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1. AGRICULTURE

Role of Research Scientists in the Popularization of the Traditional Insect Taxonomy

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The Scenario

The science of insect taxonomy already breathing heavily to survive in the highly competitive and commercialized approach towards the science now a days. The traditional practice of insect taxonomy involves the classification and naming of insect species based on their physical characteristics and evolutionary relationships. Being the basic science branch and rapidly growing popularity of the molecular identification of the species has highly undermined the importance of traditional taxonomy and in turn the taxonomists who are the trained under the highly acclaimed experts in the traditional taxonomy. This is mostly due to the convenience and increased accessibility of these molecular techniques. These techniques, such as DNA barcoding, allow for faster and more accurate identification of species based on their genetic sequences, rather than relying solely on physical characteristics. This has led to an increased emphasis on molecular approaches in insect classification and a decreased reliance on traditional morphological methods. Another factor contributing to the decline of traditional insect taxonomy is the lack of funding and support for taxonomic research. Taxonomy is often considered a "low priority" area of research by funding agencies and institutions, which can make it difficult for taxonomists to secure the resources needed to conduct their research work. In addition, the decline of traditional insect taxonomy can also be attributed to the loss of taxonomic expertise i.e. “taxonomic impediment” (Petrović, 2022). With fewer opportunities for formal taxonomic training and a lack of career paths for taxonomists, many experienced taxonomists. The simplicity of gathering data on species identification and overall biodiversity using molecular tools has created a false perception among some ecologists, molecular biologists, policymakers, and the public that these innovative tools can entirely replace the traditional taxonomy approach. As a result, the need for the time-consuming expertise of morphologically-based taxonomists and entomologists has been undermined. (Ebach et al. 2011). are retiring or leaving the field, and there are few younger taxonomists to take their place.

Holding nothing against the importance of the molecular techniques these improvements are for the betterments of the sciences and its careful incorporation into the taxonomical studies will with certainty improve the quality of the research. Still, it is disheartening to see the traditional approached being side-lined for the sake of easier and convenient methods which were supposed to be the supplementary or complimentary approaches to the classical taxonomy. It is also discouraging to know that journals often don’t accept the papers without molecular taxonomy without even recognising the merits of the research work. Understanding the basics of insect taxonomists takes years of hard work, dedication and often to no avail but it teaches a person to become better student of the science and unless these students keep coming

into the mainstream and acknowledged by the scientific fraternity it will be difficult to keep the firm footing of the science in the today's scientific playground. The list of insect taxonomists working in the field is getting shorter and shorter by the time and this shrinking clad of the insect taxonomists are and will struggle to provide the important scientific inputs to the science. Since, the Linnaeus and Darwin's work the profession was highly respectable and adorned by the many but lost its limelight in present scientific portfolio and barely maintaining its footing. While traditional insect taxonomy is still an important field, its decline highlights the need for greater support and resources for taxonomic research, as well as the importance of embracing new molecular techniques and interdisciplinary approaches to classification and species identification.

The scientific community has an important role to play in the promotion of insect taxonomy, particularly in light of its recent decline and can help promote insect taxonomy by-

Through Advocacy and Awareness: The scientific community can help raise awareness of the importance of insect taxonomy by advocating for the field and highlighting its contributions to science and society. Scientists can communicate the value of taxonomy to the general public, policy-makers, and funding agencies, emphasizing the crucial role of taxonomy in conservation, ecosystem management, and public health.

Through Collaboration and Partnerships: Collaboration between taxonomists and other scientists, such as ecologists, molecular biologists, and conservationists, can help to promote the integration of taxonomy into broader research programs. Collaboration and partnerships can also help to foster interdisciplinary research and facilitate the development of new tools and techniques for insect taxonomy.

Through Capacity Building: The scientific community can support the development of taxonomic expertise by investing in training programs and mentoring opportunities for students and early-career researchers. This can help to ensure that there is a new generation of taxonomists to continue the work of insect classification.

Through Data Sharing: Finally, the scientific community can promote the sharing of data and resources for insect taxonomy, such as specimen collections, genetic data, and taxonomic expertise. This can help to facilitate the work of taxonomists and make their findings more accessible to other researchers.

Overall role of the scientific community is vital in promoting insect taxonomy, both by advocating for its importance and by supporting the development of taxonomic expertise and resources. By working together, scientists can help to ensure that the field of insect taxonomy continues to thrive and contribute to our understanding of the natural world. Major work on insects in India is carried out by the entomologist engaged in the agricultural pest management agencies like ICAR, SAU's, ZSI, NBAIR, entomology departments of the state and central universities, etc. Except few they are often ill equipped to carry out the sophisticated research on insect taxonomy and needs to be provided with the all the necessary facilities and all the institutes working in the science of entomology must have their own in house insect systematics and recruitment agencies in research institutes as well as educational institutions should give special attention towards recruiting the well qualified taxonomist in order to train the students in the basic understanding of insects and insect taxonomy. This can only be possible by the promotion of the insect taxonomy by the scientific fraternity at the top level by demanding the expertise of insect taxonomist in the departments to carry out collaborative research.

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2. AGRICULTURAL SCIENCES

Viroids

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Viroids are a covalently closed circular RNA molecules. Viroids were the first circular RNAs to be discovered in nature. These are the smallest known infectious agents. Potato spindle tuber viroid was the first viroid reported, and it is widely prevalent in different potato growing areas. Citrus exocortis viroid is wide spread in citrus production areas where trifoliate ornage(Poncirus trifoliate)is used as root stock. Hop stunt viroid has a wide range of hosts. Mechanism of viroid pathogenesis in plants has been elucidated recently.

Structure of Viroids

Viroids are nucleic acids that exist naturally with no protein coat. They consist of ribonucleic acid (RNA). These mini viruses are the smallest known causal organisms of infectious diseases. They are subviral and their size ranges from 246 to 388 nucleotides in length.

The RNA structure of viroids is different from transfer RNA (t RNA), ribosomal RNA(r RNA) and messenger RNA (m RNA). Viroids are the first circular RNA's to be discovered in nature.

Important viroids causing diseases

The following are viroids that cause diseases in important crops:

- Apple scar skin viroid
- Australian grapevine viroid
- Avocado sunblotch viroid
- Chrysanthemum chlorotic mottle viroid
- Chrysanthemum stunt viroid
- Citrus exocortis viroid
- Coconut cadang cadang viroid
- Coconut tinangaja viroid
- Cucumber pale fruit viroid
- Grapevein viroid
- Grapevine yellow speckle viroid
- Hop latent ciroid
- Hop stunt viroid
- Potato spindle tuber viroid
- Tomato apical stunt viroid
- Tomato planta macho viroid
- Potato spindle tuber viroid Potato spindle tuber viroid - stiff and
- upright growth habit on infected potatoes
- Hop Stunt viroid
- Cadang Cadang disease
- Citrus exocortis viroid Grapevine yellow speckle viroid

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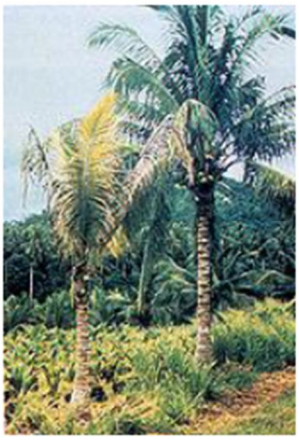
Tomato planta macho viroid

Potato spindle tuber viroid

Potato spindle tuber viroid - stiff and upright growth habit on infected potatoes

Hop Stunt viroid



Cadang Cadang disease

Citrus exocortis viroid

Grapevine yellow speckle viroid

3. AGRONOMY

Effect of Climate Change on Agriculture

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Climate change is having a significant impact on agriculture, and its effects are far-reaching and complex. Some of the key effects of climate change on agriculture include:

- Changes in temperature and precipitation patterns: Climate change is causing changes in temperature and precipitation patterns, which can impact crop growth, productivity, and distribution. Warmer temperatures can result in earlier planting and harvest dates, while changing precipitation patterns can impact soil moisture levels and water availability for crops
- Increased frequency and severity of extreme weather events:
- Climate change is also increasing the frequency and severity of extreme weather events, such as droughts, heat waves, and floods, which can have significant impacts on crop production and food security
- Pest and disease outbreaks:
- Climate change is also contributing to the spread of pests and diseases, which can have significant impacts on crop health and productivity. For example, pests and diseases that were once limited to warmer regions are now spreading to new areas as temperatures warm
- Soil degradation: Climate change is also impacting soil quality, as changes in temperature and precipitation patterns can lead to soil erosion, compaction, and degradation. This can reduce soil fertility, increase runoff, and reduce the ability of soils to retain water and nutrients

To address the effects of climate change on agriculture, farmers need to adopt a range of strategies, including:

- Adopting climate-resilient crops and production systems: This includes choosing crops that are well-suited to local growing conditions and are capable of tolerating changes in temperature and precipitation patterns
- Improving water management practices: This includes conserving water through efficient irrigation systems and improving water storage and distribution infrastructure
- Improving soil management practices: This includes reducing soil degradation through conservation tillage, crop rotation, and the use of cover crops
- Enhancing pest and disease management practices: This includes monitoring for outbreaks of pests and diseases and implementing effective control measures, such as the use of resistant varieties and biological control methods

In conclusion, the effects of climate change on agriculture are complex and far-reaching, and farmers need to be proactive in their approach to ensure that they can continue to produce crops in a changing climate. This requires a range of strategies, including the adoption of climate-resilient crops and production systems, improving water and soil management practices, and enhancing pest and disease management practices.

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4. GENETICS AND PLANT BREEDING

Significant Impact of Physical Methods of Seed Invigoration

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Introduction

Improving agriculture's sustainability while lowering its environmental impact is one of the main issues humanity is currently facing in order to meet the rising food demands of the world's population. In order to boost food productivity while avoiding negative effects on environmental goods and services, agricultural sustainability requires the development of technology and practises. High vigour seeds are a good indicator of crop emergence and long-term productivity. Since the advent of agriculture, man has been in contact with seed physiology and has quickly learned that many seeds do not germinate quickly or consistently. The effects of temperature before sowing on subsequent germination were mentioned by Evelyn in 1664, and the effect of light on seedling emergence was examined by Ingenhousz a century later.

Even though chemical compounds are still a major part of modern agriculture, using physical factors could be a good alternative to increase agricultural production yield while enhancing plant protection and storage. Compared to traditional treatments based on chemicals, physical approaches for seed invigoration provide a number of benefits. First, they require less fertilisers, which reduces the contamination of raw materials grown on farms. Another benefit is that physical means can be employed to sterilise seeds both during storage and before planting.

Physical Methods for Seed Invigoration

1. Magneto-priming
2. Radiation Treatment
   a. Gamma Radiation
   b. X-Ray
   c. Ultraviolet Radiation
   d. Microwaves
   e. Thermal Treatments

Magneto-Priming

Magneto-priming used as pre-sowing seed treatment has many advantages, such as the low economic impact, the non-destructive testing and the environmentally friendly approach being the major ones. Krylov and Tarakanova (1960) were the first to describe the effects of magnetic fields on plants; they coined the term "magnetotropism" to refer to the auxin-like effects that magnetic fields have on seeds when they are germination. The methods employed Electromagnetic field (EMF) and static magnetic field (SMF) are used in agriculture for seed priming and have been shown to improve crop output, seed vigour, and seed germination (Baby et al. 2011). Electromagnetic field (EMF) and static magnetic field (SMF) are highly different. Electromagnetic field is formed by electrically charged entities that are extended indefinitely in space; static magnetic field can only be produced by a permanent magnet, as produced by the earth's magnetic field, or with the aid of industrial operations (Mitchell and Cambrosio 1997).The effects of applying magnetic fields (magneto-priming technique) and imbibition on the chemical makeup of Triticale seed were studied, particularly in its pericarp, germ and endosperm parts, with the help of Micro-Raman (Alvarez *et al.,* 2021).

Gamma Rays

Gamma emitters are radioactive isotopes that emit gamma rays, which are high-energy photons. Gamma rays have no charge and are highly penetrating, so they can pass through thick materials such as concrete or lead. Common gamma emitters include cobalt-60, cesium-137, and technetium-99m. Qi *et al.*, 2015 showed that 50 Gy gamma irradiation gave maximal beneficial effects on the seed germination index and root

length in response to cadmium/lead stress. It suggests that low-dose gamma irradiation alleviates heavy metal stress, probably by modulating the physiological responses and gene expression levels related to heavy metal resistance in *Arabidopsis* seedlings.

X- Rays

X-rays have a wavelength in the range of 0.01 to 10 nm of the electromagnetic spectrum and energies in the range 120 eV to 120 keV. Increasing X-ray irradiation doses were seen to reduce seed germination percentage and root growth of date plam (Phoenix dactylifera L.) seeds. However, a significant enhancement of root growth was observed in response to increasing X-rays doses. A significant increase in leaf length at 0.05-0.25 Gy was observed but at higher doses reduced growth occurred (Al-Enezi *et al.,* 2012).

UV- Radiation

Most of the UV radiation not reach to earth surface due to protective layer of ozone. UV is harmful to all living organism and cause DNA damage by pyrimidine dimer formation. However, UV-C radiation is non-ionizing and it penetrates superficially into the plant tissues, which supports its potential as a germicidal agent. seedlings derived from seeds treated with the lowest UV-C dose showed higher tolerance to salinity conditions.

Like other physical seed priming methods, microwaves and thermal treatments are also used. When the microwave radiation is absorbed by living tissues, it causes ionic movement, dipole rotation and distorsion of the electron orbit which ultimately results into fast and selective heating. In a seed technology context, non-lethal MWs treatments have been extensively used for seed disinfection before sowing or storage

Conclusion

Magneto priming (MF) have been described as eco- friendly, cheap, and non-invasive technique. MF treatments responsible for balancing hydrogen peroxide through concerted action of synthesis and scavenging system which act as a signaling center for the regulation of improved vigor by triggering ABA catabolism, GA_3 biosynthesis. X-ray irradiation is beneficial where seedling health is more important like horticultural crops. These all treatments play significant role to accelerate vigorous growth of seedling and higher germination percentage.

Future Thrust

More studies are needed to identify the molecular players triggered during the seed response to physical invigoration treatments, especially in radio-tolerant species or cultivars By expanding the number of species/genotypes tested with each different approach, it will be possible to identify those targets best suitable for a specific physical treatment, preventing deleterious conditions An integrated and multi-disciplinary approach is needed to speed up basic and translational research in seed technology, finally producing guidelines for the seed operators. Effects of several radiation *i.e.* X-ray are still not fully understood so it is required to understand that radiation effects in detail. Electron Paramagnetic Resonance and other scanning method is need to be exploited to identify and understand the effect of various physical invigoration treatments

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5. SOIL SCIENCE

Salt-Affected Soils and Agronomic Methods of their Management

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Nander Maharastra.

Salt- affected soils are a common problem for many farmers worldwide, and their negative impact on crop production is well documented. The soils contain high levels of salt, which can be toxic to plants and their ability to absorb water and nutrients from the soil. This can result in reduced crop growth and yield. These soils contain high levels of salt that can be toxic to plants and reduce crop growth and yield. Salt-affected soils are a major challenge for farmers as they limit crop growth and productivity.

Globally, salt-affected soils are found in many countries including the United States, Australia, China, and Pakistan, among others. These soils are often found in areas with high evaporation rates and limited rainfall, such as arid and semi-arid regions, coastal areas, and delta regions. In India, salt-affected soils are widespread and are found in various regions including the semi-arid and arid regions of Rajasthan, Gujarat, Haryana, and Punjab, as well as in coastal areas along the east and west coasts. The country has about 13 million hectares of salt-affected land, of which about 7 million hectares are considered as highly salt-affected.

To manage salt-affected soils, farmers may need to implement practices such as leaching salt from the soil, using salt-tolerant crops, and improving irrigation management to prevent salt buildup. In addition, there is a need for research and development of new salt-tolerant crop varieties to help farmers grow crops in these challenging conditions. Here are some agronomic methods that can be used to manage salt-affected soils:

1. Leaching: Leaching is the process of flushing out excess salts from the soil by applying large amounts of water. This helps to reduce the salt concentration in the soil and improve soil fertility
2. Irrigation management: Careful management of irrigation water can help reduce salt buildup in the soil. This involves selecting the right irrigation method and scheduling irrigation to avoid waterlogging, which can lead to increased salt levels.
3. Crop selection: Choosing crops that are salt-tolerant can help reduce the impact of salt on crop growth. Crops such as barley, wheat, and some varieties of alfalfa can tolerate higher levels of salt compared to other crops..
4. Amendment application: Adding organic matter to the soil can help improve soil structure and reduce the impact of salts. Organic matter acts as a buffer, absorbing and retaining salts, and reducing their availability to crops.
5. Deep plowing: Deep plowing can help mix the soil and bring subsurface soil with lower salt concentrations to the surface. This can help reduce the concentration of salts in the root zone and improve crop growth
6. Solarization: Solarization is a process of using the sun's energy to heat the soil and kill pathogens and weeds. This can help reduce the impact of salts on crop growth by reducing the amount of salts in the soil.

In conclusion, managing salt-affected soils requires a combination of agronomic methods that are tailored to the specific soil and growing conditions. By implementing these strategies, farmers can improve soil fertility, reduce soil-borne diseases and pests, and increase crop yield.

6. AGRICULTURE

Plant Communications: An Overview

Jakku Prasanna, S. P. Ubale and P. B. Ghodke

Nander Maharastra

Plants are known for their sedentary lifestyle, but they are not limited to a single location. They interact with their environment and communicate with other living beings. Plant communication involves the exchange of information between different parts of the same plant, between plants and with their symbiotic partners such as mycorrhizal fungi and rhizobia. This information exchange plays a crucial role in plant growth, reproduction, and adaptation to environmental changes.

Plant Signaling and Behaviour

Plants have developed various modes of communication to receive and respond to environmental cues. They have the ability to sense light, gravity, touch, and other physical signals. Additionally, they can respond to chemical signals such as volatile organic compounds (VOCs) emitted by other plants. In some cases, plants can even communicate over long distances through the release of underground chemicals and other signaling mechanisms. Plants exhibit a range of behaviours in response to signals received from the environment. Some common examples include the closing of stomata in response to drought conditions, the direction of growth towards light and the release of defensive compounds in response to herbivore attacks.

Mechanisms Involved in Plant Communication

Plant communication is achieved through the exchange of various signaling molecules. These molecules can act locally or be transported over long distances. The most well-known local signaling mechanism is the release of hormones. Hormones are chemicals produced in one part of the plant and transported to other parts, where they regulate growth and development.

Another mechanism involved in plant communication is the release of volatile organic compounds (VOCs). VOCs are organic compounds that evaporate easily and are released into the air. They serve as signals between plants, with some VOCs serving as attractants and others serving as deterrents.

Signaling for Nutrient Uptake

Plants also communicate with symbiotic partners for nutrient acquisition. Mycorrhizal fungi and rhizobia form mutualistic relationships with plants, exchanging nutrients for plant sugars. These interactions are crucial for plant survival, especially in nutrient-poor soils.

Plant-Plant Interaction

Plants can interact with other plants to compete for light, water, and nutrients. They also use volatile organic compounds to attract pollinators, deter herbivores, and signal the presence of disease. Some plants can even release chemicals that inhibit the growth of neighboring plants, in a process known as allelopathy.

Defence Response to Biotic and Abiotic Stress

Plants can also respond to biotic and abiotic stress through communication. They produce specific volatile organic compounds when attacked by herbivores, which attract natural enemies of the herbivores. They also produce chemicals to defend themselves against pathogens. Additionally, they can respond to abiotic stress such as drought, flooding, and high temperatures through the release of specific signaling molecules.

Plant Parasitic Interaction

Plants can also communicate with parasitic plants, such as mistletoe and dodder. Parasitic plants attach to the host plant and extract nutrients, water, and other resources. Host plants respond to this interaction by producing chemicals to deter parasitic growth or by investing more energy into root growth to escape the parasite.

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Plant-Microbe Interaction

Plants can also communicate with microbes such as rhizobia and mycorrhizal fungi. This interaction is crucial for nutrient acquisition and the regulation of plant growth and development.

Plant communication is an incredibly complex process, with multiple modes of signaling and a range of behaviours. While much has been discovered about plant communication, there is still much to be learned.

7. AGRICULTURAL SCIENCES

Symptoms of Viral Diseases

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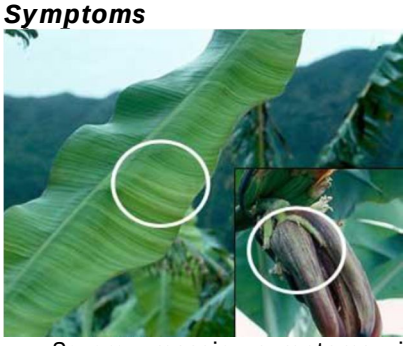
Chlorosis

Yellowing of normally green tissues due to chlorophyll destruction or failure of chlorophyll formation is known as chlorosis.

Infections chlorosis of banana - Cucumber Mosaic Virus (CMV)

Symptoms



Severe mosaic symptoms in young growth showing broadly streaked chlorotic or yellowish green bands (from margin to midrib) and patches or chlorotic mottling distributed in patches over the leaf lamina; leaves are narrow and smaller than normal and the infected plants are dwarf; rolling of leaf margins twisting and bunching of leaves at the crown and a rigid erectness in newly emerged leaves.

Vector: Aphids - Aphis gossypii and A. maidis

Mosaic

Intermingling patches of green and light green or pale green or yellowish colour on the leaves is known as mosaic.

Tobacco mosaic-Tobacco mosaic Virus (TMV) / Nicotiana Virus 1

Symptoms

Leaves develop characteristic light and dark green pattern on the lamina. Dark green areas are usually associated with the veins, which later develop into irregular crumpled swellings / blisters due to more rapid growth. Dark brown necrotic spots develop under hot weather (mosaic burn).

Virus: Rod shaped ss RNA.

Transmission: Sap, farm equipments and by contact.

Cowpea aphid-borne mosaic virus

(CAMV) on cowpea

Symptoms

Chlorosis, dark green and light green patches alternated on leaves; distortion of leaves.

Vector:Aphids - Aphis gossypii, A.craccivora, Myzus persicae.

Cassava mosaic virus on cassava (Tapioca)

Symptoms

Mosaic mottling on leaves; chlorosis of leaves; distortion of leaves; twisti ng of leaves; stunting of plants and tuber splitting

Vector: White fly - *Bemisia tabaci*

Yellow mosaic of greengram and blackgram caused Mungbean Yellow Mosaic Virus (MYMV)

Symptoms

Small yellow patches or spots intermingled with green patches on the leaves initially, later entire leaf changes yellow in colour, in severe infections discolouration o f pods and seeds to yellow.

Vector: Whitefly - *Bemisia tabaci*

Sterility mosaic of pigeonpea - Pigeonpea sterility mosaic virus

Symptoms

Intermingling of light green and dark green patches in the leaves, reduction in leaf size; small leaves clustering near the tip of the plants, shortening of internodes, stimulation of auxillary buds giving a bushy appearance. No flower and pod formation leading t o sterility of affected plant. Plants remain green till harvest.

Vector: Eriophyid mite - *Aceria cajani*

Vein clearing

Yellowing of veins or clearing of the tissues in or immediately adjacent to the veins is called vein clearing.

Vein clearing or yellow vein mosaic of bhendi - Bhendi yellow vein mosaic virus (BYVMV)

Symptoms

Initially light yellow streaks along with the smaller veins, later all the veins become yellow giving yellow network of veins. Chlorosis of interveinal areas, reduction in size of leaves and small and fibrous fruits.

Virus: Isometric with ssDNA geminate particles and bipartite genome.

Vector: Whitefly *Bemisia tabaci.*

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8. AGRICULTURE

Breaking the Stigma: Embracing Entomophagy as a Sustainable and Nutritious Food Choice

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What is "Entomophagy"

Entomophagy, the consumption of insects as food, has been a part of human diets for thousands of years. However, for a long time, it was viewed as an outdated and unsophisticated practice, with little appeal to modern palates. In recent years, however, attitudes towards entomophagy have begun to shift, and it is now being touted as a sustainable and nutritious food source for the future. The Food and Agriculture Organization (FAO) of the United Nations has been working to promote entomophagy as a healthy and environmentally-friendly practice for several years. This has led to increased interest and experimentation with insect-based dishes around the world. However, there are still many questions to be answered about entomophagy, such as which types of insects are edible, where they can be found, how they should be prepared, at what stage of life they are safe to consume, and whether they can be commercially bred. Addressing these basic queries is crucial to furthering the acceptance and adoption of entomophagy as a viable food option.

The scientific study of entomophagy initially focused on ethnozoology, which involved recording the consumption of insects by different ethnic groups and discovering insect biodiversity (Meyer-Rochow, 2005; Costa Neto and Ramos Elorduy, 2006; Dawwrueng et al., 2017). However, many people with a Western perspective considered insects to be a food curiosity of poor and uneducated tribes, leading to a lack of interest in entomophagy until the end of the previous century. In the last few decades, more information beyond anthropology has been published, highlighting the nutritional value of insects (Ramos Elorduy and Pino Moreno, 1989). Entomologists started organizing tasting events, and actual consumption of insects outside traditional entomophagous societies began. In light of this, the FAO and an international group of scientists corrected the negative image of entomophagy and recognized the potential of edible insects as a means to combat hunger and address climate change on a global scale. The potential of mass-produced insects as bioconverters to break down significant quantities of food waste under controlled conditions was also acknowledged. In 2012, the UN FAO held an expert consultation and published a resulting report titled "Assessing the Potential of Insects as Food and Feed in Assuring Food Security" (Huis et al., 2013)

Categories of Entomophagy (Grabowski et al., 2022)

1. **Traditional Entomophagy** is a global phenomenon that varies depending on the species of insects involved. It involves gathering insects from crops, wild areas, and adjacent regions and processing them using traditional methods before consuming them. This practice has evolved over time through trial and error to ensure the continued availability of resources and address food safety concerns.
2. **Non-Traditional Entomophagy** on the other hand, encompasses both the modernization of traditional practices (such as cricket farming and hygiene improvements) and the development of an entirely new agricultural industry that involves "new" insect species, such as darkling beetles and flies like the black soldier fly and housefly. Unlike traditional entomophagy, which has its roots in cultural practices, non-traditional entomophagy is driven primarily by market demand and scientific knowledge. It aimed toward (a) improving traditional entomophagy and (b)

extending entomophagy to non-entomophagous societies.

Reasons for the Adoption of Entomophagy

Numerous studies have demonstrated that insect protein is a highly viable and sustainable alternative to traditional animal protein sources. However, the question remains: why do we need to make this shift.

While there are over 2,100 species of edible insects worldwide, many countries do not consider them a viable traded commodity. This represents a missed opportunity on a global scale, as the cultivation and trade of edible insects has the potential to become a thriving multimillion-dollar industry. It is therefore important to address this issue and promote the value and potential of edible insects as a valuable food source.

With the world's population projected to reach 9.8 billion by the 2050s, current rates of food production simply cannot keep up with demand. Expanding agriculture to produce more food is not a practical solution, as there are limits to available land. Additionally, meeting the protein needs of a growing population requires raising more livestock, which in turn requires even more feed sources. This reliance on livestock has a significant environmental impact, as it is a major contributor to greenhouse gas emissions. Thus, continuing to expand livestock production would have serious consequences for the planet.

As a result, there is an urgent need to identify sustainable protein sources that can meet the world's growing food needs. Insects have emerged as a promising solution to this challenge.

Historical Perspective

Throughout human history, our diets have been primarily omnivorous. However, over time, cultural and religious factors have influenced the development of modern diets, leading to the categorization of certain foods as either "acceptable" or "primitive" based on more than just their nutritional value. This has resulted in entomophagy, or the practice of consuming insects, being largely rejected by modern societies until relatively recently.

Despite this rejection, entomophagy remains a common practice among various ethnic tribes around the world. These include the Australian aborigines, various tribes in Africa, Latin America, and Southeast Asia, as well as several ethnic tribes in the northeast states of India, such as Nagaland. Knowledge about edible insects is passed down through generations in these communities and is a valuable traditional asset (Anon., 2023).

Potential of Entomophagy

In order to gain knowledge about edible insects, it is necessary for the modern world to approach ethnic communities and acknowledge their practices. This approach can help to build important bridges between cultures. However, there is a concern among researchers that the increasing demand for edible insects may lead to overharvesting of insect populations from the wild by these communities. This would raise questions about the sustainability of the practice and could have negative impacts on insect biodiversity.

Although the practice of entomophagy is currently highly sustainable, as insects are primarily collected from the wild, it is clear that wild populations would not be sufficient to meet the growing demand for edible insects. Therefore, it is essential to implement necessary changes to ensure the continued sustainability of this practice, such as exploring new methods of insect cultivation and farming, as well as promoting responsible harvesting and management of wild insect populations. One of the most viable solutions to conserve insects and ensure sustainable entomophagy is through insect farming. Insects have the potential to be a better alternative to conventional livestock, as they can be raised on dedicated entomo-farms. Insects are well-suited for commercial rearing due to their ease of rearing, short life cycle, high reproductive capacity, and minimal resource requirements. In addition to reducing pressure on wild insect populations, insect farming is also a sustainable solution to conserve insects and the environment, while meeting the protein requirements of the growing human population. Furthermore, if ethnic communities are provided with proper training and support, commercial insect farming could also provide a livelihood opportunity for those who practice entomophagy.

Insect farming is considered a contemporary

method of utilizing insects, offering distinct advantages over gathering. By maintaining ecological awareness, farmers can ensure they do not disrupt the delicate balance of the food web (Kormondy, 1996). Insect farming can be conducted in a sustainable manner, as supported by studies such as those conducted by Berggren et al. (2019) and Guiné et al. (2021).

Factors Influencing the Safety and Sustainability of Edible Insects

- Biology of the species
- Level of knowledge of the foodstuff
- Traditional knowledge
- Efficiency of traditional methods given the societal changes and needs
- Farming conditions
- Actual processing, transport, and storage
- Consumer awareness and acceptance.

Consumer Awareness on Entomophagy

The consumer's role is a crucial factor to consider when deciding whether or not to produce insect-based food. While a food product can be sustainable and safe, it is of no use if the consumer does not consume it. This is especially true when consumers are not familiar with entomophagy. Western consumers, in particular, have specific expectations when it comes to the safety and sustainability of new food products (Dagevos, 2021).

While the primary purpose of consuming food is to obtain nutrition, food choices can also serve as a means of expressing personal and cultural identity. The acceptance of a particular food is a complex process that involves an individual's decision-making on what to eat and what not to eat.

Farmer associations, industry federations, and other lobbying groups have the potential to create programs that are tailored to consumers' needs, including programs for children. These programs can promote the consumption of edible insects while also providing information about the benefits and risks associated with them. The nutritional, ecological, and cultural education of consumers and other stakeholders can be an essential aspect of these programs.

Stigmatisation of the entomophagy will ultimately depend upon the people's perception of the food which can be improved with increased awareness among the general public on the benefits and nutritional values of the insects.

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9. HORTICULTURE

Beauty under Threat-Primerose of Arunachal Pradesh

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Abstract

The article highlights about few primula species occurring in Arunachal Pradesh. Many of the species have been recorded for the first time from the state, few of which are endemic to the region. Many species have been placed under threatened list of IUCN red list thus emphasis may be given on conservation of these species.

Keywords: Primula, threatened species, Arunachal Pradesh

Introduction

The genus *Primula* L. belonging to the family Primulaceae is one of the largest angiospermic flowering herbaceous genera comprising of 38 sections and 430 species. It is widely distributed worldwide mainly in the temperate and alpine regions, having highest diversity mainly concentrated in the Sino-Himalayan region, accounting for >75 %. It is distributed in other parts of the world including North America, Siberia and Pakistan comprising of 20, 14, and 23 species, respectively. Around 113 species of primula is found to be distributed in Bhutan, China, India and Tibet particularly in the Indo-Bhutan and Indo-Chinese Himalayan region of Sino Himalayan region, this entire Indian- Himalayan region is considered to be the centre of diversity for Primula. Maximum number of primula species in India has been reported from the Eastern Himalayan region of Arunachal Pradesh and Sikkim with 35 and 58, respectively while, 15 and 22 species each from Himachal Pradesh and, Jammu and Kashmir, respectively.

Primerose is the first flower to come to flowering in springs, it comes in a variety of shades, including white, pink, red, yellow, blue, and purple. It is grown for its aesthetic purpose and is used for decoration, flower arrangement. The flower is considered sacred by the Celts and symbolises beauty, charm, femininity, love, optimism, passion, protection, and youth. The flower which is not only valued for its beauty and sacredness but also the flower along with leaf is eaten as salad, used as tea and in wine preparation. The plant is used in traditional medicine system to treat headache, rheumatism and gout, toothache etc. Besides use in traditional medicine, the plant also has antioxidant, antidiabetic, antimicrobial and cytostatic properties due to presence of bioactive compounds like saponins.

Primula species are moisture loving herb, either growing as an annual or a perennial in marshy areas near the stream, leaves are simple and arranged in rosette, flowers of different shades arise on long stalk. The plant comes to bloom in the spring. Several species are found to be growing in temperate to alpine regions of the state from western most district Tawang at an elevation of 3500-4000 m. with 76% population to the eastern most Anjaw district at an elevation of 1500-2000m with a minimum of 4% population. More than 60% taxa of Primula in Arunachal Pradesh are found to occur in two of the western districts (West Kameng and Tawang).

Primula Species Spotted from Arunachal Pradesh:

1. ***Primula gambeliana:*** This herbaceous perennial plant was first reported in the state from Pangatengtso area of Tawang District in the year 2012 and is found to grow in few

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isolated pockets at an elevation of 3500-4000m. Besides Arunachal, it is also found to be growing in Sikkim, China and Bhutan. It has overlapping ovate farinose bud scales at base. The leaf surface is glabrous and leathery, with sparsely minute glandular in the undersurface. The inflorescence bears 1-2 umbels, each umbel bearing 2 to 8 flowers. Flowers are heterostylous having both pin and thrum type flower of purplish pink to violet-purple colour. Capsules are cylindric. It commences flowering from June to August and fruiting from August to September.

2. ***Primula Involucrata*:** In the world, it is found distributed in China, Bhutan and Nepal and in India in the states of Sikkim and Kashmir besides Arunachal where it was first spotted in the year 2012 from Pangatengtso area and Sela Pass of the Tawang district at an elevation of 3500-3900m. 2 to 6 white coloured flowers are borne on each umbel. It has both the pin and thrum type flower. Capsules are oblong and as long as calyx. The flowering starts from June and continues till August while the fruiting occurs from August to September.
3. ***Primula Ioessa***. It was first located in the state from Sela pass area of Tawang District in the year 2012, and also has its distribution in Tibet and China. It grows in isolated pockets at an elevation of 3500-4000 m amsl. Calyx campanulate to tubular-campanulate, scarcely farinose with purple tinge outside and completely farinose inside. Each umbel comprises of 2 to 8 flowers. Flower heterostyled having both pin and thrum type flower with creamish white colour petal and light-yellow mealy eye. The capsules are cylindric and are as long as calyx. Flowering begins from June and continue till August while fruiting occurs from August completes by September.
4. ***Primula Lacerate:*** The species is very rare and is endemic to N.W. Frontier of Myanmar, S.E. Tibet, Yunnan province of China and in India, Talley Wild Life Sanctuaries (Talley WLS), Pange, Lower Subansiri district of Arunachal Pradesh it is found growing at an elevation of 1800 m MSL in association with other species like Paris polyphylla Sm., Fragaria nubicola (Hook. f.), Hydrocotyle himalaica P. K. Mukh and Impatiens spp. This species was for the first time reported in India during 2013 from Talley WLS, Pange. The species produces heterostylous flower (both pin and thrum type) with single umbel bearing 2 to 5 blue to bright pink coloured flower. The flowering and fruiting occur from March to June.
5. ***Primula Oblique*:** Globally the species is found distributed in Bhutan, China, India and Nepal. In India, it is distributed in Sikkim and Arunachal Pradesh, where it was first spotted to be growing abundantly in the Panga-Teng-Tso (PTSO) area of Tawang district. The species is found to be growing in the entire western district of the state at an elevation of 3500 –4000 m. The plant produces white to creamy yellow coloured campanulate 2 to 10 heterostylous flowers (pin and thrum type) having densely farinose at the apex of corolla tube are borne in a single umbel. The calyx is tubular to campanulate and have cylindrical capsule. The species comes to flowering in the month of June to August and commences fruiting from August to September.
6. ***Primula Polonensis*:** It is a very rare species distributed only in few pockets of Anjaw and Lower Dibang Valley district, growing at an elevation of 2500 – 3500m. It is categorised under IUCN Criteria B1 ab (iii) and B2 ab (iii) category as a critically endangered species (IUCN 2012). It was first located and collected from Delei Valley (28°17'N, 96°37'E, 2900 m) of Anjaw district in June 1928 by F. K. Ward and later after a lapse of 86 years, rediscovered from Mayodia Pass (28°17'27"N, 95°55' 7.17" E, 2520 m), of Lower Dibang Valley district during June 2011. It is perennial in nature with rhizomatous fibrous roots, reddish in colour, having narrow leaf blade of ovate to obovate-oblong or oblanceolate shape with attenuated base and crenulate margin, inflorescence is an umbel, each with 3 – 10 yellow coloured heterostylous pin type flowers. Capsule is globose, included in calyx. Seeds are black in colour. The plant comes to flowering from

June to August and fruit set occurs from August to September.

7. ***Primula Sikkimensis:*** The species was first spotted growing abundantly in isolated pocket in Panga-Teng-Tso (PTSO) area of Tawang district at an elevation of 3500 -3800 m amsl a from the state in the year 2011. In India, besides its distribution in Arunachal Pradesh, it is also found growing in Sikkim and West Bengal. In the world, it has its distributed in China, Bhutan and Nepal. Flowers are heterostylous having both pin and thrum yellow coloured flower with campanulate calyx and oblong capsule. The plant commences flowering from August to September while fruiting occurs from September to November.
8. ***Primula waltonii*:** The species is considered to be closely related to *P. sikkimensis* var. *sikkimensis* and *P. ioessa* var. *hopeana.* It was first spotted in the year 2011 from Pangatengtso area at an elevation of 3800-3900m in the Tawang district. The species is native to Tibet and also has its distribution in China, Bhutan and Nepal, besides Arunachal and Sikkim in India. Each umbel bears 2 to 22, pink to deep wine purple coloured campanulate flower having creamy light yellow farinose with a dark purple eye spot. The flowers are heterostylous having both pin and thrum type flower with basifixed anthers and cylindric capsule. The plant comes to flowering from June to August and fruiting commences from August to September.

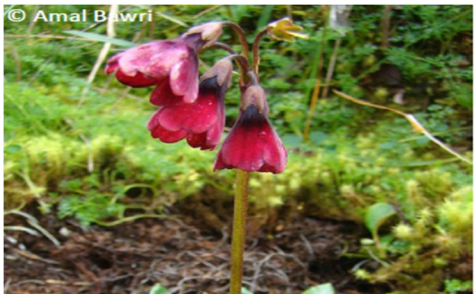
Table: List of Few Primula Species of Arunachal Pradesh

Species in Arunachal Pradesh	Altitude (m)	Flowering and fruiting season
P. atrodentata W.W.Sm.	3000–4000	April–July
P. bracteosa Craib	2500–3500	March–May
P. calderiana ssp. *calderiana* Balf. f. et Cooper	3500–4000	May–July
P. calderiana ssp. *strumosa* Balf.f. et Cooper	3500–4500	May–July
P. capitata Hook.	3500–4000	July–Oct
P. dickieana Watt	3500–4500	July–Aug
P. denticulata W.W.Sm.	1500–3500	March–June
P. gambeliana Watt	3500–4000	July–Aug
P. glabra Klatt	3500–4500	May–July
P. gracilipes Craib	3000–4000	May–July
P. hookeri Watt	3500–4000	May–July
P. irregularis Craib	2500–3500	Feb–May
P. ioessa W.W.Sm.	3500–4000	July–Aug
*P. jigmediana** Hook.f. & Thomson ex Watt	3500–4500	July–Aug
P. kingii Watt	3500–4500	June–Sept
P. mollis Nutt. ex Hook.	2000–3000	July– Aug
P. munroi Lindley	3500–4500	July–Aug
P. oblique W.W.Sm.	3500–4000	June–Aug
P. primulina (Sprengel) H. Hara	3500–4500	June–Sept
P. prenantha Balf. f. & W.W.Sm.	3000–3500	June–Aug
P. prolifera Wall.	3000–3500	May–Aug
P. sikkimensis Hook.	3000–4000	July–Oct
P. sessilis Royle ex Craib	3500–4000	Apr–June
P. waltonii Watt ex Balf.f.	3500–4000	July–Sept
P. whitei W.W.Sm.	3000–4000	May–July

P. sikkimensis

P. waltonii

P. oblique



P. kingii

P. calderiana ssp. *calderiana*

P. gracilipes

P. calderiana ssp. *strumosa*

P. dickieana

P. whitei

P. ioessa

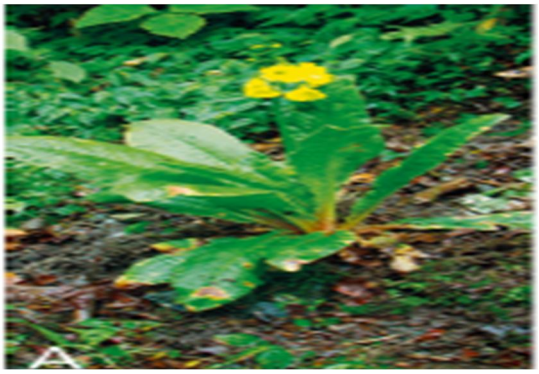
P. denticulata

P. gambeliana

P. calderiana sub sp. *bawaii*

P. involucrata

P. lacerata



P. polonensis

Conclusion

Arunachal Pradesh is a paradise to many researchers owing to its rich distribution of flora and fauna diversity. Many flora species are endemic to the state and are categorised critically endangered, endangered, vulnerable status under IUCN Red list category and many species do not fall under any of the category of IUCN Red list as the study on their population status have not been carried out yet. In the same line, many of the Primula species fall under the threatened category which includes critically rare, endangered and vulnerable status. Many of the species is very rare and the population is confined to one locality with few individuals. Anthropogenic activities, natural calamities like landslides, soil erosion and flood, and developmental activities like forest clearance for construction of highways, new plantation of commercial crops, collection of the plant species from the wild for domestication are posing threat to these species besides the grazing and stumping off by the mithuns, yaks *etc.* in their natural habitat.

Hence, proper survey, documentation and conservation of all the primula species found in the state should be taken up seriously so as to prevent complete swipe out of these species especially the endemic ones.

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10. HORTICULTURE

Bio-Fortification in Horticultural Crops

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Bio-fortification refers to increasing the bio-availability of mineral content in food cropsgenetically. Biofortification is one time investment to develop seeds that fortify themselves, recurrent costs are low and germplasm can be shared internationally. Biofortification help in overcoming malnutrition problems especially in rural areas. Application of biofortified crops would benefit farmers by increasing their income in the long term. Biofortification differs from other fortification because it focuses on making plant foods more nutritious as the plants are growing, rather than having nutrients added to the foods when they are being processed.

Biofortification Techniques

1. **Agronomic Biofortification** - Agronomic practices starting right from field preparation to the harvesting of crops at right time and right stage of the crop. Fortification is done mainly through fertilizer application alone. Fertilizer application is done eitheras foliar spraynor as soil application by increasing nutrition in food and thereby improvingthe quality of food.
2. **Conventional Plant Breeding** - In this method there are so much breeding techniques like Introduction, Selection, Hybridization, Pureline, Polyploidy, Mutagenesis, SSD (Single Seed Decent), Pedigree method, Bulk method *etc*. that through which it increases nutrient or improves quality of food.Examples for biofortification through conventional plant breeding methods includesincreasing zinc in wheat, rice, maize; iron in beans and pearl millet and pro-vitamin A in sweet potato and maize.
3. **Genetic Engineering**
   a. **Vector Gene Transfer**
      i. ***Agrobacterium* Mediated Transfer:** Thismethod is thought to induce less rearrangement of the transgene. Lower transgene tries to copy the number that direct DNA delivery methods.
      ii. **Viral vector:** They are tools commonly used by molecular biologists to deliver genetic material into cells. This process can be performed inside a living organism (in vivo) or in cell culture (in vitro). Viruses have evolved specialized molecular mechanisms to efficiently transport their genomes inside the cells they infect.
   b. **Direct gene transfer**
      i. **Micro-Injection:**By the use of a glass micropipette to inject a liquid substance at a microscopic or borderline macroscopic level. The target is often a living cell but may also include intercellular space. In this way the process can be used to introduce a vector into a single cell.
      ii. **Particle Bombardment:** The Particlebombardmentdevice, also known as the gene gun, was developed to enable penetration of the cell wall so that genetic material containing a gene of interest can be transferred into the cell.

List ff Biofortified Horticultural Crops

Crop	Developed variety	Biofortification was done for
Sweet Potato	BHU Sona, BHU Krishna	Beta carotene
Pomegranate	Solapur Lal	Iron, Zinc and Vitamin C
Cauliflower	Pusa Betakesari	Beta carotene
Cowpea	Pant Lobia -1 Pant Lobia -2	Iron, Zinc

Tomato	Pusa Uphar, Pusa Rohini Pusa Hybrid 2	High ascorbic acid
Carrot	Pusa Asita Pusa Rudhira	Anthocyanin Lycopene
Cassava	Sree Visakam	Beta carotene
Pumpkin	Arka Chandan	Beta carotene

Importance of Bio-Fortification

- Improves the plant or crop quality.
- Increase the nutritional quality in daily diets.
- Overcome malnutrition in human beings.
- Promote nations food security.
- It is especially important for poor rural community with finite access to a varied diet, fortified foods or supplements.

Conclusion

Biofortified crops, either by conventional breeding methods orby modern biotechnological tools, are not a solution formalnourishment. The ultimate aim in global nutrition remains asufficient and diverse diet for the world's population.However, biofortified crops can complement existingmicronutrients interventions; can have a significant impact onthe lives and health of millions of people, especially thosemost in need.

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11. HORTICULTURE

Recycling of Waste Water for Agricultural Use

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Out of world's clean water about 70% is used for agriculture. If we handle the same irrigating methods the world will face a huge irremediable problem like drought, famine etc. It is necessary to take a step towards the use of treated water for agricultural purposes. However, it is important to make sure that the water is treated because the untreated water will lead to major problems like soil salinization, groundwater pollution by toxic metals and organic compounds. It will also result in crop yield reduction and also human health issues because it contains some harmful bacteria, viruses and parasites. Usage of treated water can also help farmers in their uncertain situations.

Waste Water Treatment

Waste water treatment is a process of removing contaminants from the waste water and converting it into an effluent which can be returned to the water cycle with minimum impact on the environment, or it can be directly used.

Steps in Waste Water Treatment

1. **Collection of Waste Water:** By using waste water pipelines, the waste water is transported from houses, hostels and other sources to a centralized treatment facility.
2. **Odour Control:** The dirty substances in waste water will emit a foul smell. The odour treatment is carried out in the treating plant in order to eliminate the foul smell.
3. **Screening:** Screening is the process of removing large materials like plastics,

broken bottles etc.

4. **Primary Treatment**: This process is the separation of macrobiotic solid waste matter. The settled solid waste can also be used as manures.
5. **Secondary Treatment:** In this process oxygen is pumped into the tank which acts as a fuel for the growth of bacteria for better breakdown of biological solid wastes.
6. **Bio-solids Handling:** The solids which are settled down in primary and secondary treatment are collected in digesters. They are treated for a month and used as manures. Methane gas which is produced during this process can be used to produce electricity.
7. **Tertiary Treatment:** This is the final step in waste water treatment. This step is followed by disinfection process. After these processes the waste water is used for various purposes.

How Long Has Waste Water Reuse Employed in Agricultural Sector?

The practice of using waste water for agricultural purposes started long before. For example, California and Florida have been using treated water for agriculture for about 40 years ago.

Israel is known as the leader for water reuse in arid climates. They have used treated water for agricultural purposes since 1970's. Now Israel recycles 90% of water of which 85% is used for agriculture every year. The next highest wastewater recycling nation is Spain which applies 71% of its recycled water on agriculture.

Is Treated Water is Safe for Irrigation?

Strict guidelines and regulations are followed to ensure the public health protection. For example, in California, leafy green crops are subjected to strict food safety guidelines by the Leafy Greens Marketing Agreement (LGMA) that includes various testing on soil and water to ensure food safety.

Case Study: Waste Water Treatment by Wetland Plants

The wetland plant roots consist of massive microorganisms like bacteria and fungi. These massive microorganisms near the roots have the ability to degrade most of the minor pollutants. By the action of microorganisms, the roots of the wetland plants become a filter. In addition to this root filter some wetland plants have the capacity to absorb heavy metals from the water.

Waste water is allowed to flow into the gravel filled basin which is planted along with the wetland plant species and it is lined with the plastic sheet to avoid the downward movement of water. The dirty water flows underneath this system and it is never exposed to sunlight. We can place some barriers in between to enhance the upward and downward movement of water to ensure maximum contact with the plant roots. The cleaner water will emerge and flows through the big filter. This treated water can be used for irrigation.

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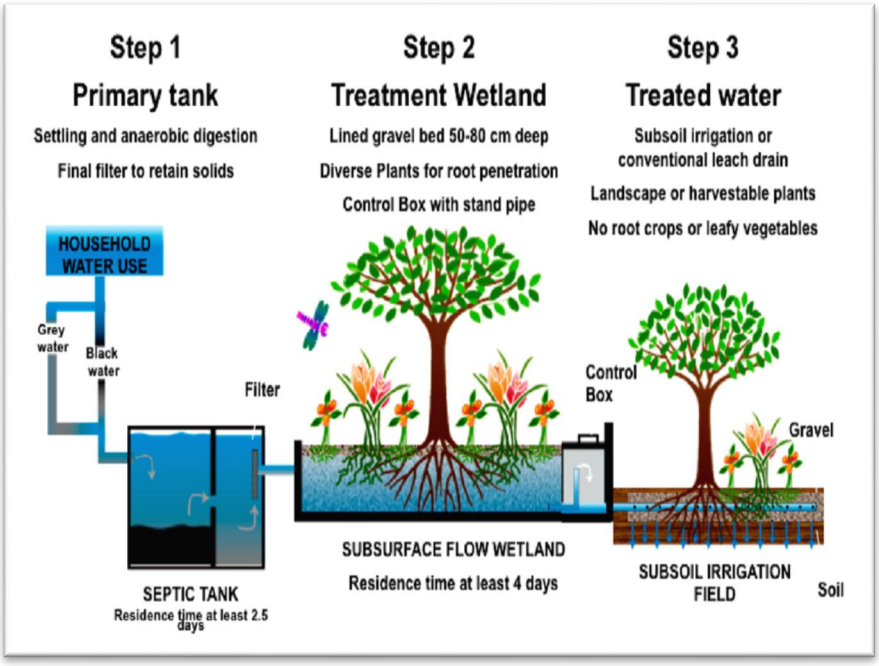

Conclusion

Recycling of water is cost effective, because the ground water table declines and there is a need to put more energy and money in pumping water. Recycling can help in saving both energy and time. Next, farmers can irrigate their field according to their need. No need to wait for rainfall and other water sources. Traditionally the agricultural irrigation is based on rivers, dams etc. Due to over population and urbanization these sources alone can't fulfil the agricultural water requirement. For example, the water requirement for rice crop will need approximately 10mm of water per day. Therefore, a crop that matures in 100 days will require approximately 1000 mm of water while a crop matures in 150 days will require 50% more. Therefore, it is necessary to proceed the alternative plan.

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12. AGRONOMY

Technological Options to Reduce the Vulnerability of Drylands to Climate Change in India

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Introduction

Intergovernmental Panel on Climate Change **(IPCC)** leaves no doubt that the Earth's climate is changing **(Christensen *et***

***al.,* 2007).** The last 60 years were the warmest in at least the last 1000 years, patterns of precipitation are changing with greater incidences of both floods and droughts. Arid and Semi arid regions are likely to experience as much as a 20% drying by the end of the 21st century with hotter summer temperatures and decreased precipitation and increased likelihood of summer droughts. Even though the global climate models are less reliable for Central Asia the region is likely to experience greater than average warming and decreased precipitation **(Christensen *et al.,* 2007).** The IPCC concludes that the observed changes cannot be explained by natural phenomena and that there is now clear evidence of human influence.

Drylands to Climate Change in India

Dryland agriculture is practiced over 85.7 m.ha. area out of 138.7 m. ha. total net cultivated area in India**.** Accounting for 60% of net cultivated area. Though dryland agriculture contributes 44% of food grain production its contribution in coarse cereals, pulses, oilseeds and cotton is about 91%, 91%, 80% and 60% respectively. Significant amount of livestock population (66%) is also dependent on dryland areas.

Impact of Climate Change in Last Few Decades in India

To sum up, expansion of rainfed agriculture as more and more regions become arid and semi-arid, increased risk of crop failures and climate related disasters and decreased yields are the important challenges that the changing climate will lead to. These will result in further deepening of poverty and food insecurity and loss of livelihoods in the rainfed regions.

Projected Climate Change Scenarios for India

According to **Lal *et al.*, (2001),** an annual mean area-averaged surface warming over the Indian subcontinent to range between 3.5 and 5.5oC over the region by 2080s. These projections showed more warming in winter season over summer monsoon. The spatial distribution of surface warming suggests a mean annual rise in surface temperatures in north India by 30C or more by 2050. The study also suggests that during winter the surface mean air temperature could rise by 30C in northern and central parts while it would rise by 20C in southern parts by 2050. In case of rainfall, a marginal increase of 7 to 10 per cent in annual rainfall is projected over the subcontinent by the year 2080. However, the study suggests a fall in rainfall by 5 to 25% in winter while it would be 10 to 15% increase in summer monsoon rainfall over the Country**.**

Climate Change Projection for India

Year	Season	Temperature Change (°C)		Rainfall Change (%)	
		Lowest	Highest	Lowest	Highest
2020s	Annual	1.00	1.41	2.16	5.97
	Rabi	1.08	1.54	-1.95	4.36
	Kharif	0.87	1.17	1.81	5.10
2050s	Annual	2.23	2.87	5.36	9.34
	Rabi	2.54	3.18	-9.22	3.87
	Kharif	1.81	2.37	7.18	10.5
2080s	Annual	3.53	5.55	7.84	9.90
	Rabi	4.14	6.31	-24.83	-4.50
	Kharif	2.91	4.62	10.10	15.1

(Lal et al., 2001)

It was also reported that the date of onset of summer monsoon over India could become more variable in future. Though some of the projected changes in climate will have both beneficial and adverse effects on the environmental and socio-economic system, the larger changes will have more adverse effects. The expected changes in climate for India indicated that increase in temperature is likely to be less in **kharif** than

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in rabi season and the rabi rainfall is largely uncertain whereas kharif rainfall is likely to increase by as much as 10 percent. Such global climate changes will affect agriculture considerably through its direct and indirect affect on crops, livestock, pest and diseases and soils, thereby threatening the food security, an important problem for most of the developing countries. The impact of climate change on different crop management levels viz., fertilizer, water management improving rainwater management through watershed development, increasing water availability and water use efficiency needs to be looked into it. All the soil processes with respect to changes in precipitation pattern and increased air and soil temperatures can influence available soil water content, runoff and erosion and need to be studied further.

However this Concept propose some promising technological options that can improve ecosystem resilience to climate change and increase the adaptive capacities of land users, i.e. their ability to sustain the flow of diverse products and services that they depend on and to do so under constantly changing conditions (Sayer and Campbell, 2003). In addition the necessary accompanying institutional and policy changes required to enable the adoption and adaptation of these technologies are briefly discussed. These examples are illustrative of recent advances in dry areas rather than a comprehensive discussion of all of the possibilities.

Promising Technological Interventions to Reduce Vulnerability to Climate Change in India

The range of technological interventions that can contribute to reducing the vulnerability to climate change by simultaneously preventing and reversing land degradation and sequestering carbon in drylands (mitigation) include; maintaining vegetative cover, grazing management, water management and salinity control, mulching and residue management, soil fertility management and crop rotations, improved fallows, shrub, halophyte and forestry plantations **(Lal, 2001, 2002, 2003).** Below we discuss some recent developments in some of these interventions that can help farmers cope with and adapt to climate changes in India.

Improving water use efficiency

For dry areas it is clear that water, not land, limits agricultural production and that improving water use efficiency and decreasing demand must be major factors in the coping and adaptive strategies for climate change

Modelling water use efficiency

On farm water use efficiency (defined as the ratio of the required amount of water for a target production level to the actual amount of water used) has recently been shown to indicate that farmers in dry areas over-irrigate their crops by 20–60% **(Shideed *et al.*, 2005)** A model has been developed to assess the on-farm efficiency of water use by fixing an amount of water available and determining how this water should be allocated based on agronomic and economic factors of crop production.

13. HORTICULTURE

Effect of Irrigation Practices on Yield of Traditional Rice Varieties

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Introduction

Rice is the most dominant staple food crop for 2.7 billion people and is very important for safeguarding the food security of the world.

Traditional rice varieties in India and across Asia are under serious threat of extinction due to arrival of modern rice varieties, high yielding varieties (HYVs), hybrids, and genetically engineered rice being developed as an outcome from partnership corporate-centered technology.

These landraces are highly nutritive, rich in minerals like potassium, sodium, calcium, micronutrients like iron and zinc.

The rice landraces, due to their adaptability to different agro climatic conditions, unique characteristics and special use are confined to only certain rice growing areas in particular season.

Material and Methods

A Field experiment was conducted during the *Samba* season of 2018-2019 at Research Farm, Agricultural College and Research Institute, Coimbatore, Tamil Nadu.

Objective of the study was effect of irrigation practices on yield of traditional rice varieties.

The experiment consisted of four varieties comprising traditional rice (*Jeergasamba* and *Kalanamak*) and rice land races (*Kavuni* and *Mapilaisamba*). Yield parameter observations were recorded on the productive tillers, panicle weight, thousand grain weight, grain yield and straw yield were at the time of harvest.

Results and Discussion

Yield of Traditional Rice Varieties

- Irrigation management practices greatly influenced rice grain yield. Statistically, significant and wide variations in the grain yield of the varieties were recorded. The mean yield of traditional rice varieties in flood irrigation was 3.1 t ha^{-1} and in AWD irrigation the mean yield was 3.3 t ha^{-1}.
- The increased yield under SRI with AWD method of irrigation might be due to favorable growing with good environment and nutrition supply and increased uptake of nutrients as recorded in SRI with AWD method of irrigation, which lead the plants to superior growth and favorable growth traits which enhanced the yield attributing characters, higher source to sink conversion, which in turn resulted in higher grain and straw yield. This is in line with the findings of **(**Yogesh, 2011**)** and Sureshkumar and Pandian (2017).
- Modified irrigation practices of Alternate Wetting and Drying (AWD) helped in formation of new tillers and recording more number tillers per unit area, which lead to higher grain yield. AWD practice also had a profound influence on the grain and straw yield of traditional rice varieties.

Table.1 Effect of irrigation practices of traditional rice varieties on water use efficiency (kg $ha^{-1}mm^{-1}$), Water Productivity (lit. kg^{-1}), Grain yield (kg ha^{-1}) and Straw yield (kg ha^{-1})

Treatment	Water use efficiency		Water Productivity		Grain yield		Straw yield	
	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
S_1 : *Kalanamak*	2.4	3.1	4238	3253	2655	2840	6671	6817
S_2 :*Jeeragasamba*	3.0	4.0	3339	2524	3369	3646	7412	7656
S_3 : *Kavuni*	3.6	4.6	2800	2173	4071	4257	7429	7663
S_4 : *Mappilaisamba*	2.1	2.6	4835	3875	2440	2581	7565	8259
Mean	2.8	3.6	3803	2956	3133	3331	7269	7598

M_1: Flood irrigation & **M_2**: Alternate wetting drying

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14. HORTICULTURE

Methods of Seed Production in Cabbage

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- Cabbage is one of the important vegetables.
- Formed by the development of densely overlapped leaves around the growing point.
- Popular in the south and South Eastern parts on India.
- Under cultivation since 2000 BC to 2500 BC.
- It is a biennial in nature having 2 specific periods of growth i.e. vegetative and reproductive phases.

Seed Production Areas in India

1. Srinagar valley (J&K)
2. Upper Kullu valley (Himachal Pradesh)
3. Lahaus valley (Himachal Pradesh)
4. Kalpa valley, Kinnaur (Himachal Pradesh)
5. Saproon valley, Solan (Himachal Pradesh)
6. Kumaon hills (Uttar Pradesh)
7. Kalimpong – Darjeeling hills (West Bengal)
8. Nilgiris (South India)

History

In 1942-43 for the first time imperial Government encouraged the seed production of European type of vegetable at Quetta in Baluchistan. At about the same time initial trials on seed production were also initiated in Kashmir, Katrain.

Seed Production

For seed multiplication of cabbage the following three methods (singh et al.,1959) can be followed depending on the suitability, type of the seed and stage of multiplication.

- Seed to seed method
- Head to seed method
- Late planting

Seed to Seed Method

- Also known as In-situ method.
- Commonly followed for Foundation and Certified seed production.
- It is the commercial method of cabbage of seed production.
- In this method, labour is not needed for uprooting, storage and replanting of heads.
- Obtain early seed yield.

There are 3 methods of seed to seed methods

- Head intact method
- Stump method
- Stump method with central core intact

Head intact Method

- Most common method.
- Head formation in mid-Dec.& is kept intact.

- Earthing up is done.
- 2 vertical cross cuts is given and care is taken not to injure the central growing point.
- Cross cuts may be given twice or thrice in the varieties, having compact heads.

Merits

- The heads are allowed to over winter in the field and no wastage of labour for shifting.
- No direct injury of snow/frost.
- Get higher seed yield.
- Selection and rouging of heads can be delayed.

Demerits

- No extra income.
- Earthing up is needed.
- Careless cross cuts may injure the terminal buds.
- Flowering and maturity is delayed.

Stump Method

- Decapitate the fully mature heads.
- The stumps will develop the flowering shoots from the axillary buds.
- Useful when selection of heads is based on internal characters like core size.

Merits

- Extra income.
- Flowering and maturity is advanced.
- Seed yield is more.
- Suitable for regions with little frost / snowfall.

Demerits: Flowering shoots arising from the stumps are decumbent.

Rotting of stumps from the cut ends after a frost/snowfall.

Stump Method with Central Core Intact

- Heads are chopped off on all sides with downward perpendicular cuts.
- The flowering shoots arise from the terminal and axillary buds.

Merits

- Higher seed yields.
- Flowering branches are not decumbent.
- Early seed maturity.
- Demerits
- The cut portion of heads are un-marketable.
- Require additional labour.

Head to Seed Method

- Mostly followed for nucleus seed production.
- True to type heads are selected, uprooted and replanted in a separate plot during Nov-Dec.
- Before replanting, the outer leaves are removed and the plants are set in the field ssuch a way that the whole stem below the head is buried in the ground with the head resting just above the surface of the soil which prevents tilting of plants due to weight of the heads.
- The soil around the base of the plant is made firm by pressing and leveled uniformly. There should not be no depression otherwise water will stagnate and may injure the root system.
- The loosely set plants get tilted immediately after the irrigation.
- Selection of true to type heads is possible only in the compact stage.
- Hence selection in the loose headed quality point of view is risky unless there is certainity of the highest quality of the seed stock used.

Modified Head to Seed Method

- Used for heavy snowfall areas during winter and the land remains covered with the snow for fairly long time.
- The compact true to type heads are selected, uprooted and stored in trenches.
- In this method trenches of size 300cm long, 90 cm wide and 75cm deep are made being convenient for storage.
- Heads are stored in a layer in single slanting position and the roots are buried 5-7cm deep in the soil.

- The trenches are covered with wooden planks and about 15cm layer of earth is spread over them and on both the sides of trenches small holes are made for vernalization.
- Due to extreme low temperature, the heads get vernalized in the trenches.
- As soon as the danger of frost is over the head is taken out and replanted in well prepared field during march-april.
- Cross cuts is given to the heads before they start bursting.
- Flowering in June-July and Harvesting of the heads in August-September.
- Generally suitable for Nucleus seed and Breeder seed production.
- Provides better scope for inspection of heads and rouging.

Late Planting

- Modification of In-situ method.
- Followed only under certain specific circumstances.
- Followed when early varieties are planted in late.
- Formation of head occur in May-June.
- Seed yield is very high, but the quality of seed may not be up to the prescribed standards.

Constraints of Seed Production

- Problems of satisfactory isolation due to cross-pollination by insects.
- Crops have to be carried over in to the second season
- Plant attains morphological shape and size during the additional growing period, which is not known to majority of the seed growers.

Bolting, Flowering and Seed Setting.

- Exposure of plants to low temperature results in transformation of leaf – primordia into floral primordia.
- The size of the plants are exposed to low temperature.
- Optimum temperature for flowering is 4.4^0c to 10.2^0c
- The larger the plants at the vernalization, greater its tendency to shoot to seed.

Curing, Threshing and Seed Grading

- The ultimate seed quality is depend upon the handling of the harvested crop and care is taken during threshing, curing and storage conditions.
- Curing with branches helps the unripened seed to ripen slowly as under normal conditions in the field.
- Curing improves the colour of the seed and also reduces the shattering lossed in the field.

Threshing

- Threshing should be done on a clear day for once – over operation.
- In the morning the crop is spread on a tarpauline or concrete floor for drying and in the afternoon the seed is extracted by beating with the sticks.
- Seeds can be separated from chaff or broken twigs by winnowing or passing through coarse mesh sieve.
- Drying of seeds to a safe moisture level of 7%

Grading and Seed Yield

- Hand grading of seeds is laborious and takes lot of time.
- Seed grading machines have overcome the difficulty.
- after grading should contain minimum of 98% of pure seed. With 7% moisture.
- Final graded seed weight will determine the quality.

Seed certification standards

1. Field Inspection
2. Field Standards
3. Seed Standards

Field Standards

General requirements

Isolation Distance

Contaminants	Minimum distance (m)	
	Foundation	Certified
Fields of other varieties	1600	1000
Fields of same variety not confirming to varietal purity	1600	1000

Rouging

- The First rouging is done at the time of handling the mature heads.
- The Second rouging is done before the heads start bursting.

Specific requirements

Factor	Maximum permitted percentage	
	Foundation	Certified
Off-type	0.10	0.20
Plants affected by seed borne diseases	0.10	0.20

Factors	Standards for each class	
	Foundation	Certified
Pure Seed (minimum) %	98	98
Inert matter (maximum) %	2.0	2.0
Other Crop seeds (maximum) number/kg	5	10
Weed seeds (maximum) number/kg	5	10
Germination (minimum) %	65	65
Moisture (maximum) %	7.0	7.0
For vapour-proof containers (maximum) %	5.0	5.0

15. AGRICULTURAL METEOROLOGY

Indigenous Climate Knowledge for Farming system

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Indigenous people figure conspicuously amongst groups identified as particularly vulnerable to climate change. Many of their territories are located in areas where impacts from global warming are expected to be both early and severe. Such vulnerable environments include low-lying islands, the circumpolar Arctic, high altitude zones and desert margins. Furthermore, climate change poses a direct threat to the livelihoods of many indigenous populations due to their traditional and continuing reliance upon resources harvested from their immediate environment. While current warming trends promise to be unprecedented, environmental and climatic change is not by any means a new phenomenon for indigenous peoples. All indigenous groups have extensive experience in responding to and negotiating such changes by modifying existing practices, shifting resource bases, restructuring relationships with the environment or altering land use or settlement patterns. This in-depth knowledge provides an essential foundation for community efforts to adapt to this most recent chapter of global climate change. Degradation of soil, decreasing water resources and changes in the climate are the three main obstacles in sustainable agricultural development. Climate including weather is an important abiotic variable influences the crop production especially in semiarid regions. Currently, sensible changes in the general circulation pattern have occurred, both atmospheric and oceanic, as well as in the energy balance of the surface and in the increase of extreme events in temperate areas. In the meantime the world

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policy and economy changed to a more global perspective and relevant efforts have been made in the research of new technologies. Earth observation from space, progress in the field of computer science, information technology via the Internet system, development of electronic devices for monitoring environmental parameters, numerical meteorological models, crop models and seasonal climatological models for climate prediction, improved substantially our ability to measure, compute and control the natural processes.

Traditional climate knowledge system

Traditional knowledge is generally defined as the knowledge of a people of a particular area based on their interactions and experiences within that area, their traditions, and their incorporation of knowledge emanating from elsewhere into their production and economic systems. Traditional knowledge is a cultural tradition preserved and transmitted from generation to generation. It is in contrast with the knowledge generated within the international system of universities, research institutes and private firms[1]. Understanding the local people perception on climate is critical for effective communication of scientific forecast. Since it is learned and identified by farmers within a cultural context and the knowledge base follows specific language, belief and process. The local weather and climate is assessed, predicted and interpreted by locally observed variables and experiences using combinations of plant, animal, insects, and metrological and astronomical indicators. Few of the weather and seasonal climate indicators used to predict the occurrence of the rainfall are given here under:

Weather cones

One of the most reliable of all natural weather indicators are pine cones. These have traditionally been used to forecast the weather as they change shape according to whether it is wet or dry. In dry weather, pine cones open out as the scales shrivel up and stand out stiffly. When it is damp, they absorb moisture and as the scales become flexible again, the cone returns to its normal shape.

Lying cows

This is one of the most well known natural weather indicators. It is said that when cows are lying down in a field, rain is on its way. This is explained by the fact that the cows sense the moisture in the air and are making sure they have somewhere dry to lie down.

Squirrel's tail

In a similar way, squirrels are often used to forecast the weather over the coming winter. If their tail is very bushy or they are collecting big stores of nuts in autumn, then a severe winter should be expected. However, little scientific evidence has been found to support this.

Aches, pain and rain

Humans have also been known to predict forthcoming changes in the weather. The weather can affect the way we feel and when damp, cold weather is expected, some people experience aches and pains. Others feel strange when it is about the thunder, and our household pets can often sense storms before we are aware of them.

- Ant colonies move en mass, sometimes carrying eggs and this is seen as a precursor to rains.
- A group of sparrows frolicking in the sand indicates that there will be rainfall that day or the next day and if they are observed to be playing in water then it is believed that the weather will be dry for some days to come.
- Lapwing bird (Tatihari) never builds nests, but lays eggs of bare soil. If the eggs are found on a higher elevation in the fields/park, it means good rains are around the corner. Eggs laid in the lower level parts of the field, imply a confidence that there will be no danger from any rain, and hence there may be a drought. Further it is also believed that if a single egg is laid, then there will be rainfall only for one month out of four months of the rainy season. If two eggs are laid then rainfall will occur for two

months and similarly four eggs indicate there will be rainfall during all the four months of the rainy season.

Ants shifting their eggs

Sparrow bathing in dust

Lapwing bird

- Frog –Loud and slimy amphibians, the frogs, are said to croak even longer and louder than usual when bad weather is on the horizon. When you hear their volume increase, you can assume a storm is brewing.
- Peacocks dancing and dragon flies swarming couple of hours before rainfall, are commonly known factors for rain prediction across the country.
- If there is a swelling on the lower portion of the camel's legs then rainfall is predicted by the farmers. The swellings are probably caused due to higher relative humidity.

16. HORTICULTURE

Entomophagy: Edible Insects for Humans

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Introduction

Entomophagy is the term used to describe the practice of consumption of insects as food. FAO estimates that insects already form part of the traditional diets of at least 2 billion people. World population is increasing; it is expected to hit 9 billion people by 2050. Current food production will need to almost double but land is scarce will have profound implications on food production, therefore UNs has formulated eight Millennium Development Goals among them 2 are important -Eradicating extreme poverty and hunger, and Reducing child mortality (FAO, 2013). FAO is interested in the use of insects as an alternative food source. Edible insects contribute to the diet of a part of the world population such as those living in Africa, Asia, and Latin America, (Banjo *et al.,* 2006). The most commonly consumed insects globally are beetles, caterpillars, bees, wasps and ants, but in some societies, there is a degree of distaste for their consumption. Insect are rich in protein, amino acids, fat, CHO, various vitamins and trace elements. (Chen and Feng, 1999). Insects also

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have a high feed conversion ratio: on average insects use 2 kg of feed to produce 1 kg of meat compared to cattle that require 8 kg for every 1 kg of meat produced. Insects are cheap and nutritious food for the vulnerable groups. (DeFoliart, 1999). FAO is looking at insects as a food source for the future.

Entomophagy

Is the practice of eating insects - including arachnids (tarantulas) and myriapods (centipedes). The word "entomophagy" derives from the Greek term éntomos, or éntomon, meaning, "insect(ed)," literally meaning "cut in two," referring to an insect's segmented body, and phăgein, "to eat." Combined, the two terms mean, "insect eating.

Consumption of Insect in Different Countries

Country	Consumption of insect
South America	Butterfly, Grasshoppers, crickets, Cicadas, Ants, Flies, Bees and Wasps
Colombia	Giant queen ants, Palm grubs and Caterpillars. Asia Grasshoppers, Crickets, Silk worm pupa, Dragonflies, Termites, and Beetles
Thailand	Giant water beetle. Africa Caterpillars, Mopane worm, Termites and Locusts
Pacific Islands	Papua, Palm grubs, Grasshoppers, Crickets, Stick insects, Mantids and Locust
Australia	Honey ants, Grubs, Moth, Bardi grubs and Cerambycid beetle
China	Silkworm pupa, Fly larvae, Cricket, Blattaria, Termites and Locusts
India	Termite, Dragonfly, Grasshopper, Ants, Eri and Mulberry silkworm, Honey bee, Cricket

Advantages

- Insects provide high-quality protein and nutrients compared with meat and fish.
- Insects are particularly important as a food supplement for undernourished children because most insect species are high in fatty acids (comparable with fish).
- They are also rich in micronutrients.
- Insects pose a low risk of transmitting zoonotic diseases.
- New efforts and standards are required to assure nutritional quality and safety of insect foods.
- Eating insects is very sustainable and healthy for the environment since raising them does not require large amounts of land or other resources.

Disadvantages

- Pesticide use can make insects unsuitable for human consumption.
- Herbicides can accumulate in insects through bioaccumulation.
- Cases of lead poisoning after consumption of chapulines were reported by the California Department of Health Services in November 2003.
- Adverse allergic reactions are also a possible hazard.

The roadmap drawn up during the Expert Consultation Meeting on Assessing the Potential of Insects as Food and Feed in Assuring Food Security in Rome in January 2012 summarized the main tasks that lie ahead:

- Further document the nutritional values of insects in order to promote insects more efficiently as a healthy food source.
- Investigate the sustainability and quantify the environmental impacts of harvesting and farming insects compared with traditional farming and livestock-raising practices.
- Clarify and augment the socio-economic benefits that insect gathering and farming can offer, with a focus on improving the food security of the poorest of society.
- Develop a clear and comprehensive legal framework at the (inter-)national level that can pave the way for more investment, leading towards the full development (from the household scale to the industrial scale) of production and trade in insect products for food and feed internationally.

Conclusion

Edible insects are a promising alternative to the conventional production of meat, either for direct human consumption or for indirect use as feedstock. Considering the immense quantities of insect biomass needed to replace current protein-rich ingredients such as meal and oil from fish and soybeans, automated mass rearing facilities that produce stable, reliable and safe products need to be developed. The challenge for this new industry will be to ensure the cost-effective, reliable production of an insect biomass of high and consistent quality. Regulatory frameworks need to be developed. The close collaboration of government, industry and academia will be essential for success.

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17. PLANT PATHOLOGY

Citrus Greening Disease: A Big Challenge for Citrus Growing Farmers

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Introduction

Huanglongbing (HLB) or citrus greening is the most severe citrus disease that has profoundly changed the size and shape of worldwide citrus production, and the negative effects keep impacting the industry as the disease continues to spread throughout the various citrus growing regions of the world. Practically all commercial citrus species and cultivars are vulnerable to HLB. The disease has an array of symptoms which can be detected anywhere on the plant, from the roots to the leaves, changing the chemical characteristics, and sensory attributes of the fruit.

It is well established that Huanglongbing is associated with the presence of the gram-negative bacteria genus *Candidatus Liberibacter* (CL). Three species are known to cause the symptoms of HLB: CL asiaticus (CLas), CL americanus (CLam), and CL africanus (CLaf). The Asian and the American species can be transmitted by the psyllid *Diaphorina citri* Kuwayama (Hemiptera: *Psyllidae*), commonly called Asian citrus psyllid (ACP), and the African species by the insect *Trioza erytreae* (Hemiptera: *Triozidae*). It affects tree health as well as fruit development, ripening and quality of citrus fruits and juice. Fruit from infected orange trees can be either symptomatic or asymptomatic. The disease affects nearly all varieties of citrus, with grapefruit, sweet oranges, some tangelos, and mandarins being the most susceptible and limes, lemons, sour oranges, and trifoliate oranges the least.

In the early stages of the disease, it is difficult to make a clear diagnosis. The symptoms are more severe during cooler seasons, more so than in warmer months. It is uncertain how long a tree can be infected before showing the symptoms of the disease

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but, when it eventually becomes symptomatic, symptoms appear on different parts of the tree. Infected trees generally develop some canopy thinning, with twig dieback and discoloured leaves, which appear in contrast to the other healthy or symptomless parts of the tree. The symptomatic leaves can be normal-sized, showing yellow coloration or a blotchy-mottle or they can be small, upright and show a variety of chlorotic patterns resembling those induced by zinc or other nutritional deficiencies. The root systems are poorly developed, showing very few fibrous roots, likely due to nutrient starvation. The affected fruits are small, asymmetrical and greener than healthy fruit. Furthermore, symptomatic fruits show higher titratable acidity and lower soluble solids, solids/acids ratio, total sugars, and malic acid levels. Among flavour volatiles, ethyl butanoate, valencene, decanal and other ethyl esters are lower, but many monoterpenes are higher in symptomatic fruit compared to healthy and asymptomatic fruit. The disease also causes an increase in secondary metabolites in the orange peel and pulp, including hydroxycinnamic acids, limonin, nomilin, narirutin, and hesperidin. Resulting from these chemical changes, juice made from symptomatic fruit is described as distinctly bitter, sour, salty/umami, metallic, musty, and lacking in sweetness and fruity/orange flavour. The changes in the juice are reflective of a decrease in quality of the fresh fruit. However, a blend with a higher proportion of symptomatic juice would present a detectable and recognizable off flavour.

General Management strategies:

Avoiding the spread of infection by removal of symptomatic trees, protecting grove edges through intensive monitoring, use of pesticides, and biological control of the vector. Enhanced nutrition by foliar sprays of readily absorbable nutrients and phytohormones. Regulating soil pH to enhance nutrient uptake, and precision irrigation based on soil moisture sensing technique.

*****

A Tribute to Dr.S.S.Purohit, By Hon. Chief Editor

In this write up I would like to share my experience with a great man, a legend, an expert of his field, a man with international recognition and a man who has done exceptionally well in his life time. Yes I am talking about a great botanist Dr. Shyam Sunder Purohit who is known in the publication line as Dr. S.S.Purohit, among his colleagues and friends as Shyamu and among college friends as Purohit or Purohit Sb.

Dr. Purohit does not need any introduction if we talk about the Botanist or the horticulturists or plant physiologists or person from Agriculture Field. The scientists contemporary to him know Dr. Purohit and his contribution very well. His introduction is also not needed for the academicians and authors who were associated with him as authors of the books or authors of articles be it research or popular article. However, for me it is not possible to proceed further without giving introduction of star which has gone for heavenly abode on **15th of May 2023**, the day which has taken, Dr.Purohit, away from his near and dears. He has left all of us leaving one son and two daughters and their families in grief.

Dr. S.S.Purohit was M.Sc. Gold Medallist from Udaipur University and served as Lecturer in various Government colleges in Rajasthan. He took the voluntary retirement from Government Service when he was working as Vice Principal of Dungar College Bikaner in the year 2000 much before his actual date of retirement which was in 2008. This in itself is evident that he was a man of great confidence and will power. One of his colleagues, who is known to me too, used to say “there are thousands of lecturers in India but (to his knowledge) only Dr. S.S.Purohit is there who has established a great empire in publishing field and got recognition internationally”.

I used to share this version of his friend with him and used to ask about what has encouraged him to be a publisher and not the author like other lecturers and academicians. To my surprise I got a very simple and straight reply that his **zeel and need** were two factors which resulted into him being a publisher. He shared his own experience with me and today I want to share the same with all the readers.

Story Behind Becoming a Publisher

The following story was narrated by Dr. S.S.Purohit to the editor: He said that a book was authored by him which was typed and formatted by himself on a simple Remington typewriter. After completing the manuscript he went to Delhi to the offices of some publishers and showed his manuscript. Every publisher used to tell him to leave the manuscript and they would let him know. As it was his original and maiden work so he was not interested in leaving the manuscript with them. He had the fear, in his mind, of copying and stealing of the matter. He stayed in Delhi for few days for this purpose. One fine morning he went to a big publishing house and took the appointment to meet the owner. He got the appointment and met with owner. The Gentleman was not very enthusiastic but asked him (Dr.Purohit) the purpose of meeting. Dr. Purohit, as he was a very straight forward and simple man, gave his manuscript immediately and requested the gentleman to arrange for publication. The Gentleman, as stated, was not very passionate and excited. He wanted to get rid of Dr Purohit so he just looked at the manuscript and said " Look Mr. I receive number of such requests on daily basis and so many persons like you come to me for this I cannot help you in the matter." Dr. Purohit requested him repeatedly, as the publisher was a renowned one. But his requests did not affect the gentleman who ultimately told him to leave his office and talk to some other publisher. Dr. Purohit, as he narrated, requested once again which angered the gentleman and he literally told him to immediately leave the office. Dr. Purohit had no option except to come out of his office. As per Dr. Purohit this was turning point of his life and he decided that he himself would publish the book. He was confident that the book once come into the market will be accepted by the students and teachers immediately. He came back to Bikaner, where he was posted, and started his first business setup in the name of Agro Botanica. The book was published by the new publisher and marketed. It received a great response from the readers' community and the new publishing house came into existence at Bikaner in Rajasthan.

The journey as an author cum publisher began and Dr. Purohit did not see back thereafter. He had the passion of reading and writing only and started writing books. To the surprise of the readers there are more than 120 titles in his name in addition to numerous articles in National and International Journals.

He was receipient of award for **best Scientific Hindi Writing** from Lucknow Hindi Granth Acadamy and the award was given by the then Honourable CM of Uttar Pradesh Shri V.P.Singh.

Agro Bios India

A name well known to almost all the Universities, Agriculture Institutes, Agriculture Colleges, KVKs, and Agriculture and Horticulture Departments of both the state and the Central Government is brain child of Dr. Purohit and was founded by him after he took the Voluntary Retirement in the year 2000. The owner of this publishing house is Mr. Updesh Purohit, Dr. Purohit's son, and till his last day he (Dr.Purohit) worked as Director of the organisation. This publishing house is known for the ethics and the principles. Agro Bios India is one of the best publishers in India with more than 1000 titles to its credit. Almost in all universities and colleges of India books of Agro Bios are in demand or are in syllabus. Not only in India but the books are in syllabus out of country too in Asian and European countries.

The whole Readers Shelf family prays God to give courage to all family members to bear this loss. **What I can express**, at the most, is that he had a profound impact on my life and he will be greatly missed. He may be gone but will always be there in my heart, I believe.

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