest, the PY paid tributes with honey and wax from NSB, which was transported from the port of Campeche to Europe, for which it was known as "Cera de Campeche" (in Spanish).

Products derived from the domestication of NSBs had various uses, mainly as a sweetener in ceremonies and as traditional medicine. Between the 3rd and 10th century when the Mayan culture was at its best, honey and wax were two of the most abundant products that were marketed in ancient times, as was salt, dried fish, henequen, blankets and copal. The Spanish conquerors demanded the delivery of honey and other NSB products as a tribute during the colonial period. In 1549, of the 173 villages that existed in the PY, 2, 438 arrobas of wax and 276 arrobas of honey were obtained, this was equivalent to paying an arroba (11.5 kg) of honey for every 20 settlers, being little more than three tons of honey, was the annual tribute to the Spaniards, which indicates the large number of colonies that should have existed at that time. However, the displacement of the meliponiculture had several factors, starting from the arrival of the Spaniards in the 16th century, when the Mayan production system underwent gradual changes when moving labor from traditional to new activities. On the other hand, the introduction of extensive livestock also initiated a gradual process of forest reduction, which increased with the emergence of henequen monoculture; With the reduction of the forest, the nesting spaces and food sources of the NSBs were also scarce, thus affecting their populations. In parallel, the introduction of sugarcane and its widespread consumption contributed even more to abandoning the activity. In addition, the introduction of European bees (*A. mellifera*), which were introduced at the beginning of the 20th century, also influenced the abandonment of meliponiculture.

On the other hand, honey bees produce a greater amount of honey compared to the NSB, which also had an impact on the reduction of activity, since NSB growers saw in beekeeping an option to continue with the activity. Currently, honey bee honey production reaches an average volume of 55,000 tons per year, and on the other hand there are no data on honey production of NSB. Meliponiculture is an activity at risk of being lost in the region, this due to a reduction in the number of jobs and due to the fact that people who are engaged in this activity are of advanced age, coupled with the fact that new generations lose interest in she, in its traditional management and cultural importance. However, the activity presents many opportunities for development, remains essential generational change of meliponiculture in YP.

Photo credit: Authors



From the Editor's

Dear Readers,

I wish my warm wishes!!

In November issue, we recount the various projects and popular articles. This issue includes Annual awards by Academy for its members actively involved in their field or events and activities organised by the Academy. NESA is well known for its environmental awareness activities.

Once again, I express sincere and huge thank to all the persons who contributed writing the wonderful and inspiring articles, without which there wouldn't have been this newsletter issue. Please continue sharing such articles and share with your friends also.

I would like to thank President and General Secretary, NESA, New Delhi, and the Editorial team including Print, Designer and Publication committee for their nonstop support and efforts throughout this edition.

Hope this edition makes an interesting read. Please feel free to offer any suggestions for improvement.

**Dr. Sushma Tiwari**  
*Associate Editor*

**Dr. R. S. Tomar**  
*Editor-in-Chief*



To,

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