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

### 1. ENVIRONMENTAL SCIENCE

**Rainwater Harvesting, A Potential Step Towards Conserving the Water**

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Rainwater harvesting is a method of inducing, collecting, storing and conserving local surface runoff for agricultural production and domestic usage.

**Basis for water harvesting**

- Water is essential to all lives—human, animal and vegetation.
- Adequate supplies of water be developed to sustain such life.
- Preserve the hydrological balance and the biological functions of all ecosystems.

**Need for harvesting rainwater**

- To attain self-sufficiency for fulfilling the water needs.
- Supplying water to ever-increasing population.
- To reduce over dependence on depleting and polluted ground water.
- Preventing soil erosion and run off.

**Method of rainwater harvesting**

There are two methods used for harvesting rainwater

- **Surface runoff harvesting**: Runoff water could be caught and used for recharging...
Roof top rainwater harvesting: The rainwater is collected from the roof of the house/building. Collected water can be stored in water or diverted to recharge aquifers.

Components of rainwater harvesting system
- Catchment: Here the rainwater is directly received and collected.
- Transportation: collected water is transported to the storage unit.
- First flush: Used to flush off the water received from the first shower to avoid possible contamination of storage unit.
- Filter: Used to remove colour, dirt, turbidity, microbes and insects remains present in the water.

Recharging the ground water:
Main principle is to allow the percolation of rainwater in to the ground instead of surface runoff. Different ways to recharge the groundwater is as follows
- Recharging of bore wells
- Percolation Tanks
- Recharge pits
- Recharging of dug wells
- Soak ways or Recharge Shafts
- Recharge Trenches

Significance of rainwater harvesting
- Rainwater is a comparatively clean and available free of cost.
- Rainwater is not chlorinated and acts as a supplement to groundwater or municipal water connections.
- It lower the water supply cost and can provide back-up source of water during emergencies.
- It is socially acceptable and environmentally friendly.
- Make use of simple and affordable technologies that are easy to maintain.
- Reduces possible flood from runoff and prevents top soil from being eroded.
- Is free from sediments, fertilizers and pesticides contamination.
- Is best suited for water deficit areas and could be used for domestic purpose.
- It can be used to recharge groundwater and to irrigate the crops.

Precautions while adopting rainwater harvesting technology
- Maintaining clean roof or terraces free from dust and algal growth, to be used for harvesting.
- Roof should be free from toxic substances and materials such as chemicals, rusting iron, manure, detergent and faecal matter.
- Nesting of birds on the roof should be prevented.
- Polluted water should not be used to recharge ground water and only be recharged through rainwater.
- Before recharging, filtering should be provided and is regularly monitored and maintained.
- Before the arrival of rainy season, the whole system viz. roof catchment, pipes, screens, first flush, filters, tanks should be checked.

Conclusion
Water is regarded as the river of life, is now fast depleting and getting contaminated through various natural and anthropogenic factors and resulting in far reaching consequences on both biotic and abiotic resources. Harvesting the rainwater, its judicious use and maintaining the water balance is the potential step to conserve the water as the best gift to the future generation.

References
2. **AGRICULTURE**

**Plastic Pollution in Soil**

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**The Issue**

Since its rise in the 1950s, the plastics sector has increased significantly and today represents one of the largest and most economically important sectors to our society. The properties of this material, such as its durability, malleability, light weight and low costs, have contributed to the growth of the sector and its multiple applications. For instance, plastics are extensively used in packaging, car manufacturing, building and construction, and agriculture. Despite the multiple benefits that the material offers, plastics are associated with high levels of waste and leakage to the environment. This is the result of single-use plastics applications, inadequate end of-life treatment, low recyclability and reusability rates and high potential of disintegration into micro-plastics (Geyer et al., 2017).

**Sources and pathways**

As is the case for marine litter, plastics find their way to terrestrial environments through different sources and as a result of certain trends and practices.

**primary microplastics**

Represent an important source of marine and freshwater litter, these have also been identified in terrestrial environments as a result of sewage sludge containing micro fibres and microplastics being applied to agricultural land (Horton et al., 2017).

**Secondary microplastics**

They are released during municipal solid waste collection, processing, transportation and landfiling. In addition, wind contributes to the dissemination of microplastics, either across land, or from land to water and vice versa. On land, secondary microplastic contamination is also linked to the use of agricultural plastics, such as polytunnels, silage bailing and plastic mulches. Additional plastic items used for agricultural purposes and which therefore represent potential sources of microplastic contamination in soil are containers, packaging and netting. Fragmentation on land is then enhanced through sunlight, which has a greater impact on these plastics than it does on those in the water (Horton et al., 2017).

**Challenges**

Harmful substances and chemicals – Additive substances such as chemicals are commonly added to plastics and are therefore likely to be present in microplastics in the environment, representing a potential harm.

Biodegradability concerns – Plastics are widely used in agriculture and all present differences in their rate and level of degradability in the soil, depending on the main polymer component.

Ingestion – Microplastics could enter the food chain and therefore potentially contaminate food for human consumption, inevitably leading to ingestion.

**Policies and regulations to address the challenges**

A range of measures are implemented throughout the plastics value chain which can either directly or indirectly reduce the leakage of plastics into soils and the wider environment.

**Product design**

Upstream measures affect the production of plastics, aiming at increasing its reusability and recyclability. Extended Producer Responsibility (EPR) schemes and the modulation of fees based on criteria of reusability, durability and recyclability play...
an important role.

**Bans and phase-outs**
Bans and phase-outs are widely applied to plastic products or even specific uses (e.g., cosmetics) due to the increasing concern over the health and environmental risks of certain plastics applications.

**Taxes and charges**
Taxes and charges are market-based instruments which provide incentives to reduce the use of certain materials, products or specific applications.

**Regulations on fertilisers**
Regulations can help to determine how fertilisers are manufactured, handled and applied. National legislation in some cases provide specific guidelines on contaminants.

**Conclusions and way forward**
The problem of plastic pollution in terrestrial environments and more specifically in the soil has only recently been receiving attention. In addition to representing an important source of marine litter, plastics are produced, consumed and disposed of on land, highlighting the presence of plastics in the terrestrial environment as well.

Moreover, research shows that plastics are increasingly being used for agricultural purposes, further evidencing the potential of plastics contamination in the soil. While a number of measures are being implemented with the aim of tackling marine plastic litter, further emphasis is needed to address the inadequate treatment of plastics and the leakage of both macro and micro plastics on land.

**References**

3. **AGRICULTURAL ECONOMICS**

**Economic Slowdown of Indian Economy**
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**Introduction:** Economic slowdown represents that growth rate of economy is slowing down which is measured in terms of GDP. The crisis brewing within the Indian economy has gained unanimous acceptance by now. Even the latest annual report of the RBI for the fiscal year 2018-19 (or FY19) confirmed that the Indian economy has indeed hit a rough patch. The growth of real GDP for the first quarter of 2019-20 was 5.0 per cent as compared to 8.0 percent in the corresponding period of previous year (Fig. 1), whereas the growth rate of real agriculture, industry and services sectors is estimated at 2.0 percent, 2.7 percent and 6.9 percent respectively in Q1 of 2019-20. This is an indication of tougher times ahead. This is the third instance of an economic slowdown for India in the past decade after the ones that began in June 2008 and March 2011. The technical term for the same is growth recession. A recession is defined in economics as consecutive quarters of contraction in GDP. But since India is a large developing economy, contraction is a rarity. A growth recession is more commonplace where the economy continues to grow but at a slower pace than usual for a sustained period, what India has been facing nowadays.
Factors causing Slowdown: Both Macro and Micro factors are affecting the economic growth of the country.

Micro Economic Factors: Small or individual factors like Inflation in particular commodity, income of certain group of individuals, etc. are affecting the economic growth. This is visible from production as well as on consumption point of view

- Slowdown in Automobile Sector: Automobile sector slowdown affected the growth of economy to a large extent. E.g.: Maruti Suzuki, largest car maker of India, had posted a double digit growth rate of 14% during 2018 (first Quarter) but during 2019 it came down to less than 2%. Due to which they announced cut in production which led to fall in total output further causing the GDP of country to fall. Secondly, the employment generation came down. Thirdly, consumption or demand of consumer showed decline in the economy's growth. As India is a demand driven economy due to which there is a fall in GDP.
- Discretionary expenditure on products like Cars, Air conditioners, etc. consumer durables came down. But now there are signs of its shifting to non discretionary items like food, etc. if it totally passes to non discretionary items, it will cause major course of worry. Because it will lead to major fall in GDP as consumption expenditure contributes to 56 % of GDP of India.

Macro Economic Factors: Eight core sectors (steel, cement, electricity, natural gas, refinery, crude oil, fertilizer and coal) are important contributors of 40% of industrial production of India. They also showed significant decline in their growth. Ultimately worsening the situation of economy of the country.

Reasons for present economic Slowdown:

- Demand for Passenger Vehicles slowed down due to huge fuel price, high rate of interest, less credit availability.
- Demonetization & GST: Demonetization and GST both had long term penetrated effects on GDP growth. During present phase, informal sectors faced a lot. Cash was crewed out of economy and business found difficult to grow. Currency in circulation fall down by 1%. Slowdown is a crisis triggered by a liquidity crunch due to the note ban. India has a substantial informal economy that runs on cash. A large portion of this involves legitimate activities that are below the tax threshold and therefore should not be thought of as part of the “black” economy. Agriculture, for example, constitutes around 15 per cent of GDP, runs mainly on cash, and is mostly tax-exempt. The farm economy was hit by the sudden withdrawal of cash from the system during demonetization.
- Bank credit slowdown due to lesser credit availability. As bank has to make provisions to cover the bad loans. Increase in NPA led to stringent rules by RBI for bad loans and lack of credit led to lack of investment and further slowdown. PCA by RBI also led to downfall in credit availability in economy.
- Investment: Gross Fixed Capital Formation (GFCF), a metric to gauge investment in the economy, too has declined from 34.3 per cent in 2011 to 28.8 per cent in 2018 as per government data. Similarly, in the private sector, it has declined from 26.9% in 2011 to 21.4% in 2018. (Gross fixed capital formation (GFCF) refers to the net increase in
physical assets (investment minus disposals). It does not account for the consumption (depreciation) of fixed capital.

NBFC crisis started with IL&FS crisis which is a shadow banking sector provides credit to the industrial sectors. Here also liquidity crisis occurred in NBFC which made slowdown in economy by cutting down the credit availability and reduction in consumption and production.

Conclusion
Recession can be short-lived if corrective actions are taken immediately, failure of which can have a prolonged effect on the health of an economy. Amidst the news of slowdown, rise in FDI inflows from $12.7bn (FY19) to $16.3 bn (Q1 FY20) brought respite for the government. In a welcoming move, government revised GST for the automobile sector, opened up FDI in contract manufacturing sector and even announced the recapitalization of the banking sector. Together with these, it should also focus on optimum utilization of funds granted by RBI and direct them to boost investment in the economy both infrastructural and research investment. Way Forward: Some of the measures are listed below which may help to improve the economic conditions:

1. Simplify GST: Government must radically simplify and rationalize the GST regime, even if it means a loss of revenue in short term.

2. Revive agriculture: Government must find innovative ways to kickstart rural consumption and revive agriculture.

3. Capital creation: Government must tackle the lack of credit for capital creation. It is not only the public sector banks, but also the NBFCs that are choke.

4. Revive jobs centric sectors: Key job-intensive sectors like textiles, auto, electronics and affordable housing must be revived and assured priority lending, especially for MSMEs. Also narrated for taking measures to boost investment, especially private investment, that is the key driver that drives demand, creates capacity, increases labour productivity, introduces new technology, allows creative destruction, and generates jobs.

5. Boost exports: We need to find ways to address export markets that have opened up as a result of the trade wars between the United States and China.

6. Development of Infrastructure: There needs to be a credible roadmap for massive public infrastructure development, including through private investment.

References:
https://economictimesofindia/news/economy/indicators

4. AGRICULTURAL MICROBIOLOGY
Pseudomonas Fluorescens as a Biocontrol Agent
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INTRODUCTION
It is aerobic, gram-negative bacteria, ubiquitous in agricultural soils and has many traits that make them well suited as biocontrol agents of soilborne pathogens.
competence, and the mechanisms of pathogen suppression.

**Mechanisms of Bio-Control Pseudomonas Flurescens against Different Plant Pathogens**

1. **Antibiosis:** It defined as heterogeneous group of lowmolecular-weight organic compounds that are deleterious or harmful to the growth or metabolic activities of other microorganisms. The production of one or more antibiotics is the most important mechanism of plant growth promoting rhizobacteria which facilitates the antagonistic against many phytopathogens. Six classes of antibiotic compounds are better associated with biocontrol of plant diseases: Phloroglucinol, phenazines, pyrrolnitrin, pyoluteorin, cyclic lipopeptides and hydrogencyanide. The important antibiotic 2, 4-diacetylphloroglucinol (DAPG) produced by *Pseudomonas* has effectively cause membrane damage to *Pythium* spp. and particularly has inhibitory action against zoospores of *Pythium* spp.*Pseudomonas* are potential biocontrol agents, that showing competitive interactions with other microorganisms including fungi, bacteria, protozoa and nematodes by producing lipopeptide bio-surfactants. It has the capacity to produce phenazine antibiotic, showing antagonistic activity against *Fusarium oxysporum* and *Gaeumannomyces graminis*.

2. **Competition For Root Niches And Nutrients:** Soil microorganisms are highly dependent on plants for the nutrients they secrete in the rhizosphere. The surface surrounding rhizosphere is significant carbon sinks and provides a large number of other important nutrients such as H+, free oxygen iron, water, enzymes, mucilage, antimicrobials vitamins, plant growth regulators, and other secondary metabolites. Thus, the root attracts a great diversity of microorganisms, including pathogens, creating competition for these nutrients and niches. *Fluorescent Pseudomonas*

and some other fast growing PGPRs adapt themselves to such condition and they thus become competitive with pathogens. They move using their flagella and are guided through chemotactic responses and reach root surfaces by active motility facilitated by flagella. Bacterial lipopolysaccharides, in particular the O-antigen chain, can contribute to root colonization. The O-antigenic side chain of *P. fluorescens* PCL1205 has been found to be involved in root colonization. The ability of PGPRs to colonize roots is related to their ability to secrete a site-specific recombinate. Endophytic *P. fluorescens* strain ALEB 7B inhibit the growth of *Atheliarolfsii* strain SY4 by secretion of antibiotics and lytic exoenzymes and competition for spaces and nutrients.

3. **HCN Production:** HCN has been long known for its role in disease suppression. The production of HCN is one of the mechanisms involved by *fluorescent Pseudomonas* in disease suppression. The rate of HCN production by microbes may also vary depending upon the crop species probably due to difference in amino acid composition of root exudates. Certain HCN-producing bio-control *fluorescent pseudomonas* are implicated for their role in the induction of resistance against diseases caused by phytopathogenic fungi, such as *Thielaviopsis basicola* on tobacco, *Septoria tritici*, and *Puccinia recondita f. sp. tritici* on wheat. HCN inhibits the terminal cytochrome c oxidase in the respiratory chain. However, apart from its beneficial role in plant disease protection, microbial HCN may have deleterious effects on several plants. A close relationship is hypothesized to be present between the bio-control activity of *fluorescent Pseudomonas* and their HCN production ability.

4. **Siderophore Production:** Synthesis of iron-chelating compounds, such as siderophores, by *Pseudomonas* is a characteristic feature visible in some
isolates from bulk or rhizosphere soils. In culture media with trace amounts of iron, a yellow-green halo can be observed, which may be fluorescent under ultraviolet light. Iron is an important micronutrient required by the microbes and being highly insoluble is often a limiting condition in the rhizosphere. Iron binding ligands (siderophores) for iron acquisition to have a competitive advantage over other microorganisms. These siderophores bind to ferric iron in the soil or the root zone and are then taken up using outer membrane receptors. Their different affinity to ferric iron depends on their structural, that is, hydroxymate- and phenolate/catecholate-type structures, classified as either pyoverdins or pseudobactins. Kloepper, was the first to isolate fluorescent siderophore from strain B10 with disease suppression activity. Therefore, it restricts the growth of deleterious microbes by limiting iron availability. Interestingly, siderophore-mediated iron competition by \( P.\) \textit{fluorescens} may also be useful to prevent growth of human pathogen \( \text{Escherichia coli} \) O157:H7 growing on food products.

5. \textbf{Induced Systemic Resistance (ISR):} Colonization of plants with some plant growth promoting microorganisms may lead to ISR and protection of plants against various pathogens. ISR is generated in response to an external stimulus that provides plants with defensive immune capacity. The mechanisms of ISR include growth promotion, physiological tolerance, induction of cell wall reinforcement, and increase in production of phytoalexins, defense enzymes, antioxidants, proline, pathogenesis related proteins. Under iron limited conditions several \( P.\) \textit{seudomonas} produce salicylic acid which in turn play a major role in SA-dependent signal transduction pathway. Induced systemic resistance is broadly defined as activation of latent defense mechanisms in plants prior to pathogenic attack. The mechanism has been hypothesized rhizobacterial systems. It is associated with increased synthesis of certain enzymes such as peroxidase, increased levels of certain acid soluble proteins and the accumulation of phytoalexins in the induced plant. The seed bacterization of common bean with \( P.\) \textit{fluorescens} S97 was reported to suppress the halo blight caused by \( P.\) \textit{syringevp. phaseolicola} through induced systemic resistance mechanism.

5. **PLANT PATHOLOGY**

**Biosensors in Detection of Plant Pathogens**

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Worldwide, plant diseases cause major economic losses in agricultural production. Monitoring and detection of diseases in plants is critical for sustainable agriculture. Early information on crop health and disease detection can facilitate the control of diseases through proper managemental strategies. Widely used detection methods are real-time polymerase chain reaction, microarray and enzyme-linked immunosorbent assays (ELISA) that can be highly sensitive and specific, but they often require extensive sample cleanup and biomolecule purification. In this context, biosensors show promising potential due to their speed of analyses as well as label-free detection of pathogens. A biosensor is analytical device rely on the intimate coupling of a biological recognition element with a physical transducer to convert the biological signals into a electrical signal or
other signals, proportional to the concentration of analytes. A basic unit of biosensor includes a receptor, transducer and processor. The sensing elements may be enzymes, antibodies, nucleic acids or whole cells forming a recognition layer that is integrated with transducer via immobilization. Prof. Leland C. Clark, the father of biosensors, established the concept of utilizing a biological sensing element for the detection of different analytes. Transducers are based upon the parameters of measurement which may be amperometric (current measurement at constant potential), potentiometric (potential measurement at constant current), piezoelectric (measurement of changes in mass), thermal (measurement of changes in temperature) or optical (detect changes in transmission of light). Adsorption, encapsulation, matrix entrapment, covalent binding, cross linking are the major immobilization methods used to achieve close contact between bioreceptor and transducer. Based on biological sensing unit used, biosensors are classified into immunosensor, DNA biosensors and enzyme biosensors. Applications of biosensor techniques are plenty and detection techniques used are ever advancing to suit the purpose of these applications. As one of the most destructive and widespread disease of rice (Oryza sativa) i.e blast caused by Magnaporthe oryzae has a significant negative impact on rice production, blast shows asymptomatic lesions in the initial infection stage, and it will massively propagate further leading to severe loss. Therefore, the most effective method to save the crops from blast is timely detection of M. oryzae in the initial infection stage (within 3 days after infection) using magnetic-controllable electrochemical biosensor for the ultra sensitive and specific detection of M. oryzae in rice plant by using M. oryzae’s chitinases (Mgchi) as biochemical marker and a rice cDNA encoding mannose-binding jacalin-related lectin (Osmbl) as recognition probe has notable advantages such as higher sensitivity, excellent specificity, short analysis time, robust resistibility to complex matrix and low cost (Yang et al., 2014). Ralstonia solanacearum, the causal agent of potato bacterial wilt, is a soil-borne bacterium that can survive in the soil for a long time. The development of sensitive on-field detection methods for this pathogen is highly desirable due to its widespread host range and distribution. A sensitive biosensor based on gold nanoparticles to detect R. solanacearum in soil was thus developed to detect unamplified genomic DNA of R. solanacearum in farm soil. Gold nanoparticles functionalized with single stranded oligonucleotides served as a probe to detect R. solanacearum genomic DNA. The advantages of this strategy include rapidity, facile usage and being a visual colorimetric method (Khaledian et al., 2017)

Biosensors are specific, sensitive, rapid and economical. Thus providing a viable alternative to plant pathogen detection methods. However, problems remain associated with these biosensors are chemical/physical stability of the transducers in the biological samples tested, difficulty in immobilizing biomolecules on transducer surface, poor signal, etc. These problems can also overcome in future. Efforts and funds need to be mobilized to manufacture biosensors on a large scale so as to benefit and make to commercially available for plant pathogen detection.

References
Nonhost resistance is a resistance of plant species against all non-adapted pathogens. It is a broad-spectrum plant defense that provides immunity to all members of a plant species against all isolates of a microorganism that is pathogenic to other plant species. Mechanism of nonhost resistance includes preformed defenses, inducible defenses and defense signalling and downstream processes. The combined deployment of both preformed defenses and inducible defenses along with incompatible host physiology fully combats infection by nonhost pathogens. There are two categories of nonhost resistance: Insight into Types I and II nonhost resistance using expression patterns of defense-related genes in tobacco. Type I, which does not result in visible cell death; and Type II, which entails localized programmed cell death or hypersensitive response (HR) in response to nonhost pathogens, the genes responsible for these two systems have not yet been intensively investigated at the molecular level. Although all cereal crops belong to the grass family (Poaceae), most of their diseases are specific to a particular species. Thus, a given cereal species is typically resistant to diseases of other grasses and this nonhost resistance is generally stable viz., maize resistance gene functions against bacterial streak disease in rice. To determine the feasibility of transferring nonhost resistance genes (R genes) between distantly related grasses to control specific diseases a maize Rxo1 gene that recognizes a rice pathogen, *Xanthomonas oryzae* pv. *oryzicola*, which causes bacterial streak disease was identified and used in development of rice transgenic lines (Zhao et al., 2005). Hydrogen peroxide is indispensable to *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) induced hypersensitive response (HR) and nonhost resistance in *Nicotiana benthamiana*. An exogenous supply of H$_2$O$_2$ at a concentration of 0.1M accelerated *Xoo* induced HR, while the elimination of H$_2$O$_2$ by the application of a catalase blocked the HR-mediated suppression of bacterial growth in *N. benthamiana* (Li et al., 2015). NHR is the plant resistance at species-specific level. The expression of genes involved in nonhost resistance to confer durable and broad spectrum disease resistance is challenging, as it may alter basic plant metabolism. Identification and characterization of plant genes involved in nonhost resistance to develop elite crop varieties, either by molecular breeding or genetic engineering, that express broad-spectrum and durable disease resistance against host pathogens is a sustainable approach for future agriculture.

References


Molecular Breeding

Challenges and Opportunities for Development of Novel Crops

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Introduction

Gene or genome editing includes set of techniques which could assist scientists to modify genomic sequences of a particular target or, plant in precise manner. The techniques enable us to alter the molecular framework of a target gene and its expression behaviour in a predestined region so that it could provide novel insights of structural, functional and expression importance of genomics of an organism. Emergence of various genome editing tools and techniques has brought substantial excitement among agricultural scientists because of its high throughput, simplicity, accuracy and as it offers more opportunities to develop improved and high yielding crop varieties with valuable traits or exclusion of undesirable traits. Research is in progress to improve such crop varieties with novel traits includes higher yields, abiotic stress tolerance, pest and disease resistance, and augmentation of nutritional values, etc. Improving crops with gene or genome editing provides an array of options either by altering nucleotide sequences found in the genomes, altering the allele or by insertion of a novel gene. Due to its higher accuracy, gene editing is widely used techniques than other conventional breeding or genetic engineering methods. Henceforth, this technology is a very efficient and powerful tool that can be useful for securing the world’s food supply chain. In addition to improvement of novel agronomic traits, enhancing the nutritional value of important crops, the genome editing technologies may also provide one of the most effective ways to produce crop that can resist adverse climatic conditions.

Genome editing: Tools and Techniques

Basically, Genome editing is a molecular tool which involved a set of techniques, such as site-specific nuclease (SSN) and a site-specific recombinase (SSR) system for targeted DNA breaks. Both systems entail recognition of a known target sequence. The nuclease in SSN system creates single or double strand DNA breaks and influence DNA repair pathways endogenously. It is basically performed by four main classes of SSN technology developed to cleave specific DNA or genomic sequences includes transcriptional activator-like effector nucleases (TALENs), mega-nucleases (MegaN), zinc finger nucleases (ZFNs), and clustered regularly interspaced short palindromic repeat/CRISPR-associated protein (CRISPR/Cas nuclease) system. Likewise, Several SSR technology such as Flp/FRT and Cre/loxP mediated systems, are proficient to knock-in or knockdown genes in the genome which are mainly depend upon the orientation of recognition sites, for example loxP and FLP site resides at flanking of the target sequences. It was reported in several study that the recombinase mediated gene or genome engineering mainly depends upon action of recombinase which induces higher frequencies of homologous recombination.

How do genome editing tools enable targeted genome modification?

Genome editing uses recent advanced technology to enable site specific genome modification (Voytas and Gao, 2014). Currently, Genome editing or genome engineering techniques are among the most
promising technologies in applied biological science which can develop array of industrial innovation. In general, Genome editing could be done through either site-specific nuclease or site-specific recombinase systems.

1. **Genome Editing Mediated by Site-Specific Recombinase (SSRs):** SSR is a commonly used genomic engineering strategy for implementation and stable modification of the target genome. Numerous site-specific recombinase systems are under study, such as Cre/loxP and Flp/FRT, which have been identified to execute genomic modification (Wang et al., 2011). SSRs are useful tools for manoeuvring of genomes and for gene expression analysis in diverse organisms.

2. **Genome Editing Mediated by Site-Specific Nucleases (SSNs):** SSNs mainly rely on construction of endonucleases proficient of cleaving nucleotides in a set of genomic sequence. SSN has two components, namely DNA-binding domain and specified DNA repair mechanisms. DNA-binding domain binds with sequence to be cleaved whereas after cleaving a specified DNA repair mechanisms activates leading to modification of genes at target sites (Gaj et al., 2013). Currently there are four different SSN families are being used genome modification.
   a. **Meganucleases (MegaN):** Meganucleases (MegaN) are naturally occurring endonucleases, which can recognize and cleave large DNA sequences (12 to 40 bp) in genomes (Abdallah et al., 2015). In addition, being less toxic in tissues MegaN is considered as more beneficial SSN system than others. Apart from its ability to recognise large sequences, it make MegaN as perfect tools for genome editing, but major limitation of this techniques is its rare occurrence and inability to cover all potential loci.
   b. **Zinc Finger Nuclease:** DNA-binding motif such as Zinc finger found in transcription factors which control gene expression. The C-terminal component of each Zinc finger specifically recognizes the DNA sequence to be cleaved. Several approaches are being used to design specific zinc finger nucleases for targeted DNA break of sequences.
   c. **TALEN System:** The TALEN system broadly developed from the transcription activator-like effectors (TALES) produced by the Xanthomonas genus, a phytopathogenic bacteria (Boch and Bonas, 2010). It is widely used genome editing tool because of higher efficiency, accessibility and more safe to use. TALENs are mainly artificial restriction enzymes that could target nucleotide sequences to cleave at specific site.
   d. **CRISPR/CAS System:** A novel genome editing system, called CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) has been first identified in bacterial that gave immunity against viruses. The CRISPR system consists of two major component, non-coding RNAs and Cas (CRISPR associated proteins), which have endonuclease activity. This system directs RNA mediated genome engineering in higher organisms.

**Genome engineering for crop Improvement**

Even though most of genome engineering technologies used to date for crop improvement practice is in nascent stage, some crop or cultivar have been developed world wide using these technologies. Gene knockout using SSNs has been used to expound important genes that could be employed for crop improvement in different plant species, including important crops such as rice, wheat, barley, maize, sorghum and soybean (Voytas and Gao, 2014) The ultimate goals of plant breeding are universal across crop species, for example improving yield potential, extending shelf life of fruits and
vegetables, increasing nutritional content and secondary metabolites and tolerance to biotic and abiotic stresses. Thus in this context available Genome editing tools could be used as an effective tool to design or tailored smart crop with such an important characteristic features.

**Conclusion and Future perspectives**
Plants are used as primary sources of nutrients by both human and cattles. For many decades, conventional breeding was solely used to improve the important properties of staple crops. The presence of diverse alleles in nature ensures improvement of different crops, either by conventional breeding, transgenic developments or genome editing. Genome editing is one of efficient and non-transgenic technology which target precise location at genome for possible modification which is entirely deferent from genetic engineering. Nevertheless, this system faces a numeral obstacles including biosafety regulatory, public acceptance and it needs more technological investments. Apart from such limitations developing crops by genome editing tool are expected to be more acceptable in near future.

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## 8. GENETICS AND PLANT BREEDING

**Crop Biofortification: A Sustainable and Feasible Strategy for Developing Safer and More Nutritious Diets**

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**Introduction**
Despite years of advancements in crop improvement program in relation to cope the food and nutritional security, is still under at hostile level. Several hidden conflicts and climate alterations are trouncing the poorest peoples very deadly and effectively it targeting several parts of the world into everlasting crisis. Even though access to food has improved substantially over the past few decades but large section of peoples worldwide are unable to receive enough nutrition from the food they eat. These foods are substantially poor in overall nutritional contents. Recently, it was noticed and documented that in the nearby future, several threatening clauses such as changing climatic conditions, global population explosion, constricting agricultural lands, rising food prices and environmental stressors will have significant and highly uncertain impacts on both food and nutritional security status of the world. As we know, nutrient deficiency (both, minerals and others) retards the overall growth and development of both crops and humans by causing various diseases. Dietary deficiencies of bioavailable essential
nutrients can be alleviated by adopting various interventions such as through dietary diversification, industrial fortification and, nutraceutical supplementation. But, these interventions are not much effective in terms of cost, time, availability and impact. Since, dietary diversification, supplementation and food fortification programmes work best in urban areas, whereas biofortification is a feasible means of reaching malnourished rural populations with limited access. Hence, with this holistic vision we tries to elaborate the progress and prospects of different biofortification strategies for improving nutrient resiliency in crops, which is likely to play an endeavour role in the effort to ensure comprehensive nutritional security.

**Biofortification: Strategic Advantages**

Dietary deficiencies badly affect more than two to three billion or one in three people, worldwide (FAO, 2016). Deficiency occurs when dietary intake and bioavailability of nutrients are too low to maintain good health. Over the last 50 years, food prices have increased steadily and substantially, making it more and difficult for the poor to afford dietary quality (Bouis and Saltzman, 2017). However, it has various advantages such as long-term, cost-effectiveness, ability to reach remote and rural populations with limited access. Biofortification of crop need only one-time investment for developing biofortified varieties which can be grown and consumed consecutively year after year.

**Implementing biofortification: A major challenges**

For success of a particular crop biofortification program, these questions must be addressed prior to start the program:

- Whether conventional plant breeding strategies are able to augment the adequate nutrient density in staple crops?
- Whether the nutrients absorbed by the crop from soil are able to bioavailable at sufficient levels in edible portion of crops?
- Whether the grown biofortified varieties are accepted by the consumers and eat in sufficient quantities to sustain their dietary requirements?
- Whether it can resolve the “Double Burden: Nutrient deficiencies and associated health issues?”
- Can we feed the ever-growing mouths through Biofortification?

**Enhancing nutrition in foods: Biofortification Approaches**

As a consequence of increased environmental concerns, rapid urbanizations and industrializations, our productive lands are now drastically shrinking day-by-day. As a result, it is believed that global food production may soon be insufficient if the growth rate of the population will not be checked. To feed all of these growing populations, it is enormously essential that agricultural productivity must be extensively amplified within the next few decades. Thus, to secure nutrient enriched food for every mouth, crop scientists has to acquire a strategy through which they can get better productivity of nutrient enriched crops without distressing soil health perspectives (Dimpka and Bindraban, 2016).

1. **Agronomic Intervention:** Biofortification through improved agricultural practices could be an effective and sustainable approach to handle this nutritional security concerns. Farmers have applied fertilizers directly to soil for hundreds of years to improve soil health. The major drawback of this intervention is the cost and impact of the fertilizers on soil, environment and consumers health (human and cattle).

2. **Genetic Intervention:** Genetic biofortification is a strategy that utilizes plant breeding techniques to produce crops with higher nutritional contents, reduced level of anti-nutrients and increased the substances that promote nutrient uptake and transportation to the source-to-sink. Thus, It offers a sustainable solution to alleviate the malnutrition problems by exploring natural genetic variation to develop mineral-dense crop (Velu et al, 2014). In the current scenario, several genetic strategies have been employed and tailored for nutrient bioaccumulation in
the crop.

a. **Conventional plant breeding:**
   Since, adoption of green revolution, conventional plant breeding has made outstanding progress in increasing crop productivity in combination with developments in agricultural technology. Breeders utilize several molecular biology techniques like QTL mapping, association mapping and marker-assisted selection (MAS) for assortment and introgression of desired genes in the target crops.

b. **Transgenic approach:**
   Biofortification of crop enriched with nutrients can be achieved through plant breeding practices, in which parents having trait of interest are crossed over generation to generations to produce cultivars with desired level of nutrients. Transgenic or genetic engineering are one of approach for biofortification which are advantageous when nutrient governing traits does not exist naturally in the crop (e.g., provitamin A in endosperm of rice grain) or when bioavailability of nutrients cannot be achieved by conventional plant breeding efforts.

**Modern technologies to design future biofortified crops**

In this new plant breeding era, genomics can be an effective and feasible approach, which can assist conventional breeding to develop nutri-dense staple crops. Recently, several advanced genomic technologies have emerged that can assist trait specific crop biofortification. These includes SNPs array, next-generation sequencing, transcriptome profiling, oligo-directed mutagenesis, gene silencing (RNA interference), genome editing (ZFNs, MegaN, TALENs and CRISPR/Cas9) technologies, etc.

**Conclusion and future prospects**

It is noticeable, but occasionally we are unable to understand that how our agriculture and food systems provide huge amount nutrients and compounds that our body required to sustain productive and healthy lives. No doubt, Agriculture plays several important roles to sustain the life on the earth. But due to several eco-agricultural constraints it is now to date clear that agriculture is unable to perform their proper functioning spatially in developing countries. Thus, Biofortification and other technological interventions needs scaled up in these countries. It also needs proper evidence and expertise to assemble all the technological innovations for nutrient enrichment in target crop in effective manner. Thus, we can finally say that genetic as well as agronomic biofortification approaches work complementarily but in synergistic manner. Although there is a knowledge gaps and more tasks ahead may discouraging, but employing biofortification is the only feasible and cost-effective approach to ensure a more nourishing future.

**References**


technology

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Introduction

Nutriseed Packs are meant for single time placement in soil at the time of sowing to act as nutrient pile for slow release of nutrients. It is a tubular assembly for placing in soil to raise a plant. Normally fertilizers are broadcasted (surface application) in crop fields, hence the fertilizer use efficiency is low. In this situation, Nutriseed Pack technique helps in improving the nutrient use efficiency and crop yield. Nutriseed Pack Technique has been recently developed in the Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore. Each Nutriseed Pack contains seed at top, enriched manure in the middle and encapsulated fertilizer at bottom. With placement of Nutriseed Packs, adequate level of available nutrients will be slowly released up to the harvest stage of crop.

By placing a Nutriseed Pack vertically or horizontally in soil, each plant can be established. Nutriseed Pack gives support for each plant in the root zone in terms of optimum nutrient supply, biological activity, release of pesticide, etc. and consequently enables the fullest utilization of nutrients by plants. There is no wastage of fertilizer nutrients with Nutriseed Pack. Instead of sowing a seed, a Nutriseed Pack is to be placed in soil. No top dressing is required. Horizontal placement of Nutriseed Pack is equally effective as that of vertical placement.

Reason behind its usage

Average land holding of Indian farmers is 2 hectares. Field operations are begun mostly at the start of season or at the time of supply of water from dams. Nowadays labour scarcity in villages prevails particularly at start of crop season. This delays timely sowing of seeds, fertilizer application, etc. In crop production, fertilizers are costly input. Improper, delayed and broadcast applications of fertilizers are major reasons for the reduction in the yield of crops. Under these circumstances, the readymade method like Nutriseed Pack placement would help farmers to achieve the expected yields. Farmers have to simply purchase them from village industries and use them right away. After implanting Nutriseed Packs in soil the entire nutrient requirement of crop is taken care of. If Nutriseed Pack technology is adopted for deep placement of fertilizer nutrients it can save the fertilizer and labour cost.

Nutriseed Pack placement has been brought out as an alternative means of fertilization in crop production in the place of fertigation or surface broadcast. Yield improvement of 10 to 30 per cent for Nutriseed Pack placement has been recorded in major cereal and vegetable crops over conventional method of fertilizer application. The adoption of this technique lies with the
production of Nutriseed Packs in large numbers and making it available to the farmers adequately at the time of crop season. By the use of automated machineries, Nutriseed Packs can be produced at cheaper cost, thereby reducing cost of crop production for farmer. Cost reduction is due to savings in fertilizer input, cost on labour involved in fertilizer application.

**Impact on Agricultural and horticultural crops**

Originally the concept of Nutriseed Pack was developed for the production of field crops which are propagated by seeds like rice and maize. Later, the technique was applied to crops raised by seedlings. Nutriseed Pack technique has been well tested in research trials and demonstration plots on crops like maize, rice, cotton, cauliflower, tomato, carnation and marigold and found to record more yield and profit over the conventional broadcast method of fertilizer application. Horticultural crops like cauliflower (Aaron, 2011), carnation and marigold (Muthukrishnan and Arulmozhiselvan, 2013) were grown using nutriseed pack which resulted in high yield compared to fertilization by conventional surface broadcast.

### Sale Price of Nutriseed pack

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of Products</th>
<th>Quantity</th>
<th>Selling Cost (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Nutriseed Pack for maize</td>
<td>1 No.</td>
<td>0.80</td>
</tr>
<tr>
<td>2.</td>
<td>Nutriseed Pack for Vegetable</td>
<td>1 No.</td>
<td>1.00</td>
</tr>
<tr>
<td>3.</td>
<td>Nutripellet Pack (without seed)</td>
<td>1 No.</td>
<td>0.75</td>
</tr>
<tr>
<td>4.</td>
<td>Fertilizer Pellet Pack (without seed and manure)</td>
<td>1 No.</td>
<td>0.50</td>
</tr>
</tbody>
</table>

### Advantages of Nutriseed pack technology

- Fertilizer nutrients are given to crops at required amount throughout crop season. No top dressing is required.
- Soil nutrients are not removed and suitable for all soil types.
- Weed growth is reduced in between planted rows.
- Bioinoculants help crop in N fixation, P mobilization and biocontrol of soil borne pathogens.
- Enrichment of manure pellet with pesticide controls stem borer, leaf miner, etc at early stage of crop.
- Suitable for drip irrigation also. Fertigation equipments are not required.
- Several inputs are made available in single location. Farmers can easily get Nutriseed Packs from Village Industries and use them straight away in field.
- Farmers need not know or learn what fertilizers to buy, how much to use, when to apply, etc. After placing Nutriseed Packs farmers only have to irrigate the field for getting expected yields.
- Employment opportunities will be available to workers in village Industries throughout the year for Nutriseed Pack production. In order to know about the method of production of Nutriseed Packs a machinery room facility with prototype machineries is available in the Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore. Entrepreneurs and self-help groups can visit the Nutriseed Pack machinery room and learn about the technology for starting a village industry on their own.

By Nutriseed Pack placement, because of increased fertilizer use efficiency, 50% fertilizer NPK can be saved when compared to 100% NPK blanket dose prescribed for conventional surface broadcast method of fertilizer application.
10. HORTICULTURE

Home fragrance- A waft of potpourri

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What is Potpourri?

Potpourri is a mixture of dried, naturally fragrant plant materials used to provide a gentle natural scent commonly in residential settings. It is usually placed in a decorative wooden bowl or tied in small bags made from sheer fabric. Dried flowers plays a common component of potpourris.

Origin

The word potpourri comes into English from the word “pot-pourri,” which was the French name for a stew with a wide variety of ingredients called, a specialty of the town; Potpourri is often used to refer to any collection of miscellaneous or diverse items.

The basics of potpourri are: thoroughly dried aromatic plant materials, decorative plant materials such as whole spices, chips of pleasant-smelling wood and citrus peel, essential oils and fixative, which combines with the essential oils to preserve their fragrance.

There are some naturally scented plants used in potpourri includes:

- Mentha leaves and flowers
- Mugwot (toxic, adds a musky note to the mix, another moth repellent)
- Orange Fruit Peel
- Pelargonium Leaves from the scented verities
- Pinyon pine Shaving and cones
- Rose Flowers, hips and oil
- Rosemary leaves and flowers

Preparation of potpourri

The trick to potpourri is thoroughly drying everything properly.

1. Gather clean and pests-disease free goods on dry, sunny days. Pick flowers at their peak, shrubs and herbs just when they are about to flower. Always collect 4 times the amount you will need for the final potpourri mix as flowers, leaves etc. will shrink when dried. The ingredients can be gathered and dried independently, then mixed later.

2. Pull off the petals and scatter them loosely on clean paper or stiff plastic in a cool shady place, indoors or outdoors, with ample air circulation. Some recipes suggest sprinkling them lightly with coarse uniodized salt, to fix its colour and make fast-dry of petals. Alternately, gather them loosely in netted shopping bags and suspend the bags from trees or a balcony to help them dry. In case of quick drying method use microwave, place the petals and leaves on high heat for two minutes. Cut the herbs with scissors, leaving a short stem, and tie in small bunches, suspending them upside down in a cool, shady place. Allow them to dry well for several weeks.

3. Mix all the ingredients together and to these ingredients, add a few drops of compatible essential oil. Oil gives a stronger, more long-lasting scent than dried ingredients alone can provide.
4. To prolong the potpourri's scent, use any of these fixatives - orris root, oak moss, cellulose, ground gum benzoin or fiberfix. Fixatives absorbs and retains the volatile scented essences. The best known fixative is orris root which will be available wherever you purchase your essential oils. It is sold in powdered or chunk form. Chunks tend to be effective longer and can be used in sachets or pillows but chunks can't shift through the fabric as the powdered form. Use a ratio of two tablespoons of fixative to about four cups of dried material.

Storage of potpourri
Originally, potpourri was stored in closed ceramic jars which were kept opened when people used the room. The jars were generally placed near a heat source, so that, the perfume would expand in the warm air and fill the room with fragrance. When the people went out, the lids went back on to keep it closed.

Nowadays, the beauty of potpourri is also considered to be part of its charm. Displayed in various ways, dried petals, whether scented or not, can be layered in glass containers, placed in baskets, decoupage boxes, ceramic or silver dishes.

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11. AGRICULTURAL ENGINEERING

Rainwater Harvesting – A Plan on Artificial Recharge of Ground Water Table

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India is the largest user of groundwater in the world. Food grain security of the country is largely dependent on water resources and groundwater resources play major role in irrigation sector. The climate is continuously changing mainly because of change in ecosystem; as result the temperature change is at alarming rate. The length of rainy and winter season has been reduced, while the span of summer season has been significantly reduced. In response, at several places the ground water structure like bore well, tube well, open well etc., have now been started to failure. Peoples are not getting water for their livelihood, crop cultivation becomes impossible, reservoirs are drying etc. In this situation, the harvesting of natural water plays very important role to dilute the problem of water shortage.

Need for Water Harvesting
Rainwater is the main source to feed the demand, that is either for ground water recharge or filling the surface water bodies. As compared to the last several years, the amount of rainfall has been abruptly reduced might be due to change in eco-system. The reduction in level of magnitude has resulted declining water table, apart from due to heavy exploitation of ground water, either in agricultural sector, industries or for domestic usage. And it has been reached at alarming stage, worldwide. As for as India is concerned, in spite of high average annual
rainfall of 1170 mm in comparison to the global average rainfall (800 mm), still there is scarcity of water for fulfilling various demand of the country. It is general observation, that during rainfall occurrence most of the rain water gets flew away to the fluvial system, which ultimately meets to the sea or big water body. A little rainwater is left over the ground surface for ground water recharge, while also results into very little enrichment of water table. All these facts basically force to search the alternatives to harvest the rainwater.

Water Harvesting Structures

**Tassa:** This pits are constructed during dry season by digging the soil, down slope. For making safe storage of runoff, the stones are placed at upslope side around the pits. After constructing such pits in the field, about 1 or 2 handful of dry dung are applied to the pits and covered with the soil, about 2 weeks before occurrence of rainfall.

**Half Moons:** The shape of half moon of bund guides the runoff to enter into their storage space; and also allows to escape excess runoff from around the ends of half moon bank. Its storage area varies from 10 to 20 m². It is constructed by digging the soil and placing the cut soil, around, in the shape of half moon along contour lines is decided on the basis of required ratio between catchment area to the cropping area.

**Contour stone bund:** This type of water harvesting structure is constructed with the help of stone pieces. First the position of contour lines is fixed in the field and then a foundation trench is dug along the marked contour line. The depth of foundation trench varies from 5-10 cm and width 35-40cm. After trenching the foundation, the stone pieces are placed in that and tightly packed.

**Contour bund:** The construction of bunds can be easily done by using machines, due to this reason this method of water harvesting is found suitable for large area. These bunds are constructed on contour at close spacing.

**Permeable rock dams:** It is also one of the water harvesting structures, constructed at the valley bottom. These are used for floodwater harvesting, in which runoff water is spread. The water gets stored in the permeable zone of dam. The valley bottom consists of deposited sediment layer, which is very permeable in nature.

**Direct Artificial Recharge (DAR)**

This is usually carried out using wells. Radial wells and infiltration galleries are also used in direct recharge. While an artificial recharge well can be compared with a pumping well operated in reverse, in fact the hydraulic behavior is very different. Difference between pumping wells and recharge wells is that recharge tends to reduce ground subsidence, rather than promoting it.

**Water Recharge Wells**

The cheapest process is to inject recharge water by force after removing the valve from the bottom of the pump. In this way the flow resistance through the pump impeller is very high. Another method is to alternate recharge periods with pumping periods in order to flush the well; while this operation is not expensive it is potentially dangerous because air contained in recharge water may block the aquifer. A well filter may be located some meters above the top of the water recharge level or aquifer to eliminate any danger of aquifer blockage by the air carried into the system in the recharge water.

**Mixed Systems of Water Recharge**

These represent the best recharging methods, because many of the problems caused by transport of fine materials are eliminated: in this way the risk of aquifer obstruction is reduced. When basins and recharge wells work in combination the basins recharge the first aquifer; wells pump water from this aquifer and then inject it into a lower one. A ring zone of impermeable material of radio Ro is located around every well. This is necessary to slow water flow to ensure minimum circulation in the aquifer, so that recharge water arrives into the well sufficiently filtered and mixed.
Advantages of ground water recharge

- Groundwater recharge stores water during the wet season for use in the dry season, when demand is highest.
- Aquifer water can be improved by recharging with high-quality injected water.
- Recharge can increase the sustainable water yield of an aquifer significantly.
- Recharge methods are environmentally attractive, particularly in arid regions.
- Most aquifer recharge systems are easy to operate.
- In many river basins, controlling surface water runoff to provide aquifer recharge reduces sedimentation problems.
- Recharge with less saline surface waters or treated effluents often improves the quality of saline aquifers, facilitating use of their water for agriculture and livestock.

12. AGRONOMY

Need of Nano-fertilizers in Agriculture

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The word Nano means one-billionth, so nanotechnology refers to materials that are measured in a billionth of a meter (nm). A nanometer is so small that the width of a human hair is 80,000 nanometers. The term "Nanotechnology" was first defined in 1974 by Norio Taniguchi of the Tokyo Science University. Nano-technology, abbreviated to "Nano-tech", is the study of manipulating matter on an atomic and molecular scale. By and large nanotechnology deals with structures in the size range between 1 to 100 nm and involves developing materials or devices within that size. The size of a nano-material is typically about 1 to 100 nanometers. They can be naturally occurring or engineered. Due to their extremely minute size, they have many unique properties that are now being explored for new opportunities in agriculture. There are naturally occurring nano-particles that have been previously proposed for agricultural use, such as zeolite minerals and engineered nano-materials can now be synthesized with a range of desired chemical and physical properties to meet various applications. Nano-fertilizers are being studied as a way to increase nutrient efficiency and improve plant nutrition, compared with traditional fertilizers. A nano-fertilizer is any product that is made with nano-particles or uses nano-technology to improve nutrient efficiency.

Agricultural land is decreasing day by day due to erosion, environmental pollution, unconscious irrigation and fertilization. On the other hand, it is necessary to increase agricultural production in order to meet the needs of the developing industry as well as the nutritional needs of the growing population. In the recent years, nano-fertilizers have begun to be produced to obtain the highest amount and quality of production from the unit area. Previous research shows that nano-fertilizers cause an increase in the use efficiency of plant nutrients, reduce soil toxicity, minimize the potential adverse effects of excessive chemical fertilizer use, and reduce fertilizer application frequency. The most important properties of these fertilizers are that they contain one or more of macro and micronutrients, they can be applied frequently in small amounts and are environmentally friendly. However, when applied at high doses, they exhibit decreasing effects on plant growth and crop yields, similar to chemical fertilizers. Present agriculture is generally chemically intensive where using more doses of chemicals for insect, disease, weeds and nutrient management to get maximum
production per unit area without caring about natural resources and ecosystems. In present agriculture fertilizer contributes to the tune of 50% of the agricultural production but increasing use higher doses of fertilizers does not guarantee to improved crop yield but it leads several problems like degradation of soil and pollution of surface and underground water resources. Nano-fertilizers are synthesized or modified form of traditional fertilizers, fertilizers bulk materials or extracted from different vegetative or reproductive parts of the plant by different chemical, physical, mechanical or biological methods with the help of nanotechnology used to improve soil fertility, productivity and quality of agricultural produces. Nanoparticles can made from fully bulk materials. At nano-scale physical and chemical properties are differ than bulk material. Rock phosphate if use as nano-form it may increase availability of phosphorus to the plant because direct application of rock phosphate nano-particles on the crop may prevent fixation in the soil similarly there is no silicic acid, iron and calcium for fixation of the phosphorus hence, it increase phosphorus availability to the crop plants.

Three classes of Nano-fertilizers have been proposed:

- Nano-scale fertilizer (nano-particles which contain nutrients).
- Nano-scale additives (traditional fertilizers with nano-scale additives).
- Nano-scale coating (traditional fertilizers coated or loaded with nano-particles).

Need of Nano-fertilizers

Indian agriculture feels the pain of fatigue of green revolution. In the past 50 years, the fertilizer consumption exponentially increased from 0.5 (1960’s) to 24 million tonnes (2013) that commensurate with four-fold increase in food grain output (254 million tonnes). Despite the resounding success in grain growth, it has been observed that yields of many crops have begun to stagnate as a consequence of imbalanced fertilization and decline in organic matter content of soils. The optimal NPK fertilizer ratio of 4:2:1 is ideal for crop productivity while the current ratio is being maintained at 10: 2.7: 1 in India. Nitrogenous fertilizers, particularly urea are heavily subsidized by the government and thus its application is more obvious than other nutrients. The fertilizer response ratio in the irrigated areas of the country has decreased from 13.4 kg grain/kg nutrient applied in 1970’s to just 3.7 kg in 2005. In other words, more amounts of fertilizers is required to produce the same quantity of grain output. For instance, 27 kg NPK/ha was required to produce one tonne of grain in 1970 while the same level of production can be achieved by 109 kg NPK/ha in 2008. In order to achieve a target of 300 million tonnes of food grains and to feed the burgeoning population of 1.4 billion in 2025, the country will require 45 million tonnes of nutrients as against a current consumption level of 23 million tonnes. The extent of multi-nutrient deficiencies are alarmingly increasing year by year which is closely associated with a crop loss of nearly 25-30%. The extent of nutrient deficiencies in the country is in the order of 89, 80, 50, 41, 49 and 33% for N, P, K, S, Zn and B, respectively. In fact, the country is in need of a Second Green Revolution.

Nutritional value and health

Nano-fertilizers providing greater role in crop production and several research study revealed that nano-fertilizers enhanced growth, yield and quality parameters of the crop which result better yield and quality food product for human and animal consumption. This translates into an improvement to three major areas of production.

Advantages of application of Nano-fertilizer as follows,

- **Slow release**: The nano-capsule slowly releases nutrients over a specified period of time.
- **Quick release**: The nanoparticle shell breaks upon contact with a surface such as striking a leaf.
- **Specific release**: The shell breaks open when it encounters a specific chemical or...
Moisture release: The nano-particle degrades and releases nutrients in the presence of water.

Heat release: The nanoparticle releases nutrients when the temperature exceeds a set point.

pH release: The nano-particle only degrades in specified acid or alkaline conditions.

Ultrasound release: The nano-particle is ruptured by an external ultrasound frequency.

Magnetic release: A magnetic nanoparticle ruptures when exposed to a magnetic field.

Conclusion
Nanofertilizers are important in agriculture to increase crop yield and nutrient use efficiency, and to reduce excessive use of chemical fertilizers. Many of these nanotechnologies are still in the early development stage for both medical and agricultural uses. Nanofertilizers are envisioned to have the potential to revolutionize agriculture.

13. AGRONOMY
Conservation Agriculture and its role in Drylands
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Conservation agriculture aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs (FAO). The concept of conservation agriculture evolved from zero tillage. Conservation agriculture is aimed to conserve without harming a natural resources. Its objective is economically, ecologically and socially sustainable agricultural production. The need to feed the burgeoning population and increasing use of fertile land for non-agricultural purposes has led policy makers shifting their attention to relatively less fertile lands in the arid and semi-arid areas as cradle of next green revolution. Today, 560 million poor people live in rural areas in the semi-arid tropics throughout the world. Agriculture in drylands are afflicted with numerous constraints including water scarcity, soil degradation, low soil fertility, low risk bearing capacity of tenants, low farm mechanization, lack of interest from private sector to invest into agriculture due to its unreliable nature and expanding desertification. The main cause of soil degradation include not only intensive cultivation of soil preparation under conventional agriculture, but also the removal or burning of crop residues, inappropriate crop rotation that do not maintain vegetation cover on soil surface or allow appropriate build-up of organic matters, besides deforestation and poor rangeland management.

What is Drylands:
The areas receiving annual rainfall more than 750 mm but less than 1150 mm. These are arid, semi-arid and dry sub-humid areas. Length of growing period of arid region is 1-75 days, for semi-arid is 75-119 days and for dry sub-humid regions is 120-180 days. The area covered by arid regions are 7 %, semi-arid regions 18 % and dry sub-humid regions 20 % in the world. Moisture conservation practices are necessary for crop production. Dryland farming has evolved as a set of techniques and management practices used by farmers to continually adapt to the presence or lack of moisture in a given crop cycle. Dryland farmers know that to financially succeed they have to be aggressive during the good years in order to offset the dry years.
Why it is needed?

It conserve soil and moisture, by adopting several management practices like mulching, intercropping, and by some agronomic practices like contour farming, cover crops and mechanical practices like contour bunding, terraces. Water is limiting factor in dryland agriculture so conservation of moisture is needed. It conserve natural resources like land, water without harming their status. Total cultivated area of India is 143 M ha out of this 108 M ha area is under dryland. There is 58 % of area is under dryland region in India. About 42 % of total yield is comes from dryland regions. About 62 % peoples are linked with dryland farming in India. Conservation agriculture balances yields, resource conservation and increased efficiency for smallholder farmers.

What is Conservation Agriculture:

A concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. Conservation Agriculture aims to achieve sustainable and profitable agriculture by promoting three principles: minimum soil disturbance, soil cover and crop rotation.

1. **Minimum Soil Disturbance:** Direct planting through the soil cover without seed bed preparation. It may do not disturb the soil. Minimal soil disturbance means no tillage. Minimum mechanical soil disturbance which is essential to maintaining minerals within the soil. The crop residue are decomposes and increase the nutrient capacity of soil as they are conserve moisture in it. Reduce erosion and prevent water loss by maintaining the soil cover. No-Till plus mulch reduces surface soil crusting, increases water infiltration, reduces run-off and gives higher yield than tilled soils. Similarly, the surface residue, anchored or loose, protects the soil from wind erosion. Producers can save 30% to 40% of time and labour by practicing the no-till process.

2. **Maintaining Soil Cover:** Protects the soil surface from aggregate destruction by maintaining the soil cover by using straw, crop residues or different cover crops. Enhances water infiltration by water fall on ground are not move fastly as they are conserve in surface of land ultimately increases the infiltration. Reduces soil erosion as cover crop on it. Helps to maintain soil temperature. Increase in organic matter as the crop residues after some times decomposes and improve the soil fertility. The energy of raindrop falling on a bare soil result in destruction of soil aggregates, clogging of soil pores and rapid reduction in water infiltration with resulting run-off and soil erosion. According to Fryer, The relationship between soil loss by wind erosion and the percent of soil cover. Covering 20 % of the surface reduced soil losses by 57 %. Covering 50 % reduced soil losses by 95 % compared to soil with no cover. Crop residues reduces runoff losses and protecting soil surface that are prone to crusting from raindrop action. It also reduce evaporation losses.

3. **Crop Rotation:** Crop selection and choice of cultivars are important decisions made by producers for dryland agriculture. By making accurate decision which crop should be taken by farmers. Crops should be thrive under adverse conditions. Crops should have a short stature with limited leaf area to minimize transpiration. Crops have deep dense root system to procure the soil water and nutrients to maintain the plant growth in adverse conditions. Use early maturing crops like cover crops, smoother crops to grow better and give satisfactorily yield. Plants mature before available soil moisture is exhausted. Crop diversification remains an important step towards the goal of increasing profitability and sustainability of dryland agriculture. Crop rotation should be including legumes.
Problems in Applying Conservation Agriculture in Dryland Regions:
- Competitive uses of crop residues.
- Weed preponderance.
- Lower crop yields.
- Lack of new implements and operating skills.
- Nutrient immobilization.
- Carry-over of insect-pests and diseases pathogen.
- Low investment capacity of dryland farmers.
- Lack of sufficient research on conservation agriculture in drylands.

References:

14. PLANT PATHOLOGY

Coffee Rust and their Management

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Coffee is a genus of flowering plants in the family Rubaceae. Coffee species are shrubs or small trees native to tropical and southern Africa and tropical Asia. The seeds of some species called coffee beans, are used to flavor various beverages and products. The coffee plant affected by various diseases among the diseases rust one of the serious fungal disease is coffee rust. Hemileia vastatrix is a fungus of the order pucciniales that causes coffee rust.

Symptomology
Infection occurs on the coffee leaves. It mostly affects leaves or sometime affects tender shoots. The first observed symptoms are small pale yellow spots on the upper surface of the leaves. These spots gradually increase in diameter, masses of orange uredospore appear on the under surface of the leaves. The powdery lesions on the undersides of the leaves can be orange yellow to red orange in color and there is varied from one region other region. The infected leaves drop prematurely, leaving long expenses of twigs devoid of leaves. Finally reduce the yield.

Pathogen characteristics
Coffee leaf disease was first reported by an English explorer on wild coffee species in the Lake Victoria region of east Africa in 1861. In 1869 the reverend H.J. Berkeley and his assistant Mr.Broome, reporting in the gardener's chronicle, described the fungus they found associated with the disease on some dried coffee leaves sent from Ceylon (now srilanka), they gave the name Hemileia vastatrix to the devastating fungus with half–smooth spores. Hemilia vastatrix producing dikaryoticmycelium. Occasionally under cool, dry conditions towards the end of the season, teliospores produce basidia each of which forms four haploid basidiospores. Absent of alternate host.
Survival of the pathogen

*Hemilia vastatrix* survives primarily as mycelium in the living tissues of the host and since infected leaves drop prematurely this effectively removes a large amount of potential inoculum from the epidemic. But a few green colored leaves always persist through the dry season & dryuredinospores can survive about 6 weeks, so there is always some viable inoculum to infect the newly formed leaves at the start of the next rainy season.

**Spore dissemination**
Uredospore can be dispersed by both wind and rain.

**Infection**
Uredospore germinate only in the presence of free water (rain/heavy dew). Pathogen requires about 24-48 hours of continuous moisture. So while heavy dew is enough to stimulate uredospore germination.

**Sporulation**
It takes 10-14 days from infection for uredinia to develop uredinospore to be formed the rust lesions continue to enlarge over a period of 2 to 3 weeks. A single lesions will produce four to six spores that releasing about 3,000 00 uredinospores over a period of 3 to 5 months.

**Management**
- Collection & destruction of infected leaves from the field
- Growing resistant varieties like S 238, S 395
- Foliar spray of Bordeaux mixture 0.5% before flowering, during rainy seasons in the month of August-September - and October respectively will prevent from the disease.

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**15. HORTICULTURE**

**Strategies for Improving Drought and Salinity Tolerance in Fruit Crops**

Shashi

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**Introduction**
Climate change is one of the most serious problems in the world today cause Food insecurity for large populations and poverty. Abiotic stresses such as salinity, drought, nutrient deficiency or toxicity, and flooding limit crop productivity world-wide. Drought and salinity are two major stresses that affect 1/3rd world population including human health and agricultural productivity (FAO, 2006). Both water stress and salt stress affected more than 10% of arable land, which results in rapid increase in desertification and salinization world-wide.
Drought

Drought is a stress environmental condition in which dearth of water severe enough to check the plant growth. Drought is classified into 2 broad categories; 1. Soil drought 2. Atmospheric drought

Effect of Drought in Fruit Plants

The severity of drought depends on many factors such distribution of rainfall, evaporation and moisture storing capacity of soils. Drought induce numerous morphological, physiological and biochemical changes in all plant organs.

Functioning of stomata - Water deficit causes the guard cells of the stomata to lose their turgor this closes the stomata.

Gas Exchange Limited - In turn reduces carbon assimilation reduce vegetative growth and severely retard the development of plant reproductive organs.

Photosynthetic activity: Reduction in photosynthesis, which arises by a decrease in leaf expansion, premature leaf senescence and associated reduction in fruit production.

Oxidative damage: Generation of reactive oxygen species takes place react with proteins, lipids and DNA, causing oxidative damage and impairing the normal functions of cells.


Mechanism for Drought Tolerance

Plants adapt to survive under drought stress by the induction of various morphological, biochemical and physiological responses.

1. Morphological mechanisms

Escape: Escape from drought is attained through a shortened life cycle or growing season. Allowing plants to reproduce before the environment becomes dry. Like in Coffea (Coffea arabica) and cacao (Theobroma cacao) flower and fruit when rains follow a drought period.

Drought Avoidance: Efficient water absorption from roots. Reducing evapotranspiration from aerial part. Like in Ber, Aonla, Datepalm, Tamarind etc.

Drought Tolerance: Some plants have the ability to tolerate dehydration or maintain turgor pressure through an osmotic adjustment. An increase of antioxidative defence mechanism

2. Physiological mechanisms

Osmotic Adjustment: Osmotic adjustment allows the cell to decrease osmotic potential and, as a consequence, increases the gradient for water influx and maintenance of turgor.

Osmoprotection: The organic and inorganic solutes act as osmoprotectants.

- Inorganic solutes - (K⁺, Ca²⁺, and Mg²⁺).
- Organic solutes - (proline, glycinbetain, aspartic acid, protein, and sugars).

Plant Growth Regulator: ABA, brassinosteroids, jasmonate, salicylic acid and nitric oxide induce stomata closure.


Drought Resistant Strategies

For ensuring the food security for the increasing human population Several strategies are suggested.

- Water management: There are two approaches; 1. Partial Root zone Drying 2. Regulated Deficit irrigation.
- Exploitation of the agronomic practices by which plants can perform well under water stress conditions.
- Selection of crop cultivars that require relatively lower quantity of water for their growth and crop productivity.

Transgenic Approach

Drought tolerance in plants by transfer of genes leading to the synthesis of protectants, such as osmolytes and antioxidants. Transgenic apple (‘Royal Gala’) plants overexpressing a cytosolic APX (ascorbate peroxidase) gene has indicated an increased
tolerance stress. The introduction of p5cs gene in the citrus rootstock Carrizo citrange conferred higher accumulation of proline in leaves.

**Drought Tolerant Rootstock**
- **ALMOND-** Prunus xerophila, P. amygdaliformis, and P. eleagnifolia, native to arid regions, are highly drought tolerant.
- **BER-** Zizyphus nummularia and Zizyphus lotus are drought tolerant.
- **APPLE –** Drought tolerant rootstock-M-7, M-25, MM-111, MI-793.
- **GRAPE-** Rootstock 110R is highly drought tolerant. Dogridge (Vitis champine)- tolerance to drought and salinity.
- **PEAR-** Pyrus betulaefolia is the most drought tolerant, followed by Pyrus calleryana.

**Salinity stress**
Salinity is the presence of excess soluble salt in the soil causes reduction in growth and leaf burning in fruit crops. According to (FAO, 2008) over 6% of the world’s land is salt affected. In addition, out of 230 million hectares of irrigated land, 45 million hectares (~20%) are salt affected. In India, 4.10 mha lands have been reported to be saline soil. Salt affected soils are found in Indo-Gangetic plains, arid regions and coastal areas. The malady continues to increase due to the mismanagement of canal irrigation as well as due to brackish groundwater irrigation.

**Salinity -Mineral Nutrient Relations**
Presence of salts on the soil is usually associated with osmotic and ionic negative effects and lowers the biological activity. Salt accumulation in root zone causes the development of an osmotic stress and inhibition the uptake of essential nutrients like K⁺, Ca²⁺ leading to nutrient deficiency. Salinity leads to K deficiency and toxicity of Na and causing leaf blackening anecrosis, reduce fruitfulness and yield. Salinity can directly affect nutrient uptake, such as Na reducing K uptake or by Cl⁻ reducing NO₃⁻ uptake.

**Salinity Tolerance Mechanisms**
Plants have adapted a variety of mechanisms of salt tolerance. The mechanisms are:
- Salt exclusion-Na⁺ exclusion by roots ensure that Na does not accumulate to toxic concentrations within leaves.
- Salt excretion.
- Osmotic adjustment.
- Membrane composition.

**Salinity Tolerance Strategies**
Several strategies have been used to reduce the impact of salinity in fruit crops. Ion exclusion-Salt tolerance features of it is related to its capacity to restrict the uptake and transport of Cl⁻ and Na⁺ ions from the rootstock to the above ground parts. Ion sequestration, Osmotic adjustments, Macromolecule protection-Enzyme, Membrane transport system adaptation.

**Salinity Tolerant Rootstock**
- **GRAPE-** Grape rootstocks Dogridge and 1613 tolerant to saline. These rootstocks tolerated salinity by exclusion of chloride. The rootstock like B-2/56,110R and 1103P have better sodium exclusion ability than Dogridge and Salt Creek.
- **MANGO-** In Mango salinity tolerance increasing in order Chandrakaran < Moovandan < Bappakai < Nekkare < Kurukkan < Terpentine < Ollur.
- **GUAVA-** Accessions like Psidium nidle and Psidium catellianum could withstand the stress with 15-25 per cent mortality while other cultivars exhibited 50 per cent and more.
- **CITRUS-** Salt tolerance studies in citrus showed that rootstocks Rangpur lime and Cleopatra mandarin were tolerant.
- **ANNONA –** Annona diversifolia and Annona reticulata tolerant to salinity
- **PLUM-** Rootstock-GF557, Marianna GF8/1, Myrobalan29C etc
- **APPLE-** Salt tolerance rootstock-M7, M8, M9, M25
16. HORTICULTURE

Effects of Climate Change on Fruit Crops

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Climate Change
Climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Causes of climate change
2. Anthropogenic Causes:
   a) Green Houses Gases: Carbon dioxide (CO₂), Methane (CH₄), Nitrous oxide (NO₂), Chloro fluoro carbons (CFCs), Ozone (O₃), Water Vapors (H₂O).
   b) Land Use Change: Deforestation, Urbanization.

Actually What Happened in climate Change
- The rate of change in climate has been triggered in recent years.
- The global average temperature has risen by 0.2 to 0.6°C during 20th Century.
- World sea level rise by about 15-20 cm.
- Concentration of GHG has increased by about 30% over the last 2 Centuries.
- The level of atmospheric CO₂ has increased from 280 ppm in 1850 to 385 ppm presently (+37%).
- Methane concentration increased @ 149% since 1850 (1.94ppm).

Green house effect
Radiation reaching the planet is partly absorbed, causing the Earth to emit thermal radiation and part of the radiation is reflected back to the atmosphere.

- Water vapour and radioactively active CO₂, CH₄, N₂O and O₃ etc. partly trap the reflected radiation to warm the surface temperature, a natural phenomenon known as the ‘Greenhouse Effect’. The direct effect of this is to warm the earth’s surface and troposphere or lower atmosphere. This process is known as green house effects.

Challenges due to climate change
- High temperature: High temperature affects the photosynthetic functions of plant.
- Evapo-transpiration: Leading to severe crop water stress particularly in fruit which contain more than 90% water and ultimately influences the yield and quality.
- Salt stress: In plants reflected in loss of turgor, growth reduction, wilting, leaf curling and, leaf abscission, tissue necrosis and ultimately death of plants.
- Low precipitation: Reduces the irrigation water.
- Drought: causes an increase in solute concentration in the soil environment leading to an osmotic flow of water out of the plant cells.
- Flooding: reduces the oxygen level in the root zone inhibiting aerobic processes.
- Outbreak of disease and pest: Due to extreme climate.

Climate Change Challenges For Fruit Crops
- Fruit mineral production and composition could be affected.
- Warmer winters and reduced frosts will weaken vernalization, potentially reducing yields in some crops.
New pests and diseases. Possible increase in mycotoxin risk due to changes in fungal growth. Potentially more inputs (such as water) required for higher yields and canopy cover.

Climate Change in India
Indian agriculture is facing challenges due to several factors such as increased competition for land, water and labor from non-agricultural sectors and increasing climatic variability. It has been projected by the recent report of the IPCC and a few other global studies that unless we adapt, there is a probability of 10–40% loss in crop production in India by 2080–2100 due to global warming.

Impact of climate change on fruit crops
- Low perfect flowers.
- Increase the pollination failures.
- Increased physiological disorders.
- Reduce colour development in apples.
- Early maturity of Citrus, Grapes etc.
- Advancement of bud burst in Almond.
- Delayed panicle emergence due to low temperature.

Climate Change Adaptation and Mitigation
- Adaptation: Adaptation is the process through which people reduce the adverse effects of climate and adaptation measures are meant to protect a community against projected climate change impacts.
- Mitigation: A human intervention to reduce the sources or enhance the sinks of greenhouse gases, for example, reducing the carbon footprint of business operations by cleaner fuels, reducing electricity consumption, etc.

Types of climate change adaptation strategies for fruit crops
- Short term climate change adaptation strategies: Land and water management, Crop management, Nutrient management, Pest management, Crop and cultivar substitution.
- Long term climate change adaptation strategies: Change in land use, Heat and drought tolerant crop varieties.

Adaptation of fruit crops
Management of plant architecture, Use of heat shock proteins, Use of abiotic resistant root stocks, Use of plastics for crop production, To use the Agro-Horti cropping system, Conservation of soil moisture, Use greenhouse technology if possible, Use of green biomass for improving micro, Climate during hot weather, Use of shelter belts or wind breaks to overcome the effects of hot wind with reducing the temperature, Water use efficiency and irrigation methods etc.

Mitigation measures
- Adopting proper policies and protocols at global, national and state levels.
- Strict adherence to rules and regulations.
- Reducing the rate of global warming by reduced consumption of fossil fuels.
- Use of clean and eco-friendly technologies.
- Promoting carbon sequestering / carbon locking / carbon trading.
- In-situ and Ex-situ biodiversity conservation measures.
- Creating all round public awareness.

Climate change opportunities for Horticulture
- Potentially less CO₂ needed for glasshouses.
- Earlier and quicker ripening e.g. with a 2°C temperature increase, some apple varieties could bloom and mature up to 3 weeks earlier.
- Possible increase in yields due to more carbon dioxide available for growth and development.
- Some crops will benefit from increasing temperatures e.g. onions, legumes, carrots and sweet corn.
- The crops every year suffer from frost, hail storm etc and reduces the growth, yield and quality. But now due to climate change, the frequency and intensity of frost, hail storm will be decrease which will help to improve the yield and quality.

Conclusion
Climate systems may change more rapidly than in the past due to heavy industrialization, rapid utilization of fossil fuel and deforestation. Global mean temperatures increased by 0.74 °C during last 100 years. Changes in temperature and precipitation will influence new disease and pests on fruit crops. By adapting mitigation strategies in order to sustain fruit production under impact of climate change and need
more time to become effective.

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17. SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
Role of Bio-Fertilizer in Organic Agriculture
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Introduction
Organic farming has emerged as an important priority area globally in view of the growing demand for safe and healthy food and long term sustainability and concerns on environmental pollution associated with indiscriminate use of agrochemicals. Bio-fertilizers are being essential component of organic farming are the preparations containing live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulolytic micro-organisms used for application to seed, soil or composting areas with the objective of increasing number of such micro-organisms and accelerate those microbial processes which augment the availability of nutrients that can be easily assimilated by plants. Biofertilizers play a very significant role in improving soil fertility by fixing atmospheric nitrogen, both, in association with plant roots and without it, solubilise insoluble soil phosphates and produces plant growth substances in the soil. They are in fact being promoted to harvest the naturally available, biological system of nutrient mobilization (Venkatashwarlu, 2008).

Need of Bio-Fertilizers
Indiscriminate use of synthetic fertilizers has led to the pollution and contamination of the soil, has polluted water basins, destroyed micro-organisms and friendly insects, making the crop more prone to diseases and reduced soil fertility.

Demand is much higher than the availability. It is estimated that by 2020, to achieve the targeted production of 321 million tones of food grain, the requirement of nutrient will be 28.8 million tones, while their availability will be only 21.6 million tones being a deficit of about 7.2 million tones.

Depleting feedstoc/fossil fuels (energy crisis) and increasing cost of fertilizers. This is becoming unaffordable by small and marginal farmers, depleting soil fertility due to widening gap between nutrient removal and supplies, growing concern about environmental hazards, increasing threat to sustainable agriculture. Besides above facts, the long term use of bio-fertilizers is economical, eco-friendly, more efficient, productive and accessible to marginal and small farmers over chemical fertilizers (Subba Roa et al., 2001)

Potential Characteristic features of some bio-fertilizers
Nitrogen fixers Rhizobium: belongs to family Rhizobiaceae, symbiotic in nature, fix nitrogen 50-100 kg/ ha in association with legumes only. It is useful for pulse legumes like chickpea, red-gram, pea, lentil, black
gram, etc., oil-seed legumes like soybean and groundnut and forage legumes like berseem and lucerne. Successful nodulation of leguminous crops by Rhizobium largely depends on the availability of compatible strain for a particular legume. It colonizes the roots of specific legumes to form tumor like growths called root nodules, which acts as factories of ammonia production. Rhizobium has ability to fix atmospheric nitrogen in symbiotic association with legumes and certain non-legumes like Parasponia. Rhizobium population in the soil depends on the presence of legume crops in the field (Arun et al., 2007)

**Azospirillum:** belongs to family Spirilaceae, heterotrophic and associative in nature. In addition to their nitrogen fixing ability of about 20-40 kg/ha, they also produce growth regulating substances. Although there are many species under this genus like, A. amazonense, A. halopraefers, A. brasilense, but, worldwide distribution and benefits of inoculation have been proved mainly with the A. lipoferum and A. brasilense. The Azospirillum form associative symbiosis with many plants particularly with those having the C4-dicarboxylic path way of photosynthesis (Hatch and Slack pathway), because they grow and fix nitrogen on salts of organic acids such as malic, aspartic acid. Thus it is mainly recommended for maize, sugarcane, sorghum, pearl millet etc.

**Azotobacter:** belongs to family Azotobacteriaceae, aerobic, free living, and heterotrophic in nature. Azotobacter are present in neutral or alkaline soils and A. chroococcum is the most commonly occurring species in arable soils. The number of Azotobacter rarely exceeds of 104 to 105 g-1 of soil due to lack of organic matter and presence of antagonistic microorganisms in soil. The bacterium produces anti-fungal antibiotics which inhibits the growth of several pathogenic fungi in the root region thereby preventing seedling mortality to a certain extent. The occurrence of this organism has been reported from the rhizosphere of a number of crop plants such as rice, maize, sugarcane, bajra, vegetables and plantation crops

**Blue Green Algae (Cyanobacteria) and Azolla:** These belongs to eight different families, phototrophic in nature and produce Auxin, Indole acetic acid and Gibberlic acid, fix 20-30 kg N/ha in submerged rice fields as they are abundant in paddy, so also referred as "paddy organisms". N is the key input required in large quantities for low land rice production. Soil N and BNF by associated organisms are major sources of N for low land rice. The 50-60% N requirement is met through the combination of mineralization of soil organic N and BNF by free living and rice plant associated bacteria. To achieve food security through sustainable agriculture, the requirement for fixed nitrogen must be increasingly met by BNF rather than by industrial nitrogen fixation.

**Phosphate solubilizers:** Several reports have examined the ability of different bacterial species to solubilize insoluble inorganic phosphate compounds, such as tricalcium phosphate, dicalcium phosphate, hydroxyapatite, and rock phosphate. Among the bacterial genera with this capacity are pseudomonas, Bacillus, Rhizobiu. There are considerable populations of phosphate solubilizing bacteria in soil and in plant rhizospheres. These include both aerobic and anaerobic strains, with a prevalence of aerobic strains in submerged soils. A considerably higher concentration of phosphate solubilizing bacteria is commonly found in the rhizosphere in comparison with non-rhizosphere soil. The soil bacteria belonging to the genera Pseudomonas and Bacillus and Fungi are more common.

**Phosphate absorbers (Mycorrhiza):** The term Mycorrhiza denotes “fungus roots”. It is a symbiotic association between host plants and certain group of fungi at the root system, in which the fungal partner is benefited by obtaining its carbon requirements from the photosynthates of the host and the host in turn is benefited by obtaining the much needed nutrients especially phosphorus, calcium, copper, zinc etc., which are otherwise inaccessible to it,
with the help of the fine absorbing hyphae of the fungus. These fungi are associated with majority of agricultural crops.

**Zinc solubilizers:** The zinc can be solubilized by microorganisms viz., *B. subtilis*, *Thiobacillus thioxidans* and *Saccharomyces sp.* These microorganisms can be used as bio-fertilizers for solubilization of fixed micronutrients like zinc. The results have shown that a *Bacillus sp.* (Zn solubilizing bacteria) can be used as bio-fertilizer for zinc or in soils where native zinc is higher or in conjunction with insoluble cheaper zinc compounds like zinc oxide (ZnO), zinc carbonate (ZnCO₃) and zinc sulphide (ZnS) instead of costly zinc sulphate.

**Potential role of bio-fertilizers in agriculture**

- The incorporation of bio-fertilizers (N-fixers) plays major role in improving soil fertility, yield attributing character. In addition, their application in soil improves soil biota.
- Under temperate conditions, inoculation of *Rhizobium* improved number of pods plant⁻¹, number of seed pod⁻¹ and 1000-seed weight (g). In rice under low land conditions, the application of BGA+ *Azospirillum* proved significantly beneficial in improving LAI and all yield attributing aspects.
- It is an established fact that the efficiency of phosphate fertilizers is very low (15-20%) due to its fixation in acidic and alkaline soils and unfortunately both soil types are predominating in India accounting more than 34% acidity affected and more than seven million hectares of productive
- Land salinity/alkaline affected all so managed. Therefore, the inoculations with PSB and other useful microbial inoculants in these soils become mandatory to restore and maintain the effective microbial populations for solubilization of chemically fixed phosphorus and availability of other macro and micronutrients to harvest good sustainable yield of various crops.

**Conclusion**

Bio-fertilizers being essential components of organic farming play vital role in maintaining long term soil fertility and sustainability by fixing atmospheric di-nitrogen (N=N), mobilizing fixed macro and micro nutrients or convert insoluble P in the soil into forms available to plants, there by increases their efficiency and availability. In context of both the cost and environmental impact of chemical fertilizers, excessive reliance on the chemical fertilizers is not viable strategy in long run because of the cost, both in domestic resources and foreign exchange, involved in setting up of fertilizer plants and sustaining the production. In this context, organic manures (bio-fertilizers) would be the viable option for farmers to increase productivity per unit area.

**References**


18. FOOD TECHNOLOGY

Areca Tea - A Potential Health Benefits

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Introduction

The areca nut is the fruit of the areca palm (Areca catechu), which grows in much of the tropical Pacific (Melanesia and Micronesia), Southeast and South Asia, and parts of east Africa. It is commonly referred to as betel nut so it is easily confused with betel (Piper betle) leaves that are often used to wrap it (paan). The term areca originated from the Kannada word adike and dates from the 16th century, when Dutch and Portuguese sailors took the nut from Kerala to Europe.

In India areca in grown in an area of 4.73 lakh hectare with the production of 7.06 lakh tons. The production of areca has increased from 2.51 lakh ton in 1991-92 to 7.06 lakh ton in 2016-17. Export of the product is only 8510 tons in 2014-15 whereas we are still importing 50036 ton. The areca industry is widely fluctuating because of high price disparities, threat of ban on areca products, poor value addition and highly inadequate export potentials.

Areca nut consumption and its effect on human health is of much concern in recent times in India. A recent study by the experts at SDM Research Centre in Udupi has found significant anti-diabetic properties in Areca tea. The study states that the activity profile of areca tea is similar to that of anti-diabetic drugs. The study is important especially when there are discussions about the 'harmful' effect of arecanut and the ban on pan masala and supari. However, in India, it has always been believed that arecanut has medicinal qualities and that supari could be bad only when the ingredients mixed in it along with arecanut are harmful.

Areca Tea

Areca Tea is made using processed, naturally grown areca nut. A patented processing method is used to extract active molecules from areca nut and converted into a hot beverage named as areca tea. Areca tea is known for its health benefits. It is already helping lots of people in health issues like acidity, gastritis, cholesterol and has given best results for diabetic people. Areca tea is naturally sweet to taste and rich in antioxidant, rich in proline and natural anti-aging molecules are present only in areca nut among 150 medicinal plants.

NivedanNempe - The Founder of Areca Tea was born in the southern part of India, in a village called Mandagadde, located in the district of Shivamogga, Karnataka. Farmers in the region of the Malenadu where Nivedan was born, depend on Areca Nut for their livelihoods. As per the statistics that he collected, over 5 lakh families were dependent upon Areca Nut cultivation and this triggered the thought of alternate value-added product development. As a pharmacist, Nivedan started working on the photo-chemistry of Areca Nut and sent it to various labs for chemical identifications. In the meanwhile, he collected research papers published on Areca and found that it contains aqueous tannins and many useful chemicals such as anti-oxidants, Proline (Amino Acids) and digestive enzyme enhancing agents. With all the information he had gathered he started working on a new product. Extracting tannins from Areca and aided by his research, Nivedan introduced a new product to the world of tea lovers – Areca Tea.
The AITMC (All India Technical Management Council) under ‘Make in India Excellence Award’ recognized his research and awarded Areca Tea as ‘Innovative Product of the Year’ for 2014-15. With an FSSAI Certificate for production of Areca Tea, Nivedan has also received Intellectual Property Rights from the Patenting Authority.

Health benefits
The seed of *Areca catechu* L. (*Arecales*) is commonly known as betel nut, extensively chewed in many tropical countries of the world (at least 10% of world population). It has been a popular traditional medicine in China, Thailand, Sri Lanka, India, used in the treatment of different diseases like dyspepsia, constipation, beriberi, oedema, diarrhoea urinary, gynaecological disorders and to heal footsore. Traditionally its powder has been used as dentifrice in toothpaste, as taeniacide (kills tapeworms) especially in animals. Areca has high tannin and total polyphenolic content. The extracts of areca nut show potent anti-oxidative and free radical scavenging activity. Areca nut is rich in anti-oxidants which neutralizes and removes free radicals from the body keeping it healthy and immune (Hannan *et al.*, 2012).

Areca Nut also contains high proportion of proline, a free amino acid which is a biosynthetic precursor to collagen. Biologically as age advances, the elasticity of skin significantly decreases by elastase activity resulting in wrinkles. The inhibitory effect of Areca Nut on elastase exhibited 90% inhibition. The number of elastin fibers (responsible for the elasticity of the skin) are increased and gets protected against degradation (Lee and Choi, 1999). The most common diabetes found today is the Type II Diabetes also known as Metabolic Diabetes. Areca Nut aids in digestion increasing metabolism causing a control over Type II Diabetes. Areca Nut extract exhibit a strong inhibitory action on pancreatic cholesterol esterase up to 39.1% which lowers the cholesterol absorption. Areca Nut extract also shows inhibitory activity on triglyceride absorption (Park *et al.*, 2002).

Sushruta, in the 1st century AD, wrote that 'it tends to cleanse the mouth, impart a sweet aroma to it, enhance its beauty and cleanse and strengthen the voice, tongue and teeth, the jaws and the sense organs'. Areca was touted as a medicine for digestive and dental health. It was used to facilitate bowel movements and reduce intestinal worms. Apart from its value when chewed, the nut has considerable uses in medicine too. Paan chewing with betel nut is popularly believed to prevent tooth decay. According to Yunani physicians, betel nut is considered digestive, contractive and diuretic, strengthening the heart and regulating menstrual flow. It is used for overcoming swollen eyes, mental confusion, chronic urinary distress and pus formation. It is also a nerve tonic and an aphrodisiac (Chandak *et al.*, 2013). Increased consumption of caffeine results in insomnia, high blood pressure and stress as caffeine amplifies stress hormones. Areca tea contains no caffeine which results in decreased anxiety, better sleep and better health.

References
19. AGRICULTURE

Health benefits and Post-harvest management of bitter gourd:

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Bitter gourd (Momordica charantia L.) is a seasonal vegetable of a member of the Cucurbitaceae family and known as Karela commonly in India. The characteristic bitter taste of bitter gourd is due to the bitter principle 'Momordin'. The important bitter gourd growing states are Maharashtra, Gujarat, Rajasthan, Punjab, Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, West Bengal, Orissa, Assam Uttar Pradesh and Bihar. Bitter guard have a very low calories but dense with precious nutrients. It is an excellent source of vitamins B₁, B₂ and B₃, C, magnesium, folic acid, phosphorus, and manganese and has dietary fiber. It is rich in iron contains twice the beta-carotene of broccoli, twice the calcium of spinach, and twice the potassium of a banana. Bitter gourd contains unique phyto-constituent that has been confirmed to have a hypoglycaemic effect called charatin. Bitter gourd is anti-diabetic, stimulant, stomachic, laxative, blood purifier and control diabetes. It is antitodal, antipyretic tonic, appetizing and antibilious (Sandhya et al., 2000). The immature fruits of bitter gourd can be fried, deep fried, boiled, pickled, juiced, and dried to drink as tea (Myojin et al., 2008).

<table>
<thead>
<tr>
<th>Carbohydrates</th>
<th>Protein</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.70 g</td>
<td>0.040 mg</td>
<td>0.80 mg</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0 mg</td>
<td>Riboflavin</td>
</tr>
<tr>
<td>Dietary fibers</td>
<td>2.80 g</td>
<td>Thiamin</td>
</tr>
<tr>
<td>Energy</td>
<td>17 Kcal</td>
<td>Vitamin A</td>
</tr>
<tr>
<td>Iron</td>
<td>0.43 mg</td>
<td>Vitamin C</td>
</tr>
<tr>
<td>Calcium</td>
<td>19 mg</td>
<td>Sodium</td>
</tr>
<tr>
<td>Magnesium</td>
<td>17 mg</td>
<td>Total Fat</td>
</tr>
<tr>
<td>Potassium</td>
<td>296 mg</td>
<td>Zinc</td>
</tr>
</tbody>
</table>

Table: Nutritive value per 100 g in Bitter Gourd (Momordica Charantia) in row fruit (Source: USDA nutritive data based)

Health Benefits:

- **Promotes good digestion** – Bitter Gourd helps in reducing the intestinal disorders and also stomach ailment. Consuming bitter gourd on a regular basis helps in improving the overall digestive health of the body.

- **Blood purifier**: Bitter gourd juice has antimicrobial and anti-oxidant properties which help in removing toxins from the skin. It also helps in purification of blood thus reducing skin problems, blood disorders and also improving blood circulation. Bitter Gourd even hinders the growth of cancer cells within the body.

- **Diabetes**– Bitter gourd contains polypeptide, an insulin-like hypoglycemic compound (plant insulin) called and charantin, which has anti-diabetic properties, that is highly beneficial in lowering sugar levels in blood and urine. Bitter gourd has been shown to significantly improve glucose tolerance without increasing blood insulin. This can be overcome by consuming the juice of bitter gourd every day.

- **Aids digestion**: It is an excellent source of dietary fiber. Regular consumption of bitter gourd contributes to relieving constipation.
and indigestion. It supports healthy gut bacteria, which favours digestion and nutrient absorption.

**Helps in weight loss** – Eating bitter gourd regularly stimulates the liver to secrete the bile acids. These acids are essential for metabolising fat in the body. Also, bitter gourd contains antioxidants which flush toxins out of the body that ultimately helps in proper functioning of digestive system and weight loss.

**Great for eyes** – Bitter gourd has high beta-carotene content which is extremely effective in treating and preventing eye complications. Eating bitter gourd regularly can help in improving eyesight.

**Energizes the Body**; The body’s stamina and energy levels show a remarkable improvement after regularly consuming karela. It even helps improve sleep quality and reduces sleep problems like insomnia.

**Good for the Skin and Hair**; Karela is rich in antioxidants and vitamins A and C which are good for the skin. It reduces aging and fights acne and skin blemishes. It is useful in treating various like ringworm, and itching. Karela juice adds luster to the hair and combats dandruff, hair loss, and split-ends.

**Boosts your immune system**; Bitter gourd juice can also help to build our immune system and increase our body’s resistance against infection. It shields you against allergies and indigestion. The antioxidants work as powerful defense mechanisms against illness and also help fight free-radical damage that can cause various types of cancer. It reduced the risk of prostate, breast cancer risk and cervical cancer.

**Respiratory disorders**; Take two ounces of fresh bitter gourd juice and mix with a cup of honey diluted in water. Drink daily to improve asthma, bronchitis and Pharyngitis.

**Post-Harvest management and Value Addition:**

The post-harvest sector includes all points in the value chain from production in the field to the food being placed on a plate for consumption. Bitter gourd is a very perishable commodity and its post-harvest loss is about 25%. Main reason for this much loss is ripening and mechanical damage during transport. Further, polysacks bags being used to pack them cause severe damage to the fruit. Prosessing can take in following major points:

**Grading:** The fruits are graded as per its size and colour. Generally, 20-25 cm long green fruits with short neck and tubercles are preferred.

**Packaging:** The fruits are packed in bamboo baskets or wooden boxes. Before packing neem leaves or newspaper is spread at the bottom as padding material. Fruits are carefully piled up and covered with gunny bags before sending to the market.

**Storage:** As the fruits are consumed fresh, they are temporarily stored in shade before packing and transporting. During transporting, post-harvest loss can be minimized to a greater extent. Bitter gourd can be stored at ambient temperature for 4-6 days if they are harvested in a slightly immature stage. However this storage life can further be extended by storing them at 13°C.

**Value Addition of Bitter Gourd**

Bitter gourd is a highly nutrient packed fruit but during peak seasons due to lack of adequate processing facilities farmers are bound to sell their produce at low prices. So, the value addition of bitter gourd fruits can be of high potential for both small farmers as well as for large scale industries which is relatively inexpensive, quick and easy in management. The immature fruits are used in a wide variety of culinary preparations. Slices can be dehydrated and this technology is adopted in a small scale for domestic purposes. A better quality product can be prepared if driers are used for dehydration. In addition, fruits can be canned (Krawinkel and Keding, 2006). They are usually blanched or soaked in salt water before cooking to reduce the bitter taste. Incorporating bitter foods in commonly consumed food dishes can mask the bitter taste of bitter gourd (Sneeet al., 2011). The seeds of ripe fruits are used as condiment. Further, bitter gourd is used for juice preparations especially for diabetic patients and may be mixed with other fruit/vegetable juices to improve its palatability for the general consumer.
Conclusion

Bitter gourd is a very wonderful vegetable not only providing nutrition but also offering several components which show medicinal properties. Various processing technologies were investigated to produce widely acceptable products, extending shelf life and availability of all the year round and adding value of the raw products. Thus, bitter gourd has lot of health benefits with good nutritional values. The value addition of bitter gourd can ensure food security which exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life.

References


20. SOIL SCIENCE

Types of Acid Soils

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Soil acidification means an addition of acidity to the soil. Acidification occurs naturally, but faulty agricultural practices also enhance this process. Soil pH is a measure of soil's acidity or alkalinity. By definition, soil pH is the negative logarithm of hydrogen ion activity of the soil solution. In general, a soil with pH less than 7.0 is deemed as an acid soil. But, for characterisation and classification, acid soils may be defined as soils having pH less than 5.5 in 1:1 water extract that respond to application of lime.

Soil acidity is a serious constraint for crop production in many regions of the world including India. In India, out of 142 Mha of arable land, around 48 to 49 Mha is occupied by acid soils, of which 25 Mha show pH below 5.5 and 23 Mha have pH between 5.6 to 6.5 (Mandal, 1997). In India, 30% of the total cultivable area has acid soil, mainly distributed in the humid regions of South-Western and North-Eastern parts of the country and in the Himalayas (Majiet al., 2008). Soils of the humid tropics are naturally acidic. Out of the country's total geographic area, strongly acid and moderately acid soils covers 6.24 (1.9%) and 24.41 (7.4%) Mha (Majiet al., 2012). In the north-eastern region of India, approximately 95% soils are acidic, and nearly 65% soils are suffering from strong acidity with pH less than 5.5 (Sharma and Singh, 2002).

Acidic parent materials, lateralisation, podzolisation, acid rain, oxidation of sulphur, application of acid forming inorganic fertilizers, aluminium hydrolysis are the major causes of soil acidity.

Acid soils have been classified into several groups by Murthy et al. (1976) such as: Laterites, Laterite and lateritic red soils, Ferruginous red soils, Mixed red and yellow soils, Podzolic soils, Brown podzolic soils,
Brown forest soils, Grey brown soils, Foothill soils, Peaty soils, Acid sulphate soils, Degraded saline or saline-acid soils, Alluvial acid soils, Coastal alluvial soils, Marshy soils etc.

Red soils are light textured; shallow to medium in depth and usually underlain by compact sub soil. With increasing depth, the texture becomes heavier. It has low water storage capacity with more sesquioxide concretions.

Lateritic soils have cellular concretions of iron or vesicular honey-combed ferruginous masses. These soils are porous and well-drained with high aggregate stability. Because of the nature of the clay mineral (kaolinite, gibbsite and iron oxides), the water retentively is very low.

Alluvial soils are characterised by coarse texture, excessive drainage, intense leaching and least water holding capacity and found where rainfall is high (1600-4000mm).

High altitude soils are found in hilly regions of Uttar Pradesh and Tamil Nadu. These soils also many times show acidic pH between 5.5 to 6.5.

Tarai soils are found in the foot hills of Himalayas gently sloping downwards with a wet moisture regime and high water table conditions for most part of the year.

Peaty, marshy and acid sulphate soils occur in Assam, Kerala, coastal Odisha, South East coast of Tamil Nadu, and tarai region of U.P. and Bihar. These soils are characterised by black colour, heavy texture (clay to clay loam) and high acidity (pH below 4 when dry; due to oxidation of sulphides to sulphuric acid).

Acid sulphate soils are soils with sufficient sulphides (FeS₂ and others) to become strongly acidic when drained and aerated enough for cultivation are termed as Acid Sulphate Soils. Sometimes pH becomes less than 3.5. It is also known as Cat clays, since it shines and resembles eyes of cat. These type of soils are mostly found in Kerala, coastal Odisha, Andhra Pradesh, some pockets of Tamil Nadu and West Bengal (deltaic areas of Sundarban). H₂S formed in low land rice soils can cause akiochi disease that prevents plant roots from absorbing nutrients. In soils under tidal influence, the reaction of sulphuric acid with iron bearing mineral, yield basic iron sulphate, called Jarosite [KFe₃(SO₄)₃(OH)₆], which is present in most of the acid sulphate soils. These soils can be managed by keeping the area flooded (doesn’t allowing oxidation of sulphides to sulphates), Controlling water table at least up to the sulphuric horizon if not possible to provide water for stagnant of the entire solum), liming and leaching.

References
Biochar: A key element for Carbon Sequestration in Changing Climate Scenario

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Introduction:
Carbon is the most abundant element in living things and accounts for approximately 50% of the total mass of plants and animals. It is well known that the global carbon cycle is closely connected to global climate change largely through anthropogenic emissions of carbon dioxide originating from fossil fuel use and land use change (IPCC, 2007). Atmospheric concentration of CO₂ has increased from ~ 280 ppm in preindustrial era to ~ 408 ppm.

Biochar is receiving much attention as a potential tool for mitigating climate change through long-term biological carbon sequestration. Biochar is rich in carbon and depending on its ultimate use; the biochar may retain the carbon, thereby delaying or completely preventing the release of the carbon in the form of carbon dioxide. The potential of biochar application for soil organic carbon sequestration may be 1 billion tons C year⁻¹ or more.

Biochar- Biochar is produced by thermal decomposition of organic material under limited supply of oxygen (O₂), and at relatively low temperatures (<700°C). Higher chemical stability and carbon content and its potential to reside in soil over decades, makes it a potentialsink of carbon. The transformation of labile plant organic matter into biochar through pyrolysis not only reduce CO₂ emissions from energy production, but biochar additions to the soil constitutes a net withdrawal of carbon dioxide from the atmosphere. Thus, biochar could play an important role in helping to sequester carbon from the atmosphere.

Stability of Biochar: Biochar must be of significantly greater stability in the environment than other organic matter in order to extend the duration of its benefits. The principal mechanisms which stabilize biochar are intrinsic recalcitrance, spatial separation of decomposers and substrate, and formation of interactions between mineral surfaces. The relatively stable nature of organic matter protected within aggregates or through the formation of organo-mineral interactions may also be of relevance to the stability and longevity of biochar in soil.

Mean residence time of biochar: It can persist up to 13,900 years in deep-sea environments and was found to have a mean residence time of 10,000 years in. However, long-term simulations show biochar-C can reside for >100 to 2000 years. Components of the carbon in biochar are highly recalcitrant in soils, with residence times for wood biochar being in the range of 1008 to 1,000s of years, which is around 10-1,000 times longer than residence times of most soil organic matter (SOM). Therefore, biochar addition to soil can provide a potential sink for C.

Recalcitrance: Biochar is made up of biologically recalcitrant carbon that is not easily mineralized by the soil microbial
community. The C in biochar is held in aromatic form which is resistant to decomposition when added as a soil amendment making it a carbon sequestration tool. The conversion of organic matter to biochar by pyrolysis significantly increases the recalcitrance of C in the biomass. The composition changes through a complete destruction of cellulose and lignin and the appearance of aromatic structures. These changes in the composition of organic bonds by pyrolysis have a significant effect on the stability of biochar.

Particulate nature: The particulate form may have an important role in decreasing decomposition rates of biochar. Oxidation of biochar particles starts at its surfaces and typically remains restricted to the near-surface regions even for several millennia. Therefore, its particulate nature may lend stability to biochar, where the outer regions of a biochar particle protect the inner regions from access by microorganisms and their enzymes.  

Interactions with mineralsurfaces: Biochar is found in the organo-mineral fraction and interacts with minerals. Association of biochar surfaces with Aluminium (Al) and Silicon (Si) and, to a lesser extent, with Iron (Fe) was found during the first decade after addition of biochar to soil which increased more slowly within biochar structures. Coating of biochar particles with mineral domains is frequently visible in soils and suggests interactions between negatively charged biochar surfaces and either positive charge of variable-charge oxides by ligand exchange and anion exchange, or positive charges of phyllosilicates by cation bridging. These complexation reactions between biochar surfaces and polyvalent metal ions increase biochar stability.

Carbon Sequestration Potential: The sequestration potential depends on climate, soil type, and sitespecific management. Reduced decomposition is an advantage of charcoal (biochar). Globally, soil is estimated to hold more organic carbon (1,100 Gt; 1 Gt=1,000,000,000 tonnes) than the atmosphere (750 Gt) and the terrestrial biosphere (560 Gt). The principle of using biochar for carbon sequestration is related to the role of soils in the carbon cycle. Biochar are considerably more recalcitrant than soil organic matter and decomposes very slowly, over a time frame. Thus, biochar allows more carbon input as compared to the carbon output and this is the basis behind biochar’s possible carbon negativity and hence it’s potential for climate change mitigation. Further, biochar is highly stable against microbial decomposition and applying this to farmland has the potential to mitigate GHG emissions. Rice husks are typically regarded as a waste product, but can be used to sequester carbon by producing biochar. Highest biochar carbon sequestration is achieved at 500°C, despite the fact that biochar made at higher temperatures is relatively more recalcitrant than low temperature biochars. Continuing the trend forward, they predicted 3.15 Gt C yr-1 could be sequestered by 2100, which they calculated resulted in a total biochar reservoir of 148 Gt C and a corresponding atmospheric removal.
of 79 Gt C (37 ppm CO2). Assuming an addition of 3% of biochar (by mass) into the top 30 cm of the total agricultural land area (standing at around 45 million km² worldwide), the capacity worldwide would be 600 Gt C of biochar.

References

22. ENTOMOLOGY-BIOTECHNOLOGY
The CRISPR/CAS Mediated Genome Editing System for Insect Pest Management
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INTRODUCTION
It has been estimated that the global crop loss due to insect pest was 10.8% during the post green revolution period; it cost billions of dollars [1]. These goals of controlling pests must be balanced with environmental concerns, including the protection of pollinators and other beneficial species. The recent development of gene-editing technologies, such as Clustered Regularly Interspaced Short Palindromic Repeats and associated protein (CRISPR/Cas), opened new avenues for the development of novel pest control measures. CRISPR/Cas provides stable genetic modifications within pest population that facilitate both basic exploratory research, and support efforts to suppress pest populations using gene drives. The CRISPR/Cas9 system acts via a ribonucleoprotein complex, where the target recognition lobe of Cas9 directs specific binding to target DNA through interacting with homologous sgRNA and the excision lobe cuts the DNA.

MECHANISM OF CRISPR/Cas9
Since its discovery, Cas9 has been extensively used for genome editing in multiple organisms. Cas9, like engineered ZFNs and TALENs, is a programmable, sequence-specific endonuclease general structure of the CRISPR systems presented in Figure-1. Similar to other nucleases, Cas9-mediated genome editing is achieved by a two-step process: DNA cleavage followed by DNA repair (Figure-2). The sgRNA directs Cas9 to a specific genomic locus where Cas9 creates a DSB, which triggers DNA repair through intrinsic cellular mechanisms, such as non homologous end joining (NHEJ) or homology-directed repair (HDR). NHEJ causes nearly random insertion and deletion mutations (i.e., indels) at the DSB site and, thus, may lead to gene knockout (e.g., by causing a shift in the target gene's reading frame or mutating a critical region of the encoded protein). HDR can be exploited to generate the desired sequence replacement at the DSB site through homologous recombination guided by a donor DNA template, causing targeted gene deletion, mutagenesis, insertion, or gene correction. Thus, the CRISPR/Cas9 system provides a powerful platform for sequence-specific genome editing, including gene knockout, gene knockin, and site-specific sequence mutagenesis and corrections [2].

APPLICATIONS OF CRISPR GENE-EDITING IN INSECT PEST MANAGEMENT
The application of CRISPR/Cas9 in insects is still in the early stages. It has been intensely reformed for different applications in model
animals, which might clarify prospective applications in insects.

Figure-1: General CRISPR systems

Figure-2: Mechanism of Cas9 for genome editing

- **Gene Drive**: Gene drive refers to the increase in the frequency of particular genes by bias inheritance.
- **Sequence-Specific Gene Regulation**: The CRISPR inference (CRISPRi) is a modified CRISPR/Cas9 system in which dCas9 paired with sgRNA can satirically hinder transcription at the sgRNA base-pairing genomic locus.
- **Genomic Imaging**: The CRISPR/Cas9 system can be reformed as a live imaging system by tagging dCas9 proteins with enhanced green fluorescent protein (EGFP)
- **Population Suppression**: The Cas9-based gene drive could be used for population suppression is to target a gene that is essential for survival in the field but unimportant in a rearing facility (e.g. a gene essential for vision). Alternatively, a Cas9-based gene drive could be placed within a gene necessary for female development, survival, or fecundity.
- **Insecticide Resistance Management**: Another function of CRISPR/Cas9 could be to eliminate pesticide resistance. CRISPR/Cas9
can also be used to systematically knocking-down, knocking-out or over-expressing specific targeted genes which are responsible for the insecticides resistance in the insect pest.

CONCLUSION
The Molecular biotechnologies allow genetic improvement and modification across a wide range of insect pests, and have become increasingly important tools for pest management. The CRISPR gene-editing has the capacity to alter the specific gene of interest. It has been preliminarily established and developed in model and non-model insects. Highly efficient knockout and knock-in experiments have been successfully conducted in model insects such as Drosophila and silkworm, and in non-model insect. Based on CRISPR/Cas9, several well-designed systems have been developed, including gene drive and regulation and DNA/RNA tracking systems, which will have significant impact on functional studies and pest control.

5. REFERENCES

23. AGRONOMY
Nanofertilizers - A way to Sustainable Agriculture
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Introduction
World agricultural cropping systems intensively use large amount of fertilizers, pesticides, herbicides to achieve more production per unit area but using more dose than optimum of these chemicals and fertilizers lead to several problems like environment pollution (soil, water, air pollution), toxicity to different beneficial living organism present above and below the soil surface etc. Despite these problems there is also challenge to feed the growing population of the world. Investigations show that, the world population is expected to be 9.1 billion people by 2050. If food consumption in developed countries is coordinated by other parts of the world and all of these people are to be fed adequately, total food consumption will have to arise by 50 to 70 percentage. Therefore in the future, there is need to produce nutritive agricultural produce rich in protein and other essential nutrient required to human and animal consumption, and hence emphasis should be laid on production of high quality food with the required level of nutrients and proteins. For solving these problems in crop production nanofertilizers, nanopesticides and nanoherbicides may be an effective tool in agriculture for better pest and nutrient management. These nano-materials have more penetration capacity, surface area and use efficiency which avoid residues in environment. The nano-particles with size below 100 nm can be used as fertilizer for efficient nutrient management, which are more eco-friendly and reduce environment pollution. The use of nanofertilizers increase the nutrient use efficiency, reduce the soil toxicity, minimize the potential negative effects associated with over dosage and reduce the frequency of application. Hence, nanofertilizer has high potential for achieving sustainable agriculture.

Nanofertilizers
Nanofertilizers are synthesized or modified form of traditional fertilizers, bulk materials
extracted from different vegetative or reproductive parts of the plant by chemical, physical, mechanical or biological methods with the help of nanotechnology techniques. These improve the soil fertility, productivity and quality of agricultural produce. Nanofertilizers are nutrient carriers of nano-dimensions ranging from 30 to 40 nm (10^{-9} m or one-billionth of a meter) and capable of holding bountiful of nutrient ions due to their high surface area and release it slowly and steadily that commensurate with crop demand. Nanofertilizers and nanocomposites can be used to control the release of nutrients from the fertilizer granules so as to improve the NUE while preventing the nutrient ions from either getting fixed or lost in the environment. Nano-fertilizers have high use efficiency and can be delivered in a timely manner to a rhizospheric target. Major portion of nutrient fixation occurs in the broken edges of the clay particles. Zero valence nanoparticles adsorb onto the clay lattice, thereby preventing fixation of nutrient ions. Further, nanoparticles prevent the freely mobile nutrient ions to get precipitated. These two processes assist in promoting the labile pool of nutrients that can be readily utilized by plants. Fertilizer particles can be coated with nano membranes that facilitate in slow and steady release of nutrients. This process also helps to reduce loss of nutrients while improving fertilizer use efficiency of crops.

**Approach to enhance the nutrient use efficiency through nanofertilizer**

- Encapsulation of fertilizer with nanoparticles: Encapsulated inside nanostructures designed to allow the controlled release of nutrients: to do so the outer shell of nanocapsules is engineered and programmed to open when stimulated by environmental factors or man-induced pulses. Here are some examples of possible control mechanisms: Slow release
  - Quick-release
  - Specific release
  - pH release
  - Magnetic/ultrasonic pulse

- **Slow/Controlled-release Nanofertilizers:** The most successful use of nanoparticles is fertilizers with slow-release of nutrient. Because of the high surface tension, they will hold material more strongly from the plant than conventional surfaces. Moreover, nanocoatings can also provide surface protection for larger particles. Direct application of large amounts of fertilizer, in the form of ammonium salts, urea, nitrate, or phosphate compounds, may produce extremely high local concentrations which are harmful. Much of the fertilizer may be dissolved in runoff water and cause adverse effects such as pollution and will not be available to the plants of interest.

**Diffusion mechanism of controlled release**

- Fertilizer core with polymer coating
- Water penetration into the coating and core granule
- Fertilizer dissolution and osmotic pressure development
- Slow release of nutrient through swollen coating membrane.

**Advantages of nanofertilizer**

- Nanofertilizers increase nutrient efficiency.
- Reduces environmental damage and soil toxicity.
- Minimizes the frequency of the application.
- Decreased depletion of fertilizers.
- Reduce the cost of cultivation.
- Adjust the speed of nutrient released.
- Improve the crop efficiency and increase crop yield by providing the nutrients through slow release to the plants.

**Conclusions**

Since fertilizers, particularly synthetic fertilizers, have a major potential to pollute soil, water and air; in recent years, many efforts have been done to minimize these problems by agricultural practices and the design of the new improved fertilizers. Nano structured formulation through mechanisms such as targeted delivery or slow/controlled release mechanisms, conditional release, could release their active ingredients in responding to environmental triggers and biological demands more precisely. There is possibility of using these mechanisms to design and construction of nano fertilizers.
The use of these nano fertilizers cause an increase in their efficiency, reduce soil toxicity, minimizes the potential negative effect associated with over dosage and reduces the frequency of the application. A nanofertilizer mainly delays the release of the nutrients and extends the fertilizer effective period. Obviously, there is an opportunity for nanofertilizer to have a significant influence on energy, the economy and the environment, by improving fertilizers. Hence, nanofertilizers have a high potential and would play an important role for achieving sustainable agriculture.

24. AGRONOMY

Black Rice – A Super Food in New Era

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Introduction

Black rice is a type of the rice species Oryza sativa L. which is black in colour, glutinous, contains high amount of nutrients and mainly cultivated in Asia. In which, China is the richest country in the black rice resources (62%) followed by Sri Lanka (8.6%), Indonesia (7.2%), India (5.1%), Bangladesh (4.1%), and few in Malaysia. Black rice is actually heirloom rice means it is open pollinated, was grown at earlier times in the history and is not grown on a large scale in modern agriculture.

The reason they are grouped under the term “Black Rice” is the unusual dark/black colour of the grain. The pericarp (outer part) of kernel of this rice colour is black due to presence of high amount of a powerful pigment known as anthocyanins. Once cooked, the color lightens into deep purple/violet colour due to this it is also called as “purple rice”. This unusual colour makes it very popular for dessert. A similar kind of rice was consumed by the royals and nobles in ancient China refering it as “Forbidden Rice” or “Emperor's Rice” and in some of the Asian regions. Black rice now widely considered as a ‘super food’ by scientists. The term 'super food' is used to describe food items with extremely high nutritional value. Black rice is a super nutritious type of rice that is high in fiber, antioxidants, vitamins B, vitamin E, iron, thiamine, magnesium, niacin and phosphorous. Not only it is the type of rice that is richest in powerful disease fighting antioxidants but also it contains anti-inflammatory, anti-carcinogenic properties and has an ability to stop the development of diabetes mellitus, cancer, heart disease, and even weight gain.

Phytochemical Profiles and Antioxidant Activity

Black rice is potent source of phytochemical consist of 23 secondary metabolites, comprising anthocyanins, flavones, flavonoids glycosides (Quercetin-3-O-glucoside, isorhamnetin-3-O-glucoside and myricetin-7-O-Glucoside), carotenoids, vitamin E (tocopherols and tocotrienols) and γ-oryzanols have been qualitatively and quantitatively characterized in the dehulled seeds of black rice which provides health benefits and ensure the use of black rice as functional food.

The colour of this rice is due to the presence of a powerful pigment called “anthocyanin”. The anthocyanin components in black rice are about 26.3 %, and cyanidin-3-O-glucoside and peonidin-3-O-glucoside are the main effective constituents accounting for about 90 %. Anthocyanins are the flavonoids pigments and are the source of antioxidants that protect against free radicals which cause aging, cancer and disease. It also helps support memory function and coordination.
Nutritive Value of Black Rice

Nutritive value of black rice is superior to any other rice. This rice is free of gluten, free of cholesterol, low in sugar, salt and fat. It is a whole grain, super nutritious type of rice that is high in fiber, anthocyanin, antioxidants, vitamins B complex and E, iron, thiamine, magnesium, niacin, phosphorous and also it contains 18 amino acids. One one-fourth cup uncooked black rice contains approximately (in daily recommended values) 160 kcal energy, 1.5 g of fat, 34 g of carbohydrate, 2 g of fiber, 7.5 g of protein, no saturated fat, no cholesterol.

Health Benefits of Black Rice

Diabetes and obesity: Black rice is high in amylopectin content thus making it a very slow release carbohydrate diet. The slow release of sugar prevents a rapid rise in blood sugar level decreasing the risk of putting on weight and type 2 diabetes. The dietary fibers in outer layer of the whole grain aid in slow release of glucose and slow absorption by body over a longer period. It is essential to eat 100 % whole grains for prediabetes, diabetes or other forms of metabolic syndrome and insulin resistance. It is same for people who struggle to lose weight – the fibre and nutrients in whole grain assist to stop signals of hunger and discourage excessive consumption.

Antioxidant: Black rice contains more anthocyanin than any other seeds, including brown rice or red rice. It has ability to prevent cardiovascular diseases, cancer protection, brain function improvement and inflammation reduction. It also contains high amount of vitamin E which is helpful for eye, skin, and immune health.

Anti-cancer effects: Anthocyanin (antioxidants) help protect the body from free-radical damage, which can lead to cancer. A study showed that anthocyanins extracted from black rice drastically inhibit the spread of specific cancers by restricting the damage of DNA.

Healthy heart: Black rice anthocyanins can assist to keep good concentrations of cholesterol through a reduction in overall cholesterol and poor LDL cholesterol. Also studies show that the formation of dangerous atherosclerotic plaque in the arteries is decreased by black rice for clear arteries and to prevent heart stroke.

Detoxification: Consumption of black rice can detoxify the body and purify the liver with the use of elevated antioxidant levels in rice. Research shown that rabbit fed with black rice resulted in less oxidant stress, more blood antioxidants and liver detoxification than rabbit fed with white rice. The phytonutrients in black rice help the body to reduce inflammation and purify the organism from harmful matter.

Digestive and metabolic health: Dietary fiber protect against constipation, bloating and other undesirable digestive symptoms. Black rice can also contribute to avoid or enhance diarrhea because fiber adds bulk. It can also assist to feel comfortable after eating, which help you to lose weight.

Role in Anaemia: Black rice is rich source of iron. Iron when ingested in natural form is easier to get absorbed in the body. Thus it is beneficial for people who are anaemic to improve overall total iron in their body.

Gluten free cereal: Gluten-susceptible users have many of the symptoms such as bloating, constipation, diarrhea, nutrient deficiencies and an increased risk for developing the leaky gut syndrome. Black rice is naturally gluten-free grain, like other rice varieties.

Conclusion

Black rice is recently referred to as “Super Food” which it truly deserves. Consumption of black rice resulted in heart health improvement, cancer clean-up, blood sugar balance, inflammation improvement and digestive health. Naturally, black rice free of gluten and contains more nutrients and antioxidants than white rice. Awareness should be created among the people about this “super food” due to its full nutritional and therapeutic properties so that more
25. AGRICULTURAL ECONOMICS

Trend in Cotton Cultivation and Trade – Indian Scenario

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Cotton, known to be originated in Indian subcontinent, is one of the important commercial crops in the world. The chief fibre crop provides the essential raw material for the textile industry. There were historic evidences and references on the usage of cotton by mankind that dated back at least seven-thousand years. The cotton fibres are utilized in the manufacturing of thread, fabrics, linen and apparel, while the seeds are used to extract cotton oil and produce oilcake.

Global scenario of cotton

World-wide, cotton is cultivated in more than 80 countries and it is cultivated in about 312 lakh hectares. The major cotton growing countries in the world are India, China, United States, Pakistan and Brazil, while the major consumers are China, India, Pakistan, Bangladesh and Turkey.

The global area under cotton declined from 33.73 million hectares in 2017-18 to 33.54 million hectares in 2018-19. The global production of cotton was around 119 million bales in 2018-19 and it was projected that the production will increase by five per cent to 124.8 million bales in 2019-20.

Indian scenario of cotton

India is the leading producer and exporter of cotton in the world with a total production of 337 lakh bales and an export of 46 lakh bales in 2018-19. The major growing season is from October to September and the main varieties cultivated are Bengal Deshi, V-797, Jayadhar, J-34/ Bikaneri NarmaSg, Y-1, NHH-44, LRA-5166, H-4/MECH-1, S-6/4, MCU-5, DCH-32. In India, cotton is grown widely throughout the country and major cotton growing states are Maharashtra, Gujarat, Telangana, Haryana, Punjab, Rajasthan, Karnataka and Tamil Nadu.

The trend in area and production of cotton in India is shown in figures Fig 1 and Fig 2, which displays a fluctuating yet growing trend over the years from 1960 to 2018.
Cotton production and trade in India

Table 1: Growth rate (%) in area, production, export and import

<table>
<thead>
<tr>
<th>Market Year</th>
<th>Area</th>
<th>Production</th>
<th>Export</th>
<th>Import</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>2.05</td>
<td>7.91</td>
<td>122.52</td>
<td>NA</td>
</tr>
<tr>
<td>1990</td>
<td>1.49</td>
<td>-13.34</td>
<td>-34.26</td>
<td>-100</td>
</tr>
<tr>
<td>1995</td>
<td>15.29</td>
<td>18.86</td>
<td>445.19</td>
<td>-80.77</td>
</tr>
<tr>
<td>2000</td>
<td>-2.45</td>
<td>-10.25</td>
<td>34.29</td>
<td>-2.06</td>
</tr>
<tr>
<td>2005</td>
<td>0.94</td>
<td>0.26</td>
<td>456.82</td>
<td>-61.46</td>
</tr>
<tr>
<td>2010</td>
<td>9.12</td>
<td>11.16</td>
<td>-23.66</td>
<td>-58.33</td>
</tr>
<tr>
<td>2011</td>
<td>8.44</td>
<td>6.69</td>
<td>121.6</td>
<td>200</td>
</tr>
<tr>
<td>2012</td>
<td>-1.64</td>
<td>-0.70</td>
<td>-29.95</td>
<td>97.83</td>
</tr>
<tr>
<td>2013</td>
<td>-0.42</td>
<td>8.77</td>
<td>19.33</td>
<td>-43.13</td>
</tr>
<tr>
<td>2014</td>
<td>7.11</td>
<td>-4.84</td>
<td>-54.66</td>
<td>81.63</td>
</tr>
<tr>
<td>2015</td>
<td>-3.91</td>
<td>-12.2</td>
<td>37.27</td>
<td>-12.56</td>
</tr>
<tr>
<td>2016</td>
<td>-11.8</td>
<td>4.25</td>
<td>-21.06</td>
<td>155.22</td>
</tr>
<tr>
<td>2017</td>
<td>16.13</td>
<td>7.41</td>
<td>13.89</td>
<td>-38.71</td>
</tr>
<tr>
<td>2018</td>
<td>0.00</td>
<td>-8.62</td>
<td>-32.25</td>
<td>7.33</td>
</tr>
<tr>
<td>2019</td>
<td>3.17</td>
<td>13.21</td>
<td>16.78</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The rate of growth in area, production, export and import of cotton in India was widely varying throughout the time period (Table 1). The growth rate in export was found to be declining over the period from 1985 to 2019. Maximum growth in export was recorded during 1995 and 2005 which were 445 and 457 per cent respectively, while in 2014 it was highly negative i.e. 55 per cent. The low price for cotton and higher prices for competing crops in 2014-15 led to shrinkage in area under cotton and in addition to which the adverse weather led to considerable decline in production in 2015.

The negative and negligible growth rate in production and area of cotton in 2018 could be due to the uprooting of the plants by farmers in Southern Zone due to moisture deficiency, which could have possibly resulted in the increase in import growth rate. While the growth in area under cotton in India has slowed in 2019 compared to 2017, there was considerable growth in the production, which resulted in increased growth rate in export of the commodity from India and decline in the import growth rate (Table 1).

As per a report, the USDA has predicted a record yield of 390 lakh bales of cotton in India in 2019-20 as the harvested area is expected to increase to 12.9 million hectares by 2019-20 from 12.6 million hectares in 2018-19 as there is positive internal support prices by the Government of India and also, favourable monsoon, which is likely to extend the period of picking.
26. SEED TECHNOLOGY

Mid storage seed treatments

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Introduction
Prolonging the shelf life of stored seeds is always a profitable proposition and can be adopted if the procedure is cheap and easy to follow. Some protective measures need to be taken to improve the germination and field emergence of this particular crop leading to adequate plant stand. The hydration-dehydration treatment method, relatively a low cost technology has been successfully followed for the preservation of seeds (Geetharani et al., 2009). Hydration – dehydration treatment in which seeds are treated 3 – 5 months after storage (mid way between harvest and next sowing time). These mid-storage seed invigoration treatments are physiological treatments that imply an improvement in physiological status of seed, thereby achieving improved germinability, greater storability and better performance than the untreated seeds (Basu, 1994).

The germination of seeds when reduced marginally below minimum seed certification standards (70 %) before sowing time, so if any measures to increase the viability would be of great importance. To improve the germination of unutilized stock and as well as to prolong their storability mid-storage invigoration treatments are highly warranted (Renugadevi et al., 2006). These treatments would invigorate the low vigour seeds to achieve better emergence and establishment.

Mid storage treatments
Seeds in storage accumulate damage to cell membranes during senescence. Mid storage seed treatments are capable of reducing the age induced damages and restoring the seed vigour to a certain extent besides, the seed viability and productivity of stored seeds are also improved.

Hydration – Dehydration
It is the process of soaking the low and medium vigour seeds in water with or without added chemicals usually for short durations to raise the seed moisture content to 25 – 30% and drying back the seeds to safe limits for dry storage.

Mode of Action
The main purpose of hydration is to raise the seed moisture content to 25 –30% (wet weight basis) before drying back to safe limits for dry storage. The hydration - dehydration treatment may improve the vigour by controlling free radical reactions and consequent peroxidative damage to lipoprotein cell membranes.

The hydration – dehydration treatments
- Should be given only to stored seeds.
- Is effective in low and medium vigour non-leguminous seeds,
- Direct soaking of leguminous seeds should be avoided.
- Would not make a seed germinable which has already lost viability.

Types of Hydration – Dehydration treatments
- Soaking – Drying
- Dipping – Drying
- Spraying – Drying
- Moisture equilibration – Drying
- Moist sand conditioning – Drying

Soaking – Drying
Stored seed is soaked in water or solution of chemicals sufficient to cover it and kept at room temperature for 2-6 hour depending on the material with occasional stirring. The soaked seed is taken out and after surface drying in the shade for some time, dried back
to the original moisture content. Dilute solution of chemicals such as sodium or potassium phosphate (di and mono basic), sodium chloride, p-hydroxy benzoic acid, p-amino benzoic acid, oxalic acid, potassium lodide, etc can also be used at $10^{-4}$ to $10^{-3}$ M concentrations. Fungicidal and insecticidal formulations can also be incorporated in the soak water.

**Dipping – Drying**
Seeds are dipped in water or solutions of the aforesaid chemicals for only 2-5 minutes and the wet seed is taken out immediately and kept covered for 2 – 6 hours depending on the material, for absorption of surface water followed by drying back. This treatment is effective in most high and high-medium vigour seeds of rice, wheat, jute, vegetables.

**Spraying – Drying**
Seeds are spread in a thin layer and then an amount of water is sprayed on to (turning over the seed layer after the first spray) and then kept covered by a polythene sheet for 2-4 hours before drying back.

**Moisture equilibration – drying**
Here, the seeds are placed in thin layers on trays kept on a raised platform in a closed moisture saturated chamber lined internally with moist blotters giving nearly 100% RH at room temperature. After 24-48 hours, depending on the material and ambient temperature, the seed is dried back in the usual way. For soaking injury prone seeds this treatment, which gives a slow and progressive rise in moisture content, is very effective. However, difficult to practice on a large scale and is not advocated for low vigour non leguminous seeds because of possible aging effect of the treatment especially when given for prolonged periods.

**Moist sand conditioning – drying**
This treatment is similar to the moisture equilibration treatment but easier to practice. For slow and progressive moisture uptake, the seed is thoroughly mixed with pre-moistened sand, using 3 times the amount of air dry sand than seed. Moisture content of sand is adjusted to 5-10 by adding the requisite amount of water or solution of chemicals to previously washed and dried fine grain building grade sand. The addition of water should be so adjusted as to get the required hydration effect without initiating the germination process.

**References**

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**27. AGRICULTURAL ECONOMICS**

**Economics of Buffalo Milk Production in Ahamednagar District of Maharashtra**

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1,3Department of Agricultural Economics, 2Department of Physical Sciences & Information Technology, Tamil Nadu Agricultural University, Coimbatore-3.

**Introduction**
Milk production in India is predominantly the domain of small landholders and landless laborers in mixed farming system. Indian dairying has made rapid strides but animal productivity remained low over the years.
Average dairying assumes greater significance in providing employment to rural people as well as stable source of income to augment their earning from main enterprise i.e. crop husbandry. Dairy enterprise plays an important role in the rural economy by providing income and employment not only to the workers but also to the farming community in general. The returns from some holdings can be maximized by the proper combination of dairy enterprise with crop production.

The three concepts – costs, returns and profitability needs to be analyzed while assessing the economics of any production activity. In this perspective, the dairy subsector occupies a very important productive activity in agricultural economy in India as milk production is the second largest agricultural commodity contributing to national GDP, next to rice. Literatures found that crop husbandry is a land resource based enterprise and provides seasonal employment and income to the farmers whereas, dairy enterprise provides employment to the farm family not only during off season but also a regular flow of income round the year.

**Indian Scenario**

India ranks first in milk production accounting to 20 per cent of world’s production. Its production has increased from 17 million tonnes in 1950-51 to 176.35 million tonnes in 2017-18 at an annual growth rate of 4.5 per cent (GoI report, 2018). The per capita availability of milk in India is 375 g/day during 2017-18 against the world average of 331 g/day (NDDB report, 2018).

The dairy industry in India is going through major changes with liberalization policies of Government. Indian dairy industry is heading towards an accelerated and positive momentum with unprecedented growth in milk production during last 30 years. Milk also forms an important constituent of human diet, so the importance of milk in human diet cannot be over emphasized in India.

With this picture, an attempt was made to study the economics of milk production by estimating the cost of production and returns from investment on milk production thereby suggesting the ways to increase the productivity and value addition based on sound economic principle at the macro level.

The present study was restricted to dairy enterprise especially on buffalo milk production in the vicinity of Ahamednagar city. According to 19th livestock census, the total population of milch animals (cattle + buffaloes) in Maharashtra was 21.07 million heads of which, 66 per cent was cows and 44 per cent were buffaloes. The buffalo population in Ahamednagar district was 2.17 lakh head.

Purposive sampling was employed to identify the buffalo growers in the study area so as to have a clear picture on the economics of buffalo production in Ahamednagar district of Maharashtra. Costs and returns for dairy enterprise was estimated by calculating the per farm expenditure and per farm income from dairy enterprise. The benefit cost ratio was worked out to identify the profitability of the dairy enterprise.

**Results and discussion**

It was identified from the sample farms that there were 549 milch animals with the sample households, of which 23.50 per cent were local cows, 26.78 per cent were crossbreed cows and 49.72 per cent were buffaloes. The per animal investment by the sample farmers was estimated to be Rs. 32109.08 for total fixed investment and Rs. 37297.00 for the working expenditure per year.

The lactation period of buffalo was 273.69 days with the average milk production of 1787 litres in the study area. The total cost incurred in production and maintenance of buffalo was Rs. 47963.37 and the gross value of buffalo milk production was calculated to Rs. 74480 including the value of dung with the procurement price of Rs. 25.72 per litre of buffalo milk. The net profit was calculated to Rs. 26516.63 with a benefit cost ratio of 1.55 indicating that for a rupee invested in buffalo milk production the profit was accounted to Rs. 0.55 only.

Though the buffalo milk production is a
profitable venture, the profit was very less when compared to all other enterprise. This may be due to the large number of intermediaries in the procurement of buffalo milk between the farmers and the consumers. It was also found during that the study that the purchase of buffalo milk by the consumer from the retail shop was Rs. 45 per litre. The price spread was found to be Rs. 19.28 (57.15%).

Appropriate policy measures have to be implemented to reduce the price spread and to increase the producer’s share in consumer rupee.

References


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**28. AGRICULTURAL ECONOMICS**

**Prediction And Forecasting of Cashew Nut Production in India – An Arima Model Approach**

Padma Lakshmi G\(^1\), Radha M\(^2\), A Dharani Priya\(^3\)

\(^1\)Department of Agricultural Economics, \(^2\)Department of Physical Sciences & Information Technology, \(^3\)Department of Extension Education, Tamil Nadu Agricultural University – Coimbatore-3

**Introduction**

Cashew (*Anacardium occidentale*) popularly known as the “Gold Mine of Waste Land” was introduced in sixteenth century in the Malabar coast as it served as a main centre for disposal to other centres in the country and South East Asia. Now, cashewnut is an important tree nut in India as it accounted to nearly 65 per cent of the world’s cashewnut production.

As per the available statistics, the area under cashewnut cultivation in the world is about 4.36 Mha. with the total production of 4.49 MT during 2014-15. The production of cashew was highest in Vietnam contributing to 1.23 MT followed by Nigeria (0.83 MT) and India (0.79 MT). The productivity of cashew in Vietnam is more (2.12 MT/ha) as compared to India (0.98 MT/ha) during 2014-2015. Therefore in recent times, India is facing stiff competition with Vietnam and Nigeria in the international trade. [FAO, 2015]. At present, cashew is grown in India on about 1.03 Mha. area with the total production in the country had grown up to 7.25 lakh MT in 2018-19 [Source: DCCD, Kochi].

This paper attempts to predict the cashew nut production for the next five years by using an Autoregressive Integrated Moving Average (ARIMA) model and is usually called as Box-Jenkins Model. This model accepts and takes into account the non-zero autocorrelation between the succeeding values of the time series data.

**Materials and Methods**

The data on production of cashewnut was taken from the Directorate of Cashew nut and Cocoa Development, India. An ARIMA (p, q) model could be a mixture of Autoregressive (AR) that indicates that there’s a correlation between current and former values, a chance importance and a Moving Average (MA) model that shows that the price has more or less to try and do with the previous residuals.

Generally, an ARIMA model is described...
forecasting results of ARIMA (2,1,1) was identified as better model for the given cashewnut production data. Consequently, the recognized models were accurate to predict the cashewnut production. Based on the RMSE and MAPE the model (2,1,1) was identified as better model for the given cashewnut production data.

Using ARIMA (2,1,1) the five years advance production of casew nut and its ninety five percent confidence limits are estimated and given in Table 2. It could be predicted that there will be a significant increase in the cashewnut production from 2016 onwards. It is expected that the production of cashewnut will increase from 710 thousand tonnes in 2015-16 to around 900 to 1000 million tonnes during 2016-17 to 2020-21.

It was also predicted that the minimum production of cashewnut with ninety five percent confidence level may decrease in the future years and will produce

Table 1: AIC and BIC Values of Fitted ARIMA Models

<table>
<thead>
<tr>
<th>ARIMA order</th>
<th>(\sigma^2)</th>
<th>AIC</th>
<th>BIC</th>
<th>RMSE</th>
<th>MAPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2,1,0)</td>
<td>126.4</td>
<td>295.170</td>
<td>299.882</td>
<td>100.96</td>
<td>51.66</td>
</tr>
<tr>
<td>(2,1,1)</td>
<td>126.4</td>
<td>291.270</td>
<td>297.160</td>
<td>92.114</td>
<td>48.80</td>
</tr>
<tr>
<td>(2,1,2)</td>
<td>126.4</td>
<td>293.151</td>
<td>300.219</td>
<td>94.281</td>
<td>48.80</td>
</tr>
</tbody>
</table>

Table 2: Five Years Forecasting of Cashew Nut Production

<table>
<thead>
<tr>
<th>Predictive Forecast</th>
<th>Low 80</th>
<th>High 80</th>
<th>Low 95</th>
<th>High 95</th>
<th>Low 99</th>
<th>High 99</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>780.</td>
<td>830.</td>
<td>870.</td>
<td>933.7</td>
<td>579.</td>
<td>981.8</td>
</tr>
<tr>
<td></td>
<td>821</td>
<td>832</td>
<td>870</td>
<td>937</td>
<td>579</td>
<td>981.8</td>
</tr>
<tr>
<td>2017</td>
<td>805.</td>
<td>804.</td>
<td>832</td>
<td>959.7</td>
<td>602.</td>
<td>1008.</td>
</tr>
<tr>
<td></td>
<td>831</td>
<td>834</td>
<td>870</td>
<td>959.7</td>
<td>602.</td>
<td>1008.</td>
</tr>
<tr>
<td>2018</td>
<td>816.</td>
<td>812.</td>
<td>825</td>
<td>975.2</td>
<td>607.</td>
<td>1025.</td>
</tr>
<tr>
<td></td>
<td>826</td>
<td>829</td>
<td>870</td>
<td>975.2</td>
<td>607.</td>
<td>1025.</td>
</tr>
<tr>
<td>2019</td>
<td>837.</td>
<td>833.</td>
<td>845</td>
<td>996.6</td>
<td>627.</td>
<td>1046.</td>
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<tr>
<td></td>
<td>847</td>
<td>850</td>
<td>870</td>
<td>996.6</td>
<td>627.</td>
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</tr>
<tr>
<td>2020</td>
<td>860.</td>
<td>856.</td>
<td>870</td>
<td>1008.</td>
<td>650.</td>
<td>1070.</td>
</tr>
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<td></td>
<td>870</td>
<td>870</td>
<td>870</td>
<td>1008.</td>
<td>650.</td>
<td>1070.</td>
</tr>
</tbody>
</table>

Model diagnostics for cashew nut production was given in Table 1. A low values of root mean square error (RMSE) and mean absolute percentage error (MAPE) showed that the recognized models were accurate to forecast the cashewnut production. Based on the RMSE and MAPE the model (2,1,1) was identified as better model for the given cashewnut production data.
500 to 550 million tonnes during 2016-17 to 2020-21. This may be due to the natural calamities, effect of climate change, pest and disease infestations, etc., leading to the reduction in cashewnut production and productivity.

Figure 1: Forecasts from ARIMA (2,1,1)

Conclusions
Forecasting the crop production is an important contribution for the better decision making to farmers as well as the government. In this paper, an attempt has been made to identify the best ARIMA model to forecast the cashew nut production in India using time series data for twenty five years. ARIMA model was used to predict and forecast the cashewnut production. The study also statistically tested and validated through the appropriate statistical methods to remove the prediction errors in the fitted ARIMA model and the fitted model were not connected and the errors seems to be normally distributed with mean 0 and regular variance. It was found that the selected ARIMA (2,1,1) model seems to provide an suitable forecasting model for the cashew nut production in India and it was forecasted that the production of cashewnut will increase to around 900 to 1000 million tones during 2016-17 to 2020-21.

REFERENCES


Introduction:
Overbreeding of dairy cattle from a narrow genetic base has led to undesirable effects and genetic anomalies. In Dairy animal breeding, genetic disorders are one of the most important points of concern. Around 200-300 different genetic defects have been identified in cattle. Genetic abnormalities contribute to poor animal performance, structural unsoundness, semi-lethal disease, or lethal disease etc. Some common recessive genetic defects in Holstein cattle are complex vertebral malformation (CVM), bovine leukocyte adhesion deficiency (BLAD), factor XI deficiency (FXID), and bovine citrullinemia (BC). These conditions have led to significant drops in production and economic losses. Bovine leukocyte adhesion deficiency (BLAD) or granulocytopenic syndrome is a genetic disease in cattle. Bovine leukocyte adhesion deficiency (BLAD) is generally lethal in dairy cattle before reaching adulthood, thus affecting productivity and causing losses to farmers.

If genetic disease remains undetected, then it will get propagated from generation to generation continuously which will increase the occurrence of the undesirable genes in the breeding. Artificial insemination accelerates the spread of undesirable recessives and hence regular screening of the breeding sires should be carried out.

BLAD:
It is abbreviated form of Bovine Leukocyte Adhesion Deficiency. It was first identified in the early 1980s in Holstein-Friesian cattle. BLAD is an autosomal recessive hereditary disease affecting young Holstein calves.

Molecular basis and Genetics:
BLAD is an autosomal recessive hereditary disease. This condition was found to be only in Hostein breed of animals. It is not surprising that genetic conditions are breed specific, given that cattle breeds were developed in relative genetic isolation and independently of each other (Healy 1996)
The molecular basis of BLAD is a single point mutation (adenine to guanine) at position 383 of the CD18 gene (Fig 1), which caused an aspartic acid to glycine substitution at amino acid 128 (D128G) in the glycoprotein. It is known that BLAD is caused by the point mutation (A→G) at the position 383 of CD18 gene located on the first chromosome of bovine.

Clinical signs
They may be normal at birth with clinical signs appearing within 1-2 weeks of life. Affected animals show recurrent bacterial infections, pneumonia, enteritis, diarrhea, ulcerative and granulomatous stomatitis, delayed wound healing and usually die within 2-4 months of age. Holstein calves are characterized by recurrent bacterial infections, progressive periodontitis, ulcers of oral mucosa, and impaired inflammatory responses (Nagahata et al., 1993). Some animals may live past 2 years old but they have stunted growth and suffer from recurrent infections of the skin, gastrointestinal and respiratory tracts. The gastrointestinal and respiratory tracts seem to be the most severely affected with severe necrosis of both found on necropsy.

Diagnostic Testing
BLAD carriers can be detected easily by means of polymerase chain reaction followed
by restriction analysis of the amplicons. By using PCR the mutation in the DNA of the animal can be detected. Many specimens can be used for the test including blood, skin or hair. There are no age requirements for the test.

Suggestions

In cattle breeding, artificial insemination is widely used, carriers of genetic diseases are likely present within the population of breeding sires. Breeding sires should be screened for genetic diseases in order to avoid an unnecessary spread within the population. Nowadays adequate DNA tests are available to identify the suspected cases at a very young age. Identification of these carried/Heterozygous animals at a very young age may help to prevent the spread of these undesirable or faulty genes from the semen of the carrier breeding sires in order to avoid economical losses to dairy industry.

References


30. AGRONOMY

Doubling of Farmers’ Incomes through IPM

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The Indian economy is largely agrarian, with around 55% of the population dependent for their livelihoods on agriculture and allied sectors that generate 15% Gross Value Added (GVA) (Gol 2017). Indian farmers are vulnerable to impacts of climate change, water scarcity and land degradation. In addition, increasing fragmentation of holdings, extreme weather events, rising input costs and post-harvest losses pose an enormous challenge to sustaining agricultural growth. There has been considerable expansion and change in the research and extension system but the key questions remain: ‘Is this sufficient to Double Farmers’ Incomes by 2022? Is there a need for a different mindset to ensure agriculture science empowers farmers to reach their full economic potential? Can such be achieved while delivering nutrition to the nation as well as within the ecological boundaries of India’s natural resources?

Although the Indian agricultural R&D system has been one of the pioneering systems among developing countries, there are many complexities restricting the system from realizing its full potential (Ramasamy, 2013). The R&D system needs to address multiple development challenges such as efficient and inclusive growth, sustainable natural resource management and environmental safety, food safety, monitoring and management of emerging nutritional security threats - among others. To manage this complexity requires efforts and skill development within the line departments and the move towards modern data management to prioritize and target research (state and federal), coordinate with allied ministries and the private sector.

The framework to innovate in an inclusive and integrated manner to deliver intensification (4 “I”s) draws on the principle of convergence, consortium,
capacity building and collective action (4 “C”s) which are critical in developing strong intermediaries to address the consortium goal through 4 “E”s (Efficiency, Economic gain, Equity and Environmental protection) which are the important pillars for sustainable intensification and inclusive development (Wani et al, 2011).

Compressing Science of Discovery to support Science of Delivery
The first mile (discovery) needs to have the last mile (delivery) in mind. In this regard, ICRISAT and its partners are committed to reducing the time for discovery science to reach farmers’ fields. Modernization crop improvement programs to accelerate the development and release of new varieties is one such example.

Integrated Pest Management
To increase crop yields, continuous improvement of agricultural technologies is required to minimize crop losses. The challenge is to do it while protecting the environment. IPM is a big part of the solution. Increasingly it is being adopted in both developed and developing countries for long-term, sustainable agriculture that achieves adequate, safe and quality food production, improves farmer livelihoods and conserves non-renewable energy.

Benefits of Integrated Pest Management
- Improved crop profitability owing to better pest control measures & appropriate use of crop protection solutions
- Stable, reliable and good quality crop yields
- Fall in intensity of pest infestations
- Reduced potential for problems of pest resistance or resurgence
- Decreased resistance of pests to crop protection products and GM crops.

Crop protection chemicals are used during both the pre-sowing & sowing, post sowing stages of farming. To multiply their savings, it is essential that farmers use crop protection chemicals judiciously across both these steps. Use of crop-protection chemicals across the value chain can increase the overall yield of crops, not only resulting in rise in...
incomes for the farmers but also boosting their profitability with significant cut-down in crop losses.

**Prevention**

Several crop management features are designed to prevent outbreak of insects, diseases or weeds. Multiple strategies (outlined below) can be combined and optimized for an IPM program. The goal is to prevent pest populations from building up to economically damaging levels.

**Location for Crops**

Growing crops in locations where they are best suited to climate, soil and topography provides them with optimal conditions from the start. Appropriate land preparation builds on these conditions.

**Selection of Crop variety**

Choosing beneficial crop varieties, like those with disease and pest resistance, is the main feature of IPM. These varieties can be derived from traditional cross-breeding or modern biotechnology: pest-resistant and herbicide-tolerant varieties, for example, may reduce the need for other crop protection measures. GM crops can also facilitate reduced or no-till practices, thus maintaining soil health and preventing erosion.

**Crop Planting & Rotation**

Planting similar crops alongside each other can substantially increase pests and should be avoided if possible. Traditionally, some farmers sow different crops in alternate rows or under sow a crop like maize with a legume such as cowpea to help improve soil fertility and reduce weeds. Such systems can help reduce pests.

**Soil Management**

Mechanical, physical and cultural crop protection methods prevent or minimize pests as well as reduce their build-up and carryover from one crop to another.

**Water management**

Supplying water to crops is essential to plant health but it can greatly influence pest incidence and impact. Irrigation may be required, especially in dry areas or with crops that require a lot of moisture. But while flood irrigating some crops, such as lowland rice, can control weeds, it is wasteful of water and can adversely affect beneficial soil organisms. Methods to combat these risks and conserve water include drip irrigation or growing crops on ridges or raised beds.

**Monitoring**

Management of any crop requires routine inspections to assess how well plants are growing and what actions need to be taken from seeding to harvest. Walking through a field involves scouting for pests and distinguishing them from non-pests and beneficial insects. Tools like pheromone traps, diagnostics and forecasting systems can assist with such monitoring in a timely and accurate way. IPM often requires collaborative decisions within a specific geography to provide effective control of pests. Some of these decisions need to be taken by national governments in relation to quarantine regulations and legislation, provision and training of advisory services and strategies for control of highly mobile pests like locusts. Geographic information systems and remote-sensing techniques can also assist in area wide management.

**Intervention**

Reducing economically damaging pests to acceptable levels may involve cultural, physical, biological and chemical control measures individually or in combination. Costs, benefits, timing, labor force and equipment as well as economic, environmental and social impacts all must be taken into consideration.

**Cultural and physical methods**

These techniques, such as weed control by tractor cultivation or disease control by removing infected plant debris, should be assessed for their impact on plant roots and yields as well as their requirements for labor and energy. Also, the possibility of integrating cultural techniques with the careful use of
crop protection products should be explored. For example, instead of replacing manual weeding entirely with herbicides, hoeing may be used in conjunction with them.

**Biological control**

Research on nature’s own methods of pest control is yielding new products and methods that can be used in IPM programs. Many of these require similar technical expertise as crop protection products in relation to formulation, field application and resistance management. Research on nature’s own methods of pest control is yielding new products and methods that can be used in IPM programs. Using beneficial insects to control pests works best when crops are grown in controlled environments like greenhouses and plastic tunnels. There are cases when control techniques with living organisms are successful in open field conditions, such as using predatory mites against spider mites. However, biological control products are usually only efficient at low pest intensities and other interventions are often required. Bacteria, fungi, nematodes or viruses have also been mass produced to control some pests. The most common and successful is Bacillus thuringiensis (Bt), a naturally occurring bacterium, which has been used to control several important pests (e.g., caterpillar pests in vegetables, vineyards and orchards). With modern biotechnology, crops like corn and cotton can now express the insect toxin produced by this natural control agent, delivering it more effectively. One focus of research has been on mass production of micro-organisms that cause disease in insect pests and weeds or compete with plant disease-causing organisms. The second and most rapidly expanding area of biotechnology for pest control has been the development of crop varieties resistant to pests and diseases and/or tolerant to herbicides. These varieties incorporate insect or disease resistance within the plant for accurate and timely delivery of an active ingredient.

**Chemical control**

Chemical crop protection products (pesticides) are biologically active chemicals that control a range of insect and vertebrate pests, diseases and weeds. They are often the most cost effective way of controlling infestations as part of an IPM strategy. Today’s crop protection products are the result of more than 50 years of research, development and field experience around the world by the plant science industry. Before crop protection products are released in the market, they are thoroughly tested for their safety, usefulness and effectiveness. When sold, they are labeled with explicit use instructions. To get the most out of these products, they must be applied correctly. Responsible use and good handling practices limit potential pesticide residues in crops and the environment as well as help avoid pest resurgence and resistance.

Improved application techniques and equipment, such as reduced drift nozzles and spot spraying, help farmers protect untreated refuges (e.g., hedgerows and field margins) and natural habitats for wildlife and pest enemies. The timing of treatment (season and time of day) as well as the types of products used is also critical factors.

In a nutshell, application of an Integrated Pest Management program offers following long-term benefits:

- A reduced amount of broad-spectrum pesticide used in the environment
- A reduced chance of pests developing resistance towards a specific pesticide
- A reduced health risk to humans
A reduced health risk to pests and organisms that are not the target

Less harmful to the environment.

31. AGRICULTURAL ENTOMOLOGY

Invasive pest species in India

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Keywords: non-native species, Alien species,

Introduction:

Invasive species is defined as a species that is:

- Non-native (or alien) to the ecosystem under consideration and
- Whose introduction causes or is likely to cause economic or environmental harm or harm to human health.

Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary means of invasive species introductions. An invasive species is a species that is not native to a specific location (an introduced species), and that has a tendency to spread to a degree believed to cause damage to the environment, human economy or human health.

Alien species are non-native or exotic organisms that occur outside their natural adapted habitat and dispersal potential. Many alien species support our farming and forestry systems in a big way. However, some of the alien species become invasive when they are introduced deliberately or unintentionally outside their natural habitats into new areas where they express the capability to establish, invade and outcompete native species (Raghubanshi et al., 2005).

In addition to the alien invasives from across political borders, invasion of pests can also occur from one geographic location to another within the same country (Anantha krishnan, 2009). The spread of Invasive Alien Species (IAS) is now recognized as one of the greatest threats to the ecological and economic well-being of the country. These species are causing enormous damage to biodiversity and the valuable natural agricultural systems upon which we depend. Direct and indirect health effects are increasingly becoming serious and the damage to nature and environment is often irreversible. The effects are exacerbated by global change and chemical and physical disturbance to species and ecosystems.

List of invasive insects in India

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>Year of introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eriosoma lanigerum (Hausmann)</td>
<td>woolly apple aphid</td>
<td>1899</td>
</tr>
<tr>
<td>Quadraspidiotus perniciosus Comstock</td>
<td>San Jose scale</td>
<td>1911</td>
</tr>
<tr>
<td>Orthezia insignis (Browne)</td>
<td>Lantana bug</td>
<td>1915</td>
</tr>
<tr>
<td>Icerya purchasi (Maskell)</td>
<td>Cottony cushion scale</td>
<td>1921</td>
</tr>
<tr>
<td>Phthorimaea operculella (Zeller)</td>
<td>Potato tuber moth</td>
<td>1937</td>
</tr>
<tr>
<td>Plutella xylostella (Linnaeus)</td>
<td>Diamond-back moth</td>
<td>1941</td>
</tr>
<tr>
<td>Pinus pini (Macquart)</td>
<td>Pine woolly aphid</td>
<td>1970</td>
</tr>
<tr>
<td>Heteropsylla cubana Crawford</td>
<td>Subabul psyllid</td>
<td>1988</td>
</tr>
<tr>
<td>Liriomyza trifolii Burgess</td>
<td>Serpentine leaf miner</td>
<td></td>
</tr>
<tr>
<td>Hypothenemus hampei Ferrari</td>
<td>Coffee berry borer</td>
<td>1990</td>
</tr>
<tr>
<td>Aleurodiscus disperses Russell</td>
<td>Spiral wing whitefly</td>
<td>1994</td>
</tr>
<tr>
<td>Bemisia argentinfolii Bellows and Perring</td>
<td>Silver leaf whitefly</td>
<td>1999</td>
</tr>
<tr>
<td>Leptocybe invasa (Fisher and LaSalle)</td>
<td>Blue gum chalcid</td>
<td>2006</td>
</tr>
</tbody>
</table>
Viraktamath (2002)

Presently Fall army worm *Spodoptera frugiperda* Smith; Tomato pin worm *Tuta absoluta* (Meyrick); Coconut rugose spiraling Whitefly *Aleurodicus rugioperculus* Martin; Banana Skipper *Erionota torus*; Psyllid, *Heteropsylla cubana* Crawford; American serpentine leaf miner, *Liriomyza trifolii* (Burgess); Coffee berry borer, *Hypothenemus hampei* (Ferrari); Spiraling whitefly, *Aleurodicus dispersus* Russell; Silver leaf whitefly, *Bemisia argentifolii* Bellows and Perring; Coconut mite, *Aceria guerreronis* Keifer; Cotton mealy bug *Phenacoccus solenopsis*; Papaya mealy bug *Paracoccus marginatus*; Eucalyptus gall wasp *Leptocybe invasa* and *L. brontispa* incidence was noticed in India.

**Strategies for Prevention of Invasive Species:**

The potential invasiveness of the majority of the world’s species is unknown and they should be placed on a “grey list”. The basic steps in this process will vary depending on the type of organism, population size, biology, pest status, available alleviation options

- Identification
- Preliminary risk assessments
- Planning for eradication programme
- Risk assessment and monitoring.

**Stages of emergency plan:**

- Response Planning Phase,
- Investigation Phase,
- Eradication Phase,
- Withdrawal Phase, Review and documentation

**Conclusion**

Still India is free from dangerous invasive pests such as Mediterranean fruit fly *Ceratitis capitata* (Wiedemann) and many other pests. By strengthening the quarantine regulations and increasing the expertise in taxonomy will help in reducing the risk and the eradication of invasive pest species.

**Selected reference**


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32. **HORTICULTURE**

**Aloe vera Cultivation and Uses**

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**Introduction**

Aloevera (*Aloe barbadensis*) is a popular medicinal plant. It belongs to liliaceae family. It is a perennial plant, growing to the hight of 1½ - 2½ ft. Its leaves are long and thick, juicy with a wheel like. The two sides of the leaves have thorny structure with a thorny tip. The inner substance of the leaves is jelly like, with bad odour and bitter in taste. The length of the leaves ranges from 25-30 cm., while the breadth ranges from 2-5 cm. Normally it flowers during October to January and the long inflorescence has a large number of small pink flowers all around. Fruits are developed during February to April. It is normally not propagated through seeds. Vegetative propagation is easy and convenient. Of late, because of sky rocketing price of allopathic medicines with its known side effects, medicinal plants and ayurvedic medicines are becoming popular.

**Soil and Climate**

Aloevera is found to grow in hot humid and high rainfall conditions. It is grown in all kind of soils but well drained soil with high organic matter, is most suitable. It grows well in bright sun light. A rainfall ranging from 1000 – 1200 mm is ideal for aloevera cultivation. Seedling Preparation and Planting Since it is difficult to grow aloevera from
seeds, seedlings are normally raised from roots of the plants. Sucker itself can be used as seedlings as in Banana. Rainy season is ideal for sucker plantation. A spacing of 1.5 x 1 ft, 1 ft x 2 ft or 2 ft x 2 ft is followed. Land Preparation About 2-3 ploughings and laddering are done to make the soil weed free and friable. Land leveling is then followed. Along the slope, 15-20 ft apart drainage are made.

**Application of Plant Nutrients**

Before land preparation, about 8-10 tonnes FYM/ha is applied. Before the last ploughing, 35 kg N, 70 kg P 20 5, and 70 kg K2 0/ha are added. For controlling termites, 350-400 kg Neem Cake/ha may be applied. In September - October about 35-40 kg N as top dressing may be applied. If the soil is rich in organic matter, N dose can be reduced.

**Plant Protection**

Aloe vera is infested by various insets and pests. Special care is needed for their control in medicinal plants like aloevera where the juice of the leaves are directly taken as medicine. Clean cultivation, interculture operation, regular and need based irrigation, application of adequate organic manure, treatment of suker before planting, and cultivation of aloevera in sunny conditions are conducive for healthy growth of the aloe vera crop. Use of organic source of plant protection materials like raw garlic juice, neem oil (10,000 ppm) 2-3 ml / lit, tobacco extractant 20 ml / lit gave reasonably good result.

**Yield**

Harvesting of leaves starts after 7-8 months of planting. Sharp knife is used for harvesting. Care has to be taken to reduce the loss of juice from the cut portion. If harvesting is done once in a year, October - November are the best period for harvesting. Second year gives maximum yield and for about 4-5 years good yield could be harvested. After harvesting leaves are dried in shade and then in sun before storages. Flowers are collected in December - January and preserved after proper drying. Yearly 100 - 115 quintals raw leaves and 350 - 400 kg flowers / ha are obtained.

**Medicinal Quality**

Aloe vera has lots of medicinal use along with cosmetic uses which include the following

1. Aloe vera makes our body germs free by cleaning of the body, veins, etc.
2. Drinking aloe vera juice leads to skin malfunction, acne, rusty skin, wrinkle on skin, facial scars, and also to keep away the dark circles around the eyes.
3. Aloe vera is helpful to eliminate the heart-related problem along with joints pain, urine problem, and the removal of toxic substance from the body.
4. Aloevera also helpful in reducing the overweight of body by its regular use.
5. Use of aloe vera is also good for the teeth and gum health as they clean and keep them sterile.
6. Aloe vera is also used as face wash and mouth freshener.
7. Mixing a little amount of turmeric in the liver of aloe vera gives you rest when you are suffering from the headache problem.
8. Drinking aloe vera juice with the mixture of oven juice is beneficial in diabetes.

**Other uses:** Aloe Vera is a very popular potted plant. It is grown in houses for the decoration. The leaf sap is used to make a soothing and healing moisturizing cream, which is good for the dry skin. It is used in the making of anti wrinkle cream. It is even used in the preparation of shampoos.

**Cultural Importance:** Aloe Vera has been mentioned several times in the sacred scriptures. It is believed to have been used for the preservation of the body of the Jesus Christ. It is called as the plant of immorality. It is also mentioned in the holy book of Bible. It has been used by the tribal people as a medicine for the century.

**References**


