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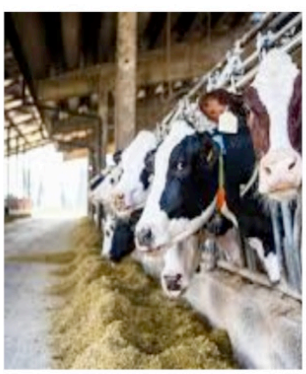

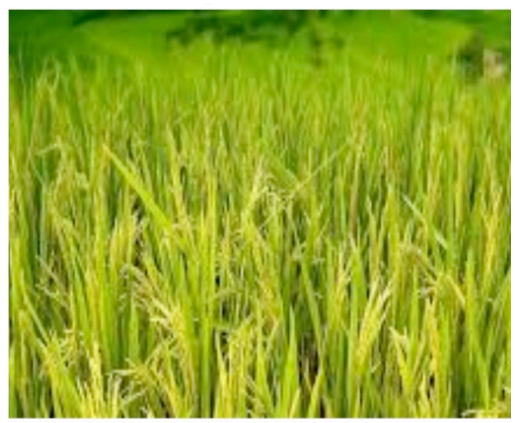

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## INDEX


| Article ID No. | Title | Page No. |
|---|---|---|
| 1 | Genetically Engineered Crops and It's Regulation in India | 1-3 |
| 2 | Utilisation of Quantum Dots in Food Industry | 4-7 |
| 3 | Introduction, Definition, Importance and Benefits of Biofertilizers | 8-9 |
| 4 | Carbon sequestration improves soil health and overcome global warming | 10-13 |
| 5 | Demand and utilization of Camel Milk in India | 14-15 |
| 6 | Farmers' suicides in India- Causes and Solutions | 16-18 |
| 7 | Principles and Requirements of Genetic Mapping in Plants | 19-20 |
| 8 | Hydroponic: A Step Ahead for Soil and Water Conservation | 21-26 |
| 9 | Vertical farming: New agricultural approach for 21st century | 27-29 |
| 10 | STCR (Soil Test Crop Response) – An Approach Towards Integrated Nutrient Management | 30-32 |
| 11 | Fall armyworm (FAW), Spodoptera frugiperda J. E. Smith (Lepidoptera: Noctuidae): An Invasive Threat to India | 33-36 |
| 12 | Fruit cracking | 37-41 |
| 13 | Bioremediation: A potential tools for Microplastic degradation in global concern | 42-43 |
| 14 | Role of Native Strains of Rhizobium in pulse Production | 44-45 |
| 15 | 'Space Foods' The Food for Zero Gravity | 46-48 |
| 16 | Effect of Medicinal Plants on Human Health | 49-52 |
| 17 | Gene disruption technology for management of stored grain insect pest | 53-56 |
| 18 | Fortification: A remedy against hidden hunger in India | 57-61 |
| 19 | Space Debris, A Threat to Environment | 62-64 |
| 20. | Medicinal and nutritional importance of Greengram | 65-68 |

Agri Mirror: Future India
Vol 1 Issue 1: May 2020

# Genetically Engineered Crops and It's Regulation in India

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***Introduction***

Plant genetic engineering methods were developed over 30 years ago, and since then, genetically modified (GM) crops or transgenic crops have become commercially available and widely adopted in many countries. In these plants, one or more genes coding for desirable traits have been inserted. Genetic engineering allows for direct gene transfer across species boundaries, some traits that were previously difficult or impossible to breed can now be developed with relative ease. The first-generation GM crops have improved traits like Herbicide-resistant crops (soybeans and maize, Pest resistance (Cotton and corn). Second-generation GM crops involve enhanced quality traits, such as higher nutrient content (ISAAA, 2019). "Golden Rice," one of the very first GM crops, is biofortified to address vitamin A deficiency. Among the various concerns related to GM crops, following are highlighted.

***Biosafety concerns***

There is a need of biosafety in GE research and development activities, an international multilateral agreement on biosafety "**the Cartagena Protocol on Biosafety (CPB)**" has been adopted by 167 parties, including 165 United Nations countries, Niue, and the European Union. The Protocol entered into force on 11 September 2003, and its main objectives are:

1. To set up the procedures for safe trans-boundary movement of living modified organisms
2. Harmonize principles and methodology for risk assessment and establish a mechanism for information sharing through the Biosafety Clearing House (BCH).

***The major biosafety concerns fall into these categories (Kumar, 2014)***:

***1. Bio-safety of human and animal health***

- Risk of toxicity, due to the nature of the product or the changes in the metabolism and the composition of the organisms resulting from gene transfer.
- Newer proteins in transgenic crops from the organisms, which have not been consumed as foods, sometimes has the risk of these proteins becoming allergens.
- Genes used for antibiotic resistance as selectable markers have also raised concerns regarding the transfer of such genes to microorganisms and thereby aggravate the health problems due to antibiotic resistance in the disease-causing organisms.

***2. Ecological concerns***

- Gene flow due to cross pollination for the traits involving resistance can result in development of tolerant or resistant weeds that are difficult to eradicate.
- GM crops could lead to erosion of biodiversity and pollute gene pools of endangered plant species.

- Genetic erosion has occurred as the farmers have replaces the use of traditional varieties with monocultures.

***3. Environmental concerns***

Effect of transgenic plants on population dynamics of target and non-target pests, secondary pest problems, insect sensitivity, evolution of new insect biotypes, environmental influence on gene expression, development of resistance in insect population, development of resistance to herbicide

***Regulatory Mechanisms in India***

Biosafety regulations cover assessment of risks and the policies and procedures adopted to ensure environmentally safe applications of biotechnology. The regulatory framework for transgenic crops in India consists of the following rules and guidelines.

a) **Rules and policies (**Rules, 1989 under Environment Protection Act, 1986, Seed Policy, 2002)

b**) Guidelines (**Recombinant DNA guidelines, 1990, Guidelines for research in transgenic crops, 1998)

The two main agencies identified for implementation of the rules are the Ministry of Environment, Forests and Climate Change and the Department of Biotechnology, Government of India. The rules have also defined competent authorities and the composition of such authorities for handling of various aspects of the rules. There are six competent authorities as per the rules.

1. Recombinant DNA Advisory Committee (RDAC)
2. Review Committee on Genetic Manipulation (RCGM)
3. Genetic Engineering Approval Committee (GEAC)
4. Institutional Biosafety Committees (IBSC)
5. State Biosafety Coordination Committees (SBCC)
6. District Level Committees (DLC).

***Out of these, the three agencies that are involved in approval of new transgenic crops are:***

- IBSC - set-up at each institution for monitoring institute level research in genetically modified organisms.
- RCGM - set-up at DBT to monitor ongoing research activities in GMOs and small-scale field trials.
- GEAC - set-up in the Ministry of Environment, Forests and Climate Change to authorize large-scale trials and environmental release of genetically modified organisms.
- The Recombinant DNA Advisory Committee (RDAC) constituted by DBT takes note of developments in biotechnology at national and international level and prepares suitable recommendations.
- The State Biotechnology Coordination Committees (SBCCs) set up in each state where research and application of GMOs are contemplated, coordinate the activities related to GMOs in the state with the central ministry.
- SBCCs have monitoring functions and to take punitive action in case of violations.

- District Level Committees (DLCs) are constituted at district level to monitor the safety regulations in installations engaged in the use of GMOs in research and application.

***Conclusion***

Adoption of GM crops by concerning the above-mentioned points can be helpful in attaining higher yield, lesser consumption of pesticides, thus ultimately helpful in achieving higher profits.

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Agri Mirror: Future India
Vol 1 Issue 1: May 2020

# Utilisation of Quantum Dots in Food Industry

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***Introduction***

Nanotechnology is an emerging branch of science and technology that deals with structures whose atomic or molecular level dimensions vary from 1 to 100 nm. A nanometer is one billionth of a meter (1 nm=$10^{-9}$). Earliest known discussion about nanotechnology was considered to be a speech by American physicist Richard Feynman in 1959. The speech was titled, "There's Plenty of Room at the Bottom". Nanotechnology has found applications in various fields like electronics, pharmaceuticals, agriculture, food and beverages, textile, cosmetics, surface coatings etc. The term 'nanotechnology' was first coined by the Japanese scientist Norio Taniguchi, 1974; where he explained the production technology that creates objects and features on the order of a nanometer scale.

The applications of nanotechnology have emerged in the field of food science and technology. Nowadays nanotechnology is being used in various fields of food science and food microbiology, including food processing, food packaging, functional food development, food safety, detection of foodborne pathogens, and shelf-life extension of food and/or food products.

One such application of nanotechnology is a fluorescence detection technique by means of Quantum Dots which are nano-biosensors.

***What are Quantum Dots?***

Quantum Dots are nanocrystals of semiconductors with narrow, very specific, stable emission spectra. The size of a quantum dot may vary from 2nm to 10nm. They consist of a core, which is most commonly made of cadmium selenide (CdSe), cadmium telluride (CdTe) or Indium phosphide (InP). The core of the quantum dots should exhibit high quantum yield. Quantum yield is the proportion of the light emitted to light absorbed by a fluorescent molecule. Quantum yield is an indicator of the brightness of the molecule.

***The Working Principle of the Quantum Dots***

The fluorescence is generated when an excited electron relaxes to the ground state. The electron emits energy when traveling back from the excited state to the ground state. The energy necessary from jumping from the ground state to the excited state comes from an external source such as UV light. The distance that the electrons have to travel from the excited state to the ground state is known as band gap. When the band gap is larger, the electron emits more energy. Smaller QDs have a larger band gap, thus, their light is bluer because higher frequency wavelength (more energy) is emitted. Bigger QDs have a smaller band gap, so, the light they emitted is redder because lower frequency is emitted.

These Quantum Dots may be further bioconjugated with several biomolecules to form hybrids which combine the unique optical and magnetic properties of nanoparticles with the specific and selective binding behaviour of the biomolecules. This property makes quantum dots efficient biological fluorescent probes for qualitative and quantitative analysis.

***Advantages of Quantum Dots over Traditional Detection Techniques***

Fluorescence labelling using organic dyes such as fluorescein isothiocyanate (FITC) or rhodamine 6G (R6G), traditional organic dyes used in biological labelling exhibit a narrow excitation spectra and broad emission spectra. When used in multicolour experiments, their narrow excitation spectra make simultaneous excitation difficult, and their broad emission spectra with long tails at higher wavelengths introduce spectral cross-talk between different detection channels, making quantification difficult among different probes. Semiconductor QDs, with photophysical properties opposite to organic dyes (i.e., broad excitation spectra and narrow symmetric emission spectra), can solve the problems encountered in multicolour experiments where organic dyes are used. Furthermore, surface passivated semiconductor QDs are highly stable against photobleaching as compared to conventional organic dyes.

The method of detection by quantum dots have been found to be easier, cheaper and takes relatively lesser time for detection in comparison to the traditional methods of detection such as GC-MS, LC-MS, AAS etc.

***Various Applications of Quantum Dots in Food Industry:***

***a) Detection of toxins***

Hu *et al*., (2014) studied the presence of acrylamide in potato chips using Quantum Dots technique. Acrylamide is a neurotoxin which is found in thermally processed food products such as potato crisps, fries, vegetable crisps, breakfast cereals, baked products like cakes, cookies and other fried baked and roasted products. It is formed due to the Millard reaction between aspargine and reducing sugars. Acrylamide is a carcinogen having high toxicity. Hence rapid detection of this compound in the food products is necessary for food safety.

The Quantitative analysis of the presence of acrylamide in the food products are done mainly by two methods i.e. by Gas chromatography- Mass spectrometry (GC-MS) and Liquid chromatography- Mass spectrometry (LC-MS) (Raffan and Halford, 2019). According to the studies conducted by Hu *et al*., (2014) it was found that method of detection by fluorescence sensing by means of Quantum Dots was a more rapid process as compared to the traditional methods of detection and was conducted at a much lower cost. It was further suggested that this novel technique could be useful for a faster on-line detection of acrylamide during food processing.

***b) Detection of trace elements***

Wei *et al*., (2012) studied the efficiency of manganese modified CdTe quantum dots to detect trace copper element in beer samples. Beer is one of the most popular alcoholic beverages in the world, and it contains copper that comes from raw materials, crop treatment or manufacturing processes.

Though copper is an essential trace element it becomes toxic if consumed in higher quantity. The copper content in beer also influences the foaming quality and the flavor enhancement. Thus, the determination of copper in beer is important for food safety and public health.

There are several methods of determination of copper in food products such as atomic absorption spectroscopy, adsorptive stripping voltammetry, inductively coupled plasma optical emission spectrometry, X-ray fluorescence spectrometry and cloud-point extraction method. However, most of these methods require sophisticated and relatively expensive apparatus, and the procedures are complicated and relatively time consuming. The method of detection by quantum dots have been found to be easier, cheaper and takes relatively lesser time for detection in comparison to the traditional methods of detection. The quantum dots were found to have high photoluminescence with quantum yield of 84%. The proposed method was successfully applied to the detection of trace copper element in beer samples without any pre-processing, and the results agreed with those obtained by AAS.

***c) Detection of foodborne pathogens***

Kuo *et al*., (2008) studied the efficiency of antibody-conjugated CdTe quantum dots for *Escherichia coli* detection. Chemically denatured bovine serum albumin (dBSA)-coated water-soluble cadmium telluride (CdTe) quantum dots (QDs), which can effectively improve the chemical stability and photoluminescence quantum yield of CdTe QDs, were successfully conjugated to an anti-Escherichia coli antibody via a cross-linking reaction. The anti-*E. coli* antibody-conjugated CdTe QDs were then used to detect E. coli O157:H7 and *Listeria monocytogenes* using fluorescence microscopy. The results successfully demonstrated the potential of bioconjugated CdTe QDs for broad biological applications, such as fluorescence-based pathogen detection and in vitro or in vivo cell imaging.

***d) Detection of flavour compounds***

An optical sensor for vanillin in food samples was developed using CdSe/ZnS QDs modified with β-cyclodextrin (β-CDs) by Durán *et al*., (2015). The vanillin-sensor was based on the selective host–guest interaction between vanillin and β-cyclodextrin. Hence the analytical potential of this sensing system was demonstrated by the determination of vanillin in synthetic and food samples (sugar, milk and custard).

Other applications of quantum dots are detection distribution of proteins in food matrices, the successful tagging of food proteins such as gluten and zein and detection of pesticides and herbicides etc.

***Conclusion***

Food safety is a prime concern to the food industry. The sensitive detection of food contaminants such as pesticides and pathogenic microorganisms is highly desirable to ensure food quality and safety. Conventional methods of detecting pesticides and foodborne pathogens are lacking in terms of sensitivity, specificity, reproducibility and speed. Tests currently used to detect them are time consuming and labour intensive. Biosensors are proving to be favourable tools for the screening of food contaminants like pesticide residues, foodborne pathogens and their toxins, because of their high sensitivity, selectivity, simplicity, reliability and field applicability. Biosensors based on micro- and nanofabrication are emerging in the area of food processing. Biosensors possess many advantages in comparison to conventional techniques in terms of cost per assay, required minimum sample volume, analytical time, and potential for multiple-analyte analysis with high sensitivity and specificity.

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Agri Mirror: Future India
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# Introduction, Definition, Importance and Benefits of Biofertilizers

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## *Introduction*

According to an estimate 240 million tonnes of food grains will be required to feed about one billion expected populations by 2000 AD in India and to achieve this milestone, a sizable quantity of mineral fertilizers will be required. The total fertilizer requirements of our country would be 23 million tonnes as against the present consumption level of 13 million tonnes per annum. The problem is so acute that it is beyond any single type of nutrient source to accept the challenge of appropriate nutrient supply. Integrated use of all the sources such as mineral fertilizers, organic manures, biofertilizers, etc. is the only alternate for improving soil fertility.

The use of organic manures and mineral fertilizers is in practice but use of biofertilizer in agriculture is not very popular. Hence, there is a need to make its use popular. The increased cost of fertilizer production coupled with progressively increasing use of chemical fertilizers particularly needed by HYV (High Yielding Varieties) are adding to the cost of cultivation of crops and causing nutritional enhancement in Indian agriculture. Recent energy crisis, rapid depletion of non-renewable energy sources like naptha, natural gas, sulphur, etc. their production also releases pollutants, nutrient potential from all organic sources in India is over 19 million ton/year which is adequate requirement to meet 70 per cent of the projected nutrient requirement for the decade ending 2000 A.D

Nutrient need of growing plant can be met through a number of sources. The major sources of plant nutrient are minerals fertilizer, organic manure, recycled waste and byproduct, biological nitrogen fixation (BNF), natural minerals and to lesser extent nutrient recycled through irrigation water and precipitation. These supplement major plant nutrients and the plant productivity for sustainable agriculture. They are important and cost-effective inputs in agriculture, plantation and commercial crops. Microbial inoculants/biofertilizers on their application multiplies in rhizosphere soil and benefit the growing crops. If the soil conditions are favorable, the populations of added microorganism are built up in the rhizosphere of plants and frequent application of microbial inoculants can be avoided. They are inexpensive and help in reducing the consumption of chemical fertilizers. The cost of production of biofertilizer is low and so is the selling price. On nutrient basis, one ton of Rhizobium inoculants is equivalent to 100 tonnes of inorganic fertilizer It has now become possible to meet a large part of our total nitrogen demand through proper husbandry of BNF (Biological Nitrogen Fixation) by micro-organism (bio-fertilizers) in crop production systems. Bio-fertilizers are capable of providing an economically viable level for achieving the ultimate goal of enhanced productivity.

## *Definition*

Biofertilizer' is a substance which contains living microorganisms which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Biofertilizers (BF) (microbial nutrients) are the products containing living cells of different types of microorganisms which have an ability to mobilize nutritionally important elements from non-usable to usable form through biological process. Although the advent of the phenomena is as old as a century, the need of its commercial exploitation was not felt in traditional agriculture. In recent years, biofertilizers have emerged as an important component of INSS (Integrated Nutrient Supply System) and hold a promise to improve the crop yields and nutrient supplies.

Biofertilizers are not fertilizers. Fertilizers directly increase soil fertility by adding nutrients. Biofertilizer, a term which refer to all such microorganism which add, fix, mobilize or solubilize the nutrient in simpler form which is easily used by plants. Their significance lies in their ability to supplement/mobilize soil nutrient with minimal use of non-renewable resources and as components of integrated plants nutrient systems. Biofertilizers are more aptly termed as Microbial/Bacterial or Fungal inoculants. Biofertilizers add nutrients through the natural processes of fixing atmospheric nitrogen, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth promoting substances. Biofertilizers can be expected to reduce the use of chemical fertilizers and pesticides. The microorganisms in biofertilizers restore the soil's natural nutrient cycle and build soil organic matter. Through the use of biofertilizers, healthy plants can be grown while enhancing the sustainability and the health of soil. Biofertilizers are very similar to compost tea. They can be thought of as an engineered compost tea where only the microorganisms that are most beneficial are used.

***Importance***

The increase in the productivity during the green revolution period is accompanied by an exponential increase in consumption of non-renewable sources of energy. In view of the fast diminishing energy sources combined with their escaling cast.

***Benefits***

1. Germination increase up to 20 percent. Improved seedling emergence and growth.
2. Increase yield from 10 to 40 percent.
3. Improve the quality of fruit and keeping quality.
4. Saving of 25 to 35 percent inorganic fertilizers.
5. Increase the availability and up take of N and P in plants.
6. Improve the status of soil fertility maintain good soil health and crop productivity.

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Agri Mirror: Future India
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# Carbon sequestration improves soil health and overcome global warming

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***Introduction***

Climate change refers to a change in the state of the climate that can be identified (*e.g.*, by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use (Kumhar *et al.,* 2019a and Kumar 2019). UNFCCC defines 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.' The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes. Global warming, the bitter fruit of industrial revolution has detrimental effects on both biotic as well as abiotic components of the earth. These effects mostly observed as increased average global temperature, unpredictable climate changes, erosion of biodiversity, floods, cyclones, storms etc., and call for immediate strategies to eliminate or reduce the causes responsible for global warming. Since carbon as carbon dioxide ($CO_2$) is the main player in global warming, so most of the options aimed at addressing the global warming are directed towards trapping of carbon from atmosphere.

***Table 1. Present scenario of greenhouse gases***

| **Greenhouse gases (GHG)** | **Preindustrial level 1750** | **20$^{th}$ century level 1999** | **Global warming potential** | **Current level** 2018 | **Increase (%)** | **Radioactive forcing (W/m$^2$)** |
|---|---|---|---|---|---|---|
| $CO_2$ | 280 ppmv | 367 ppmv | 1 | 406 ppmv | 41.2 | 1.46 |
| $CH_4$ | 700 ppbv | 1745 ppbv | 21 | 1893ppbv | 170.4 | 0.5 |
| $N_2O$ | 270 ppbv | 314ppbv | 310 | 326 ppbv | 20.7 | 0.15 |
| CFC-12 | 0 | 533pptv | 10900 | - | - | 0.17 |

PPMV= parts per million by volume, Courtesy (IPCC, 2001& 2018)

PPBV=parts per billion by volume,

PPTV= PPMV= parts per trillion by volume

Climate change is poised to have a sharply differentiated effect as between agro-ecological regions, farming systems, and social classes and groups other impacts are. (Singh *et al*., 2017; Agrawal *et al*., 2019).

1. Shift in climatic and agriculture zones

2. Impact on Agriculture soil
3. Effect on soil organic matter and soil fertility
4. Effect on biological health of soil
5. Soil erosion and sediment transport
6. Reduced soil water availability
7. Impact on soil processes
8. Salinization and alkalization
9. Pest, diseases and weeds
10. Impact on plant growth
11. Impact on crop production

***Carbon sequestration***

Carbon sequestration is the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere. The idea is to prevent carbon emissions produced by human activities from reaching the atmosphere by capturing and diverting them to secure storage, or to remove carbon from the atmosphere by various means and 'storing' it in the soil (Parihar *et al*., 2018). The Department of Energy (2006) refers to carbon sequestration as the provision of long-term storage of carbon in the terrestrial biosphere, underground, or the oceans so that the buildup of $CO_2$ (the principal GHG) concentration in the atmosphere will reduce or slow." The C sequestration process may be naturally or anthropogenic-driven. The natural process includes terrestrial sequestration in soil (humification and formation of secondary car-bonates) and trees such as biomass production and storage in aboveground and below ground components (Lal, 2004).

***Soil carbon sequestration***

Soil organic carbon is considered to be one of the largest carbon reservoirs of the terrestrial ecosystems and also plays an important role in the global carbon cycle (Lal, 2004). Ground covers (GC) is an efficient practice to reduce soil and nutrient losses in grass-based cropping system, so they can act as a sink of atmospheric carbon and improve soil fertility, efficient tool for atmospheric carbon sequestration and to protect the soil from erosion. The selection of species with greater biomass in the shoot and root systems usually increases the C input and, therefore, the SOC. Kumhar *et al.,* 2019c.

***Conservation agriculture***

Principle of conservation agriculture follows the three main processes as described by FAO.

1. Minimal soil disturbance:
2. Soil cover: Ground cover must be more than 30%.
3. Inclusion of legume.

***Forms of conservation agriculture***

Major forms of conservation agriculture include

- Minimum, reduced or no tillage
- Crop and pasture rotation
- Contour farming and strip cropping
- Cover and green manure cropping
- Fertility management
- Erosion control
- Agro-forestry and alley cropping
- Organic and biodynamic farming
- Stubble mulching

- Integrated nutrient management (INM)
- Integrated pest management (IPM)
- Irrigation management

The carbon sequestration under conservation agriculture is possible either by maximizing the carbon input or by minimizing the soil carbon loss. Carbon sequestration rate varies with plant characteristics, rotation sequence, type and frequency of tillage, fertilizer management in terms of rate, timing and placement of fertilizers in the soils and integrated management of pest and nutrients, crop and livestock *etc*. (Kumhar *et al.,* 2019b)

***Agroforestry***

Agroforestry is a viable alternative to prevent and mitigate climate change. Agroforestry was recognized by IPCC as having high potential for sequestering C as part of climate change mitigation strategies (Watson *et al.,* 2000). It can increase and stabilize agricultural yields and reduce soil erosion (Prinsley, 1990). Agroforestry is ideal option to increase productivity of wastelands, increase tree cover outside the forest, and reduce human pressure on forests under different agro-ecological regions of India. An IPCC special report (IPCC, 2000) indicates that conversion of unproductive croplands and grasslands to agroforestry have the best potential to soak up atmospheric C. In agroforestry, soil restoration process involves recovery of organic based nutrients cycle through replenishment of soil organic matters, about half of which is carbon.

***Organic Farming***

This compost contains aligned beneficial microbes, where the dry matter is rich in carbon and the green matter is rich in nitrogenous substances. When decomposition of these components takes place the carbon nitrogen ratio in the soil becomes 10:1, ideal for the proliferation of microbes. This type of farming practices not only improve the soil fertility but also increase farmers' income. Hence, we can say organic farming is one of the best ways of improving soil fertility which co-benefited the sequestration of carbon from atmospheric. Organic farming has been shown to increase the SOC contents. Therefore, it is suggested as a measure to improve the overall greenhouse gas balance of agriculture compared to conventional farming. Crop rotation and organic fertilization are both known to exert strong control over SOC in any farming system, but neither of them is uniquely organic farming.

***Conclusion***

Soil C sink capacity depends on several factors including climate, soil type, crops and vegetation cover, and management practices. Recycling organic resources containing polyphenols and lignin may affect the long-term decomposition dynamics and contribute to the buildup of SOC. Hence, it is important to explore a wide range of adaptation strategies, which could reduce the vulnerability of agriculture to climate change.

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Agri Mirror: Future India
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# Demand and utilization of Camel Milk in India

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## *Introduction*

Camel farming is an alternative to cow farming in dry land for different dairy regions of the world. Cow farming consumes large amounts of water and electricity for air-conditional halls and cooling by sprinkler system. Farming of camel milk can certainly play a far more important role in the prevention of malnutrition than it does today in arid zone of Rajasthan. The camel is better provider of food in places having heat, scarcity of water and feed. Camel milk has more fat and protein than cow's milk. Cholesterol in camel milk is lower than cow or goat milk. Camel milk has a high vitamin and mineral content and immunoglobin content. It is also high in unsaturated fatty acids and B vitamins but lower in vitamin A and $B_2$ than cow milk.

## *Camel milk production in India*

Camel milk in India has been used by Raika and other desert communities, it also finds its presence in ancient Indian medicinal texts of medicine. Camel milk use in medicine for Autism, Diabetes, TB, hepatitis, fever etc. Now a days the marketing of camel milk 10,000 litter per/ days in district of Bikaner, Rajasthan and processing done in the plant at Kutch, Gujarat. The Camel milk price is 250 to 280 rupees /lit.

## *Camel Milk Business*

Camel milk business has brought new a ray of hope to various community in Rajasthan. Unimaginable earlier, people are now getting a bigger Income from camel milk in the district of Bikaner, Barmer, Sikar, Ajmer, Jaipur, Churu in Rajasthan and Mandsaur in Madhya Pradesh etc.

## *Nutritional value of camel milk*

Camel milk is a highly nutritious food consumed by the Bedouins and many other desert communities of the world. It has been consumed in India since ancient time. When composition of camel milk was compared to human milk and it was found to be fairly resembling in terms of nutritional components. It has high lactose content, whey protein and lower casein ratios, which make highly digestive for an infant. Nutritional value of camel milk, calories 107, Fat 3.10 to 4.05 %, Snf 9 to 9.52 %, protein 4.05%, Lactose 4.07 to 4.32 % Ash 0.8% *etc.*

## *Composition of camel milk: -*

| | |
|---|---|
| Total Solid | 9 to 14 % |
| Fat | 3.10 to 4.05% |
| Water | 86 to 91 % |
| Lactose | 3 to 5 % |
| Protein | 2.3 to 4.05 % |
| Calcium 100 ml | 1100 to 1600 mg |

***Health Benefits of camel milk***

Benefits of camel milk are numerous viz. cure milk against cancer, tuberculosis, against autism, treating psoriasis, to reduces high cholesterol in blood, against Hepatitis C and B etc. The nutritional benefits of camel milk are endless. At Desert Farms, People are proud to bring nature's most nutritious dairy beverage. Camel milk is a natural pro-biotic to assist healthy bacterial growth in the gut and making it easy to digest. It may improve gastrointestinal health and systemic immunity. Camel milk is rich in Vitamin B1 (Thiamin) giving people 70% of recommended daily value per serving. Vitamin B1 may contribute to the maintenance of mental function, which also helps to regulate our metabolism. Camel milk is also rich in Calcium providing with 30% of your daily value per serving which will help build stronger bones. it is a good source of potassium and phosphorus, helping our body to maintain a healthy blood Pressure level, in combination with a low-sodium diet, which may reduce the risk of a stroke. Additionally, camel Milk has 50% less fat and 50% less saturated fat than USDA whole milk. Development of cancer depends on many factors. A diet low in total fat may reduce the risk of some cancers, while many factors affect heart disease, Diet low in saturated fat may reduce the risk of this disease. Camel milk is also a good source of protein with 10 grams of protein per bottle, helping in to maintain stronger muscles para Findings on Camel Milk The nutritional benefits of camel milk provide the foundation for its health benefits. Studies on the health benefits of camel milk are on-going and show promising results. One can find many studies on camel milk in the PubMed database. One of the major findings of camel milk is the presence of lactoferrin. Lactoferrin is used as an antioxidant protecting the body against viral and bacterial infections. The lactoferrin in camel milk according to PubMed scientists has been shown to stimulate the immune system, promote healthy intestinal bacteria to regulate the way the body processes iron reduces coronary heart disease, prevent stomach and digestive problems.

***Additional Benefits of Camel Milk***

Camel milk benefits newborns and children. It is the closest in terms of composition to a mother's milk. In many countries in the Middle East and North Africa, camel milk is used to feed malnourished children. At desert Farm People of small family camel farms have worked hard to provide you with its nature's most wholesome dairy beverage. Drinking camel milk benefits the human body in many ways. And, best of all, camel milk is delicious!

Agri Mirror: Future India
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# Farmers' suicides in India- Causes and Solutions

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## Introduction

Agriculture is the backbone of Indian economy as it supports food security of the nation and provides various livelihood opportunities to the rural people (Vasta, 2013). According to Indian Economic Survey, 2018 report, agriculture is considered as one of the major contributing sectors of national economy as it employs about 50 per cent of the Indian workforce and has contributed nearly 17-18 percent to country's Gross Domestic Product (GDP). Low and volatile growth rates under the sector and the recent escalation of an agrarian crisis in several parts of the country pose a threat not only to national food security but also to the economic well-being of the nation as a whole. Farmers are facing distress due to many factors such as poverty, indebtedness, crop failures, distress, lack of awareness on new technologies, inadequate debt, marketing of produce, natural calamities such as floods, drought, erratic rainfall and depletion of water levels (Sravanth and Sundaram, 2019).

Thus, this severe distress has led to dramatic rise in the number of suicides among farmer communities in various parts of the country. A record of 251260 farmers has committed suicide in India over the last 15 years. The States which come either under dry zone or areas under rainfed agriculture have reported the highest number of suicides the major states are Maharashtra, Andhra Pradesh, Karnataka, Madhya Pradesh and Chhattisgarh follow closely, with two thirds (68.4%) of farmer suicides being reported from these states (Ashalatha and Rajeshwari, 2018). Trend of farmers' suicide over 16 years has been presented in Table 1 and major states with most farmer suicides in India have been listed in Table 2.

**Table 1**: *Number of farmers (Farming/Agricultural labourers) committed suicide during 2000-2015 in India*

| Year | Suicide committed by the farmers (Number) |
|---|---|
| 2000 | 16603 |
| 2001 | 16415 |
| 2002 | 17971 |
| 2003 | 17164 |
| 2004 | 18241 |
| 2005 | 17131 |
| 2006 | 17060 |
| 2007 | 16632 |
| 2008 | 16196 |
| 2009 | 17368 |
| 2010 | 15964 |
| 2011 | 14027 |
| 2012 | 13754 |
| 2013 | 11772 |
| 2014 | 12360 |

| | |
|---|---|
| 2015 | 12602 |
| **Total** | **251260** |

**Source:** National Crime Records Bureau, 2015

***Table 2:*** *Top 5 states with most farmer suicides in India in 2015*

| State | Suicide committed by the farmers (Number) |
|---|---|
| Maharashtra | 3003 |
| Telangana | 1358 |
| Karnataka | 1197 |
| Chhattisgarh | 854 |
| Madhya Pradesh | 581 |

**Source:** National Crime Record Bureau, 2015

***Causes***

Considering a single defining cause for farmer suicides in India is impossible (Merriot, 2017). So here are some of the reasons for the agrarian distress, vagaries of nature like drought, flood, erratic rainfall and cyclone, land fragmentation as fragmented land holdings result in low productivity, due to rising agricultural costs- rural wages are depressed resulting in rural distress causing migration of youth towards cities, lack of institutional credit- indebtedness being the single largest cause of farmers suicide, agricultural marketing and lack of infrastructure as well as ineffective government response as focus is on credit and loan, rather than productivity, income and farmer prosperity.

Other causes like poverty, property dispute, debt burden, health issues, family problems (marriage of daughters) and personal issues. If reviewed deeply increase in input costs like chemicals, seeds, fertilizers, which are to be procured from outside, water disputes and crisis, dominance of money lenders and contractors over marketing channels are the most important factors responsible for farmers suicide.

***Solutions***

Giving monetary relief is not an effective solution. The solutions should aim at the entire structure of agriculture. Here are some solutions that could help in improving the state of the farmers by reducing the dependency of agriculture on nature, making institutional finance available to every farmer, farmers need to be guided and advised on economical methods of cultivation, small farmers should be encouraged to develop alternative sources of income to reduce the dependency on agriculture as the sole source of income (Basha 2018). Strategies for doubling farmers' income should be opted by giving emphasis on irrigation along with end to end solution on creation of resources for 'More crop per drop' Krishi Sinchayi Yojana' and by providing quality seeds and nutrients according to the soil quality of each farm.

Organic farming method can be one of best option for farmers. Since, it leads to sustainable agricultural development with better organic manures that can improve soil fertility, better yield, less input cost and better return than conventional farming (Mariappan and Zhou, 2019). This will further reduce the cost of cultivation; will reduce socio-economic problems such as farmers' suicides in the future of Indian agriculture.

"*Give a man a fish, he will eat for a day but teach him how to fish, he will eat for the rest of his life*", so goes the popular saying, the case of our Indian farmers is similar to this, what they need is a means to sustain throughout their lives without having the face the desperation that adversity drives them to. If India has to shine, it is these farmers that need to be empowered.

***Conclusion***

Efforts should be targeted at improving the entire structure of the small farmers where in the relief is not given on a drought to drought basis, rather they should be taught to overcome their difficulties through their own skills and capabilities. The Government needs to come up with pro-active solutions and the nation has to realize that farmers' suicides are not minor issues happening in remote parts of a few states, it is a reflection of the true state of the basis of our economy. Hence, it can be concluded that, unless all these causes are simultaneously dealt, the situation cannot be improved.

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Vol 1 Issue 1: May 2020

# Principles and Requirements of Genetic Mapping in Plants

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***Introduction***

Genetic mapping refers to the determination of the relative positions of genes on a DNA molecule (chromosome or plasmid) and of their distance between them. Genetic map indicates the position and relative genetic distances between markers along chromosomes. The first genetic map was published in 191 by T. H. Morgan and his student, Alfred Sturtevant, who showed the locations of 6 sex linked genes on a fruit fly chromosome. Genetic mapping is based on the principle that genes (markers or loci) segregate via chromosome recombination during meiosis (i.e. sexual reproduction), thus allowing their analysis in the progeny (Paterson, 1996). When two genes are close together on the same chromosome, they do not assort independently and are said to be linked. Genes that are closer together or tightly-linked will be transmitted together from parent to progeny more frequently than those genes located far apart. Such process or set of processes is called recombination by which DNA molecules interact with one another to bring a rearrangement of the genetic information in an organism.

***Requirements for Genetic Mapping***

1. Develop appropriate mapping population and decide the sample size
2. Decide the type of molecular marker(s) for genotyping the mapping population
3. Screen parents for marker polymorphism and then genotype the mapping population
4. Perform linkage analyses using statistical programs

***Mapping population***

The first step in producing a mapping population is selecting two genetically divergent parents, which show clear genetic differences for one or more traits of interest (e.g., the recipient or recurrent parent can be a highly productive and commercially successful cultivar but lacks disease resistance, which is present in another donor parent).

***Selection of molecular markers for mapping***

Restriction fragment length polymorphisms (RFLPs), microsatellites or simple sequence repeats (SSRs), expressed sequence tags (ESTs), cleaved amplified polymorphic sequence (CAPS), random amplified polymorphic DNA (RAPD), amplified fragment length polymorphisms (AFLPs), inter simple sequence repeat (ISSR), diversity arrays technology (DArT), and single nucleotide polymorphism (SNP) have been used for map construction in several plants.

***Polymorphism screening and genotyping of the mapping population***

The third step in the construction of a linkage map is to identify sufficient number of markers that reveal differences between parents (i.e., polymorphic markers). In general, cross pollinating species possess higher levels of polymorphism compared to inbreeding species. Once sufficient numbers of polymorphic markers have been identified between parents, they must be used to genotype the entire mapping population.

***Linkage analyses and map construction***

Several computer packages are presently available for genetic linkage mapping but the most widely used are JoinMap, MAPMAKER/EXP, GMENDEL, LINKAGE and Map Manager QTX.

***Test for segregation distortion***

For each segregating marker, a chi-square analysis needs to be performed to test for deviation from the expected segregation ratio for the mapping population (1:1 for both dominant and codominant markers in BC, RIL, DH and NIL; 1:2:1 for codominant markers in F2; 3:1 for dominant markers in F2). Segregation distortion can occur due to statistical bias, genotyping and scoring errors and biological reasons like chromosome loss, competition among gametes for preferential fertilization, incompatibility genes, chromosome arrangements or non-homologous pairing.

***Establishing linkage groups***

Markers are assigned to linkage groups using the odds ratios, which refers to the ratio of the probability that two loci are linked with a given recombination value over a probability that the two are not linked. This ratio is called a logarithm of odds (LOD) value or LOD score. The critical LOD scores used to establish linkage groups and calculate map distances are called 'linklod' and 'maplod', respectively. Marker pairs with a recombination LOD score above a critical 'linklod' are considered to be linked whereas those with a LOD score less than 'linklod' are considered unlinked.

***Determining map distance and locus order***

For calculating map distances and determining locus order, several parameters, including a recombination threshold value, minimum 'maplod', jump threshold value, and mapping function (m.f.) is needed. Only information for marker pairs with a LOD score above 'maplod' is used in the calculation of map distances and its values can be as low as 0.01 to as high as 3.0. If the value of 'maplod' equal to 0.01, the program uses even very weak linkage information. At each step, a marker is added to the map on the basis of its total linkage information with the markers that were placed earlier on the map. When map distances are small (<10 cM), the map distance equals the recombination frequency. The researcher must select one of the two genetic mapping functions (Haldane or Kosambi), which translates recombination frequencies into map distances and vice versa. Haldane's mapping function assumes absence of interference between crossovers in meiosis, whereas Kosambi's mapping function assumes a certain degree of interference. Such mapping functions convert recombination fractions into map units called centimorgans (cM). By definition, one map unit (m.u.) is equal to one percent recombinant phenotypes or 1 cM.

***Reference***


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# Hydroponic: A Step Ahead for Soil and Water Conservation

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## *Introduction*

Soil is usually the most important growing medium for any plant. It is the most important media to provides anchorage, nutrients, air, water, etc. for successful plant growth [·]. However, Soils do pose serious limitations for plant growth due to the presence of disease-causing organisms and nematodes, unsuitable soil reaction, unfavourable soil compaction, poor drainage, degradation due to erosion, etc.

Moreover, with the advent of civilization, open field/soil-based agriculture is facing some major challenges; most importantly a decrease in per capita land availability. In 1960 with 3 billion population over the World, per capita land was 0.5 ha but presently, with 6 billion people it is only 0.25 ha and by 2050, it will reach 0.16 ha[·]. Under such circumstances, in the near future, it will become impossible to feed the entire population using the open field system of agricultural production only. Naturally, soil-less culture is becoming more relevant in the present scenario, to cope-up with these challenges. In soil-less culture, plants are raised without soil. Improved space and water-conserving methods of food production under soil-less culture have shown some promising results all over the World.

Soil-less culture mainly consists of the techniques of Hydroponics and Aeroponics. The term Hydroponics was derived from the Greek word's hydro' means water and ponos' means labour [·]. In this method a plant growing by using mineral nutrient solutions without soil. This system most useful to face the challenges of climate change and also helps in production system management for efficient utilization of natural resources and mitigating malnutrition. In India, first ever Hydroponics was introduced in year 1946 by an English scientist, W. J. ShaltoDuglas.

## *How Hydroponics Works and It's Function*

Soilless culture is a man-made suggests that of providing plants with support and a reservoir for nutrients and water. In this the soilless culture can be defined as "any method of growing plants without the use of soil as a rooting medium, in which the inorganic nutrients absorbed by the roots are supplied via the irrigation water". Hydroponics is a Biotechnology of soilless cultivation of plants which is carried out in controlled culture conditions, in an artificial media but does not oppose to customary methods of intensive agriculture [·]. Plants don't need soil, but they do need the vitamins and minerals that soil can provide for them. Plants also need light, water, carbon dioxide and oxygen at the root zone. In hydroponics, plants are grown in an inert medium such as rocks or coco coir fibre, and they are fed a solution containing a perfected mix of primary, secondary and micro-nutrients. Almost any kind of plant can be grown hydroponically, including veggies, herbs, fruits and flowers.

The function of soilless cultivating method i.e. hydroponic is stimulating plant growth while controlling the quantities of water, mineral salts and most important, dissolved oxygen. The basic concept is quite simple. When roots are suspended in moving water, they absorb food and oxygen rapidly. If the oxygen content is insufficient, plant growth will be slow. But if the solution is saturated with oxygen, plant growth will accelerate. Therefore, the grower's task is to balance the combination of water, nutrients, and oxygen, with the plan's needs, in order to maximize yield and quality [·]. For the best results, a few important parameter need to be taken into account; temperature, humidity and $CO_2$ levels, light intensity, ventilation, pH and the plant's genetic make-up. All nutrients and fertilizer required for plant growth are mixed into water, which passes through the medium several times a day. An active hydroponic system uses a pump to move water, while passive systems rely on wick or the medium's ability to absorb water.

***Hydroponic System Types:***

***Wick system:***

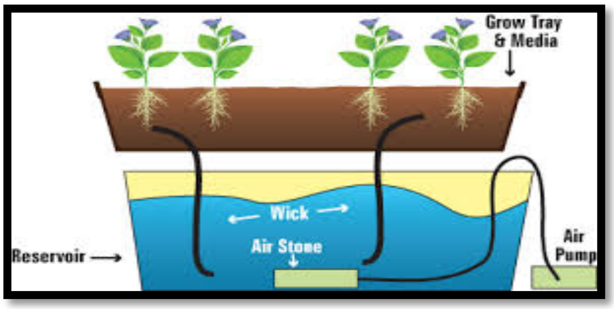


Figure 1: The Wick system

The wick system (Figure 1) is the simplest of all types of hydroponic systems. It is known as passive hydroponics because traditionally it doesn't have any moving parts, thus it doesn't use any pumps or electricity. However, the wick is the connecting part between the potted plant and food solution in the existing reservoir. Because it doesn't need electricity to work, it's also quite useful in places where electricity can't be uses, or is unreliable. Good choices include coconut coir, perlite, or vermiculite. Wick systems are good for smaller plants that don't use up a lot of water or nutrients. Larger plants may have a hard time getting enough of either via a simple wick system.

***Deep Water Culture (DWC):***

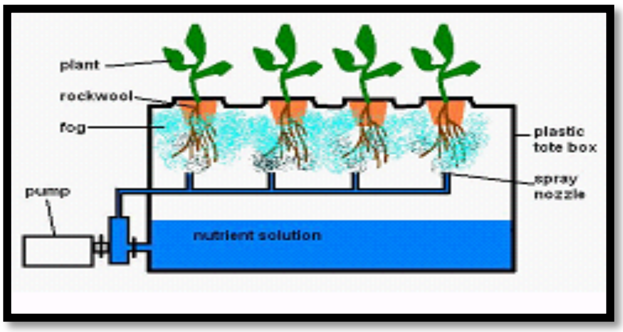


Figure 2: Deep Water Culture (DWC)

In a DWC system the roots of your plants are suspended in that solution so they get a constant supply of water, oxygen, and nutrients. To oxygenate the water, use an air pump with an air stone to pump bubbles into the nutrient solution. This prevents your roots from drowning in the water A water culture system can easily be set up in glass basins, (fish ponds), plastic boxes, ice boxes, Concrete basins or in engraved basins covered with polypropylene sheets. Since the plants are floating and continuously in contact with the nutrient solution, there is no risk of damage to plants in the event of a power outage or stop the air pump. The most convenient plants in this system are Lettuce, strawberries, and herbs grow particularly well in this system.

***Nutrient Film Technique (NFT):***

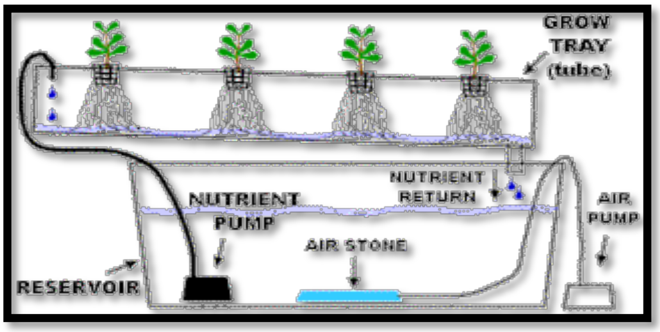


Figure 3: Nutrient Film Technique (NFT)

The nutrient film technique (Figure 3) is recirculated design to run highly oxygenated dissolved nutrients continuously over the roots of plants through a set of channels, typically grown in baskets hanging in a PVC pipe. The solution is pumped from a holding tank, through irrigators at the top of every sloping pipe and the run-off from the bottom of the channels is returned to the tank. Thus, the nutrient solution is continuously recycled. It is possible to make the angle of the pipe smaller and add an overflow pipe similar to what's in an off and flow system. This would serve to provide a reservoir of nutrients that would remain in the event of a power or pump failure. Because of the confined space of a PVC pipe and the requirement for nutrients to continuously flow over the roots, the nutrient film technique is particularly well suited to plants that have small root balls such as lettuce, strawberries and herbs.

***Ebb and Flow (Flood and Drain):***

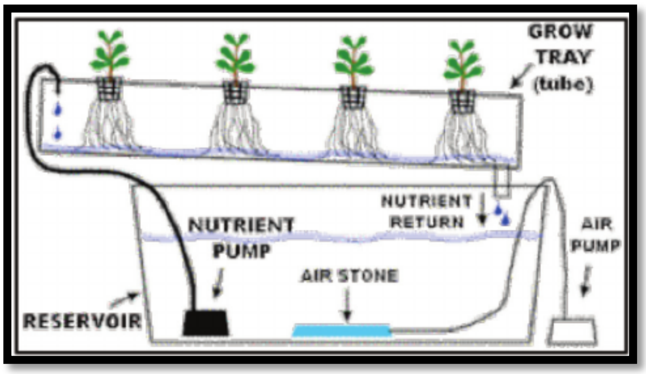


Figure 4: Ebb and Flow (Flood and Drain)

Ebb and Flow systems, which are also known by the name Flood and Drain, are a less-commonly seen system. But they're still quite effective and can be the best choice depending on your situation. The setup contains two containers, the one on top containing the plants in pots with substrate, and the one on the bottom containing the nutrient solution. Rather than the nutrient solution being passed slowly to drippers at the stem of each plant, the nutrients are pumped in large volumes into the top container, flooding the container. An overflow pipe determines the height of the nutrients, typically to where the roots begin at the base of the stem, with excess liquid being recirculated through the overflow pipe back to the bottom container. Plants with large root balls are also particularly suited to off and flow systems.

***Drip system:***

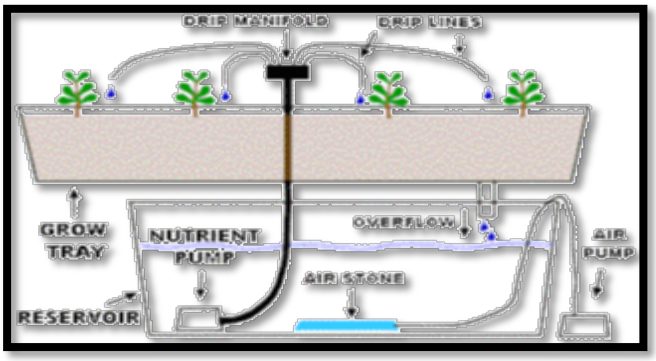


Figure 5: The Drip System

Drip hydroponic system (Figure 4) is at least two containers, one on top or higher than the other. Plants are located in the top container, while the nutrient solution is in the bottom container. The nutrient solution is pumped up to drips located by the stem of each plant with a water pump, and an aquarium air stone is used to oxygenate the water. The nutrients filter down to the plant roots and are passed back to the bottom container. Typically, both the water and air pumps run continuously with this type of system. A crop of almost any plant will grow well with this system. Plants with large root balls are particularly suited to drip systems. However, the plants are grown in supportive mediators.

***Substrate Culture (Growth Medium):***

Growth medium is the substitute for soil in soilless culture systems. The functions of growth medium are to provide the roots with oxygen bring the water and dissolved nutrients in contact with roots via irrigation system through the media, allowed to run to waste to recirculate the solution through the system and to steady the plants as supportive mediators so that they do not fall over. There are various substrates that used as growth medium are consisting of inorganic (natural; expanded clay, glasswool, gravel, perlite, pumice, rockwool, sand, sepiolite, vermiculite, volcanic tuff and zeolite or synthetic; foam mats, hydrogel and plastic foam) or organic (bark, coconut coir, coco soil, fleece, marc, peat, ruffia bark, rice husk, sawdust and wood chips) [·].

***Supply of Nutrients to the Plants:***

In hydroponics, because of limited nutrient-buffering capacity of the system and the ability to make rapid changes, careful monitoring of the system in necessary. Sources of nutrient elements with their characteristics are given in table:

| Source | Element | Characteristics |
| --- | --- | --- |
| Potassium nitrate ($KNO_3$) | N, K | Very soluble salt |
| Potassium phosphate monobasic $KH_2PO_4$ | P, K | Corrects phosphorus Deficiency |
| Magnesium sulfate $MgSO_4$ | S, Mg | Cheap, highly soluble, pure salt |
| Iron chelate | Fe Cit | Best sources of Iron |
| Boric acid $H_3BO_3$ | B | Best source of Boron |
| Calcium nitrate $Ca(NO_3)_2$ | N, Ca | Very soluble salt |

Sources of nutrient elements with their characteristics

The frequency and volume of the nutrient solution applied depends on the type of substrate used, the size of the container, the crop and irrigation systems used and the prevailing climatic conditions. Plants should be fed daily. The best time to administer the nutrient solution is between 6.00 and 8.00 am. The solution should be applied to the roots, trying to avoid wetting the leaves to prevent damage and the appearance of diseases. It is generally recommended that you apply only water to the plants once a week, in order to flush away any excess salts that have remained. Use double the amount of water normally applied, but without adding nutrients. Between 20 and 50% of the solution should be drained-off to prevent the accumulation of toxic ions and an excessive increase of electrical conductivity in the root area. The excess nutrient solution that is drained away from containers during daily watering can be reused in the next watering.

***Advantage***

There are many advantages of growing plants under soil-less culture over soil-based culture. This system produced healthiest crops with high yields. Plants may be grown closer, and only 1/5th of overall space and $1/20^{th}$ of total water is needed to grow plants under soil-less culture in comparison to soil-based culture [·]. There is no chance of soil-borne insect pest, disease attack or weed infestation too. Overall soil-less culture provides efficient nutrient regulation, higher density planting, and leading to increased yield per acre along with better quality of the produce. It is also effective for the regions of the World having scarcity of water or fertile land for agriculture.

***Limitations***

Hydroponic systems are relatively expensive, required proper preparation of containers, good quality water, careful maintenance of the pH of the nutrient solution, careful monitoring of the nutrient solution, and either changing or adding additional nutrients to meet the needs of the plants. Sanitation practices are required to eliminate toxic substances from the containers or solution. Control of disease and insect pests is necessary. Wind protection is required to reduce the evaporation of the solution and prevent mechanical damage to the plants. Intensive labour is required to promote and maintain proper conditions for crop production.

***Conclusion***

Due to rapid urbanization and industrialization as well as the melting of icebergs (as an obvious impact of global warming), arable land under cultivation is further going to decrease. Again, soil fertility status has attained a saturation level, and productivity is not increasing further with an increased level of fertilizer application. Besides, poor soil fertility in some of the cultivable areas, less chance of natural soil fertility build-up by microbes due to continuous cultivation, frequent drought conditions and unpredictability of climate and weather patterns, rise in temperature, river pollution, poor water management and wastage of huge amount of water, decline in groundwater level, etc. are threatening food production under conventional soil-based agriculture. So, that there is no option to adopting soil-less culture to help improve the yield and quality of the produce so that we can ensure the food security of our country. However, Government intervention and Research Institute interest can propel the use of this technology.

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# Vertical farming: New agricultural approach for 21st century

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***Introduction***

The world population is predicted to reach an estimated 9 billion by 2050 (Despommier *et al.,* 2013), and cities will be hosting about 80 per cent of total population (Despommier, 2010). VF is the practice of growing crops in vertically stacked layers (Birkby, 2016). VF is a revolutionary and sustainable method of agriculture as it lowers the requirement of water up to 70 per cent and also saves considerable space and soil. It often incorporates farming techniques includes controlled-environment, which aims to optimize plant growth and soil less cultivation such as hydroponics, aquaponics and aeroponics. Some common structures to vertical farming systems include buildings, shipping containers, underground tunnels and abandoned mine shafts. The main advantage of VF techniques is to increase the crop yield from a smaller unit area of land requirement. VF techniques faces economic challenges with large start-up costs as compared to the traditional farming practices. Vertical farms also face large energy input requirement due to the use of supplementary light like LEDs. Moreover, if non-renewable energy is used in vertical farms to meet these energy demands, could produce more pollution than traditional farms or greenhouses.

***Techniques of Vertical Farming***

***Hydroponics***

It refers to the technique of growing plants without soil and is a predominant system that is used in vertical farming. In hydroponic systems, growth of plants in solutions of nutrients that are essentially free of soil i.e. the plant roots are submerged in liquid solutions containing macronutrients as well as micronutrients such as nitrogen, phosphorus, sulphur, potassium, calcium and magnesium, as well as trace elements, including iron, chlorine, manganese, boron, zinc, copper and molybdenum. The advantages of hydroponics, increase yield per unit area and reduce water usage.

***Aeroponics***

It is growing of plants in an air/mist environment with no soil and very little water. By far, aeroponics is the most sustainable soil-less growing techniques, as it uses up to 90 per cent less water than the most efficient conventional hydroponic systems and requires no replacement of growing medium. Moreover, the absence of growing medium allows aeroponic systems to adopt a vertical design, which further saves energy as gravity automatically drains away excess liquid, whereas conventional horizontal hydroponic systems often require water pumps for controlling excess solution. It has also been observed that the plants that are grown with the aeroponic system uptake more vitamins and minerals, thus making the plants potentially healthier and more nutritious. Currently, aeroponic systems have not been widely applied to vertical farming, but are starting to attract significant attention.

***Aquaponics***

An Ecosystem that promotes plants and fish farming together: The term aquaponics is the combination of two words: aquaculture, which refers to fish farming and hydroponics, the technique of growing plants without soil (Kledal, 2018). This system is much like the hydroponics. Its aim is to combine the fish and plants in the same ecosystem. In this system, fish grow in indoor ponds and produce a nutrient rich waste that further acts as a food source for the plants grown in vertical farms. Nutrient rich waste water from the fish tanks is filtered by a solid removal unit and then led to a bio-filter, where toxic ammonia is converted to nutritious nitrate. Moreover, the plants consume carbon dioxide produced by the fish and water in the fish tanks obtains heat and helps the greenhouse maintain temperature at night to save energy. The plants doing their part by purify and filter the wastewater that gets recycled directly to the fish ponds. Aquaponics is generally used at smaller scale than most vertical farming innovations. However, it is still used by many commercial vertical farms that wish to produce just a few fast-growing crops instead of including the component of aquaponics. As a result, the production and economics issues are simplified and it also maximizes efficiency.

***Aero Farms***

Aero Farms consist of innovation by using the aeroponic system of farming that ensures predictable results of crop harvest, less impact on the environment, faster harvesting period and better quality of produced food under indoor farming practices. This technique helps growing greens without using any sun or soil. The vertical farming innovation uses smart light, smart nutrition, smart aeroponics and smart pest management. Aero Farms aims to transform the whole system of agriculture by building and making farms that are environmentally responsible. In short, they want to grow more crops in less space which can bring about a food revolution.

***Considerations for vertical farming***

One of the major issues currently facing under VF is that of limited scientific results related to yield potential, quality produce, energy efficiency and better utilization of resources of VF systems in order for their potential to be properly assessed. However, here are some key considerations for VF systems and their implications on its potential future success.

***Crop choice***

Crop choice in VF systems is currently limited, with most producers predominantly favoring small leafy vegetables and other salad leaves (Agrilyst, 2017). These crop types are well suited to cultivation in VF systems for a number of reasons. Their small size allows them to be grown in facilities such as stacked horizontal systems or cylindrical growth units where space, particularly in the vertical dimension, is at a premium. Small plant size also allows a higher number of plants and so potentially increased income per unit area horizontally. These crops show rapid growth and a short timeframe from germination to harvest, increasing the number of crops that can be produced in a season, further maximizing profitability and productivity. A rapid turnover of crops allows growers to better cope with problems such as crop loss due to disease or pest damage.

***Economics***

The start-up costs of VF systems are seen as a major constraint with site selection of high importance. While VF is generally discussed in relation to urban farming. This can take the advantage of land that is otherwise unsuited to unprotected cultivation and which otherwise may remain unused for food production, such as waste, depleted or heavy metal contaminated ground containing poor or unsuitable soil, or ex-industrial sites where the ground surface has been replaced with concrete or brick. The choice of rural versus urban location is an important one. For instance, it has been estimated that the installation of a rooftop glasshouse requires a minimum investment three times higher than that for a conventional ground-based glasshouse due to the required building adaptation (Brin et al., 2016).

***Environmental effects***

Vertical farming systems, reduced environmental impacts as compared to existing systems, for example by reducing transport requirements through locating production in urban areas. However, it has been calculated that the total greenhouse gas (GHG) emission of food systems, production accounts for 83 per cent, while transport only accounts for 11 per cent. In contrast, transport distances will be greatly reduced through urban localization and may lead to a net reduction in transport-associated energy requirements. Construction of VF facilities will also generate GHGs via building construction and energy use. However, the carbon footprint of the system ($CO_2$/kg lettuce) was five times higher than for conventional field-grown crops in the summer. Increased adoption of renewal energy infrastructure may therefore increase the viability and adoption of VF systems.

***Energy requirements***

As VF systems use glasshouse or controlled environment facilities, so expected use of energy may be higher than for field-grown crops. Maximizing efficiency in VF systems, which also frequently employ hydroponic culture, will therefore be key to their success, although it should be noted that soil-free cultivation can potentially increase yields up to 10 times compared to soil-based systems.

***Conclusion and recommendations***

VF is an emerging technology aiming to increase crop production per unit area of land in response to increasing pressure on agricultural production system. By utilizing protected horticulture systems such as glasshouses and controlled environment facilities in combination with multiple levels of growth surface and/or inclined production surfaces, VF is a technically demanding and expensive approach to crop production. Furthermore, VF is currently industry led, with a large number of independent start-up companies.

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# STCR (Soil Test Crop Response) – An Approach Towards Integrated Nutrient Management

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***Introduction***

Soil is an integral part of the natural resources on earth and is considered as a prime source of nutrients for the crops. Maintenance of soil health and quality is crucial for enhancing crop productivity and to feed the growing human population on earth. Fertilizers are one of the costliest inputs used in agriculture for increasing the soil fertility but use of correct amount of fertilizer is fundamental for agricultural sustainability and environmental protection. Without any information about the soil fertility status and crop nutrient requirement, farmers are dumping fertilizers in the field. This has led to either nutrient toxicity or nutrient deficiency by overuse of one nutrient and underuse of the other nutrient and this has caused adverse effects on soil and crop productivity.

It is established by various authors that use of organic manures or use of chemical fertilizers alone cannot achieve agricultural sustainability in the present farming system. Therefore, in order to maintain soil fertility and to maintain good soil health, it is necessary to use organic manures. Integrated plant nutrient management system which includes site-specific knowledge of crop nutrient requirement, nutrient supply from the soil, nutrient supply from the fertilizer and recovery efficiency of applied fertilizers are required for maintenance of soil fertility. At the same time, it can aid in meeting the ultimate goal of balanced fertilization. Applying various inputs more specifically fertilizers based on soil testing could help in using the various inputs judiciously.

***Historical Perspective***

The most appropriate method for balance fertilization is targeted yield approach. Target yield approach is known as soil test crop response approach**.** This approach is the basis for optimum resource utilization and balanced crop nutrient management. Fertilizer application based on soil test is a useful tool and fertilizer prescription equation is a unique technology to optimize need-based fertilizer application.

The concept of fertilizer prescription equation for desired yield target was first given by Troug, 1960. Subsequently, Ramamoorthy, 1967 established the theoretical basis and experimental technique to suit Indian conditions showing the linear relationship between yield and nutrient uptake. For a given quantity of yield of any crop, fertilizer requirement can be estimated considering efficiency of soil and fertilizer nutrients. Subsequently, ICAR started AICRP on Soil Test Crop Response (STCR) to develop soil test-based fertilizer recommendation for different crops. The project was initiated in 1967-68 by eminent soil scientists, Dr. B. Ramamurthy and Co-workers, at IARI, New Delhi, with eight centres at other locations. During 1970-71, five more centers were added. Fertilizer recommendations based on target yield as proposed by Ramamoorthy is different from the other approaches as it not only indicates soil test-based fertilizer dose but also the yield level that can be attained if appropriate management practices are followed in the crop production. Targeted yield approach also provides the scientific basis for balanced fertilization not only between the nutrients applied from the external sources but also with soil available nutrients.

***Methodology***

The basic data which is required for formulating fertilizer recommendation for targeted yield are-

1. Nutrient requirement (NR) in kg/quintal of produce
2. Percentage contribution from the soil available nutrient (CS)
3. Percentage contribution from the applied fertilizer nutrient (CF)
4. Percentage contribution from organic source (CFYM)

The above-mentioned parameters are calculated as:

**1. *Nutrient requirement (NR)*:**

$$\text{NR} = \frac{\text{Total uptake of nutrient}}{\text{Grain yield}}$$

**2. *Per cent contribution from soil available nutrients (CS)*:**

$$\text{CS} = \frac{\text{Total nutrient uptake in control plots (kg / ha)}}{\text{Soil test value of nutrient in control plots (kg / ha)}} \times 100$$

***3. Per cent contribution from added fertilizers (CF):***

$$\text{CF} == \frac{(\text{Total uptake of nutrients in treated plots}) - \left(\text{STV of nutrient in treated plots x} \frac{\text{Cs}}{100}\right)}{\text{Amount of nutrient added as fertilizer (kg / ha)}} \times 100$$

**4. *Per cent contribution from organic sources (CFYM):***

$$\text{CFYM} = \frac{(\text{Total uptake of nutrients in FYM treated plots}) - (\text{STV of nutrient in FYM treated plots x CS/100}}{\text{Amount of nutreint added as FYM (kg / ha)}} \times 100$$

In STCR experimentation there are two approaches deductive and inductive approach. In the deductive approach, since different levels of soil fertility is not expected to occur at a single place, therefore, normally different sites are selected to represent different levels of soil fertility and the inference is deduced and applied in general. In the Inductive Approach of STCR field experimentation, variations in soil fertility is created deliberately at a single place in the same field experiment. This approach reduces the heterogeneity in the soil type, management practices adopted and climatic conditions.

STCR experimentation is conducted under three phases –

***1. Development of fertility gradient*** – In this phase, a field which is representative of the major soil type in a region is selected and fertility gradient is developed in it by dividing it into equal strips. The first strip receives no fertilizer and subsequently increasing the standard dose of N, P and K in the other strips such that a gradient ranging from low to high is created. Then, a short duration exhaust crop is grown so that the nutrients undergo transformations in the soil with plant and microbial activity as a result of interaction between them.

***2. Test crop is grown*** - After harvest of this exhaust crop, each of the strips is divided into sub plots. Selected treatment combinations of N, P and K and FYM in addition to controls are randomly allocated in each of the strips and the test crop for which soil test calibration is required is grown to maturity following standard agronomic practices. Before application of fertilizers, soil samples are collected from each sub plot and analyzed for available nutrients by defined soil test methods. After harvest, grain and straw yield and total nutrient uptake are also determined.

NR, CS, CF and CFYM were calculated with the help of soil & applied fertilizer nutrient, crop yield and nutrient uptake of grain and straw. Equations for fertilizer requirement of nitrogen, phosphorus and potassium for targeted yield are worked out as follows:-

Fertilizer requirement equations for nutrients through use of chemical fertilizer are worked out
as -

FN= (NR/CF) ×100 T - (CS/CF) × SN
FP= (NR/CF) ×100 T - (CS/CF) × SP
FK= (NR/CF) ×100 T – (CS/CF) ×SK

Fertilizer requirement equations for nutrients through conjoint use of chemical fertilizer and FYM are worked out as –

FN = (NR/CF*) ×100 T – (CS/CF*) × SN – (CFYM/CF*) × M
FP = (NR/CF*) × 100 T – (CS/CF*) × SP – (CFYM/CF*) × M
FK= (NR/CF*) × 100 T – (CS/CF*) × SK – (CFYM/CF*) × M

Where,
FN = Fertilizer nitrogen (kg N $ha^{-1}$)
FP = Fertilizer phosphorus (kg P $ha^{-1}$)
FK = Fertilizer potassium (kg K $ha^{-1}$)
NR = Nutrient requirement of nitrogen, phosphorus and potassium
CF = Percent contribution of concerned nutrient from fertilizer
CF* = Percent contribution of concerned nutrient from FYM.
CS = Percent contribution of concerned nutrient from soil
CFYM = Percent contribution of concerned nutrient from FYM
T = Targeted yield (q $ha^{-1}$)
SN = Soil test value for available nitrogen (kg $ha^{-1}$)
SP = Soil test value for available phosphorus (kg $ha^{-1}$)
SK = Soil test value for available potassium (kg $ha^{-1}$)
M = Concerned nutrient content in organic matter

Then, statistical analysis was carried out and target yield equation was developed by fitting up of multiple regression equation

***3. Verification or follow up trial*** – The target yield equation developed is then verified at different locations for validity of the equation and target yield.

## *Conclusion*

There is a difference between “Fertilizing the soil” and “Fertilizing the crop” and Soil test crop response-based fertilizer recommendation maintains the real balance between the applied fertilizer nutrients among themselves and with the soil available nutrients. Based on this concept, soil test crop response studies have been undertaken in different parts of India in various crops like wheat, rice, pearl millet**.** Application of plant nutrients based on soil test helps in realizing higher response ratio because nutrients are applied taking into consideration the deficiency of that particular nutrient. In return, this helps in correction of the nutrient imbalance in soil and also helps to harness the synergistic effects of balanced fertilization.

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# Fall armyworm (FAW), *Spodoptera frugiperda* J. E. Smith (Lepidoptera: Noctuidae): An Invasive Threat to India

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## *Introduction*

The accidental introduction of alien invasive pest species has been resulted in a large number of established population density which led to considerable negative impact on economic of the crop in terms of production as well as market value. The alien species become invasive in introduced area due to absence of natural enemies and congenial environment parameters. Invasive species are considered as the second greatest threat to native species, only behind habitat destruction. The fall armyworm is native to the tropical region of the western hemisphere from the United States to Argentina. *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) is considered the most important pest of corn in Brazil, the third largest corn producer in the world after the USA and China. *S. frugiperda* is a polyphagous pest that causes significant losses to agricultural crops. In 2016, it was recorded in Africa causing serious damage on maize crop (Goergen *et al.,* 2016). The value of these losses is estimated at between US$2,481 million and US$6,187 million. Now in 2018, this notorious pest has entered India.

## *Spread and distribution*

*S. frugiperda* is found in most parts of the Western Hemisphere, from southern Canada to Chile and Argentina. This species was reported to have spread to Africa – São Tomé, Nigeria, Bénin and Togo in 2016 and to Ghana in 2017, causing widespread crop damage. In India, the incidence of *S. frugiperda* was observed in May 2018 in Maize fields at College of Agriculture, University of Agricultural and Horticultural Sciences (UAHS), Shivamoga, Karnataka. Further, this pest was also reported in Tamil Nadu, Telangana and Gujarat states of India.

## *Host Plants*

The fall armyworm caterpillars feed on leaves, stems and reproductive parts of more than 100 plant species in 27 different families (CABI). This pest prefers to that include maize, rice, sorghum, sugarcane, pearl millet and cotton, as well as some vegetable crops like cabbage, beet, peanut, soybean, alfalfa, onion, tomato, potato and cotton etc.

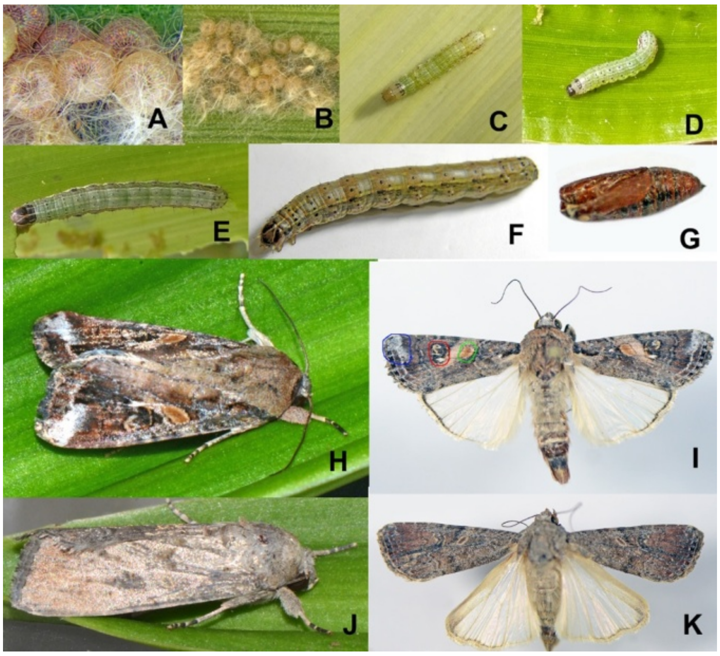
## *Description of the pest life cycle*

### *Egg*

Egg laying occurs on the inner side of the whorl and also on the under surface of the leaf in a mass of deposited in layers. Egg is dome shaped, and measures around 0.4 mm in diameter and 0.3 mm in height. Adult females lay 100-200 eggs on the lower leaves. They change from green to light brown before hatching. Eggs are covered in a protective scale rubbed off from the moth’s abdomen. Eggs are hatch in 2 to 4 days in optimum temperatures.

***Larva***

FAW typically has six larval instars. First instar larva is greenish in colour with black head while the final instars are with dark grey head and dull grey body with white sub dorsal and lateral white lines. The mature larva is with a white inverted on the head and with distinct black spots on the body. Arrangement pattern of black spots is square on 8th and trapezoidal on 9th segment. Larval duration is about 14 days during the summer and 30 days during cool weather conditions. Fall armyworm larva does not have the ability to diapause.




Life stages of *S. frugiperda*: A & B, eggs; C-F, larval instars; H, adult male in habitus; I, adult male (dorsal view); J, adult female in habitus; K, adult female (dorsal view). (Source: NBAIR, Bangalore)

***Pupa***

Pupa is reddish brown in color and pupation occurs in the soil. The mature caterpillar drops down to ground and makes an earthen cell by constructing cocoon of sand particles mixing with silk. Pair of cremasters is present on the last segment. The pupal stage lasts for 7 to 13 days and survives at the temperature range of 18-24°C.

***Adult***

Sexual dimorphism is clearly evident in the adult moths. Adult male forewing is grayish brown with reniform indistinct spot, faintly outlined in black, with a small v-shaped mark light brown orbicular spot, somewhat oval and oblique in shape and white patch at the apical margin of the wing. Adult female forewing is with a mottled coloration of grey and brown, with brown markings and without white patch near apical margin of the wing as seen in male. The duration of adult life is estimated to average about 10 days.

***Migration Behaviour***

Adult moth can migrate with a capacity of 100 km overnight and 300 miles per generation. FAW found throughout the year and having 6 to11 generations per year depending upon temperature.

***Intraspecific competition***

The incidence of cannibalism of larval *Spodoptera frugiperda* (Lepidoptera: Noctuidae) was found to account of approximately 40% mortality in the population.

***Nature of damage***

FAW infestations occur continuously throughout the year where the pest is endemic. The FAW caterpillar, or larva, cause the most damage to a variety of crops, including maize. Young larvae usually feed on leaves, creating a characteristic "windowing" effect or holes and ragged leaf edges. Young caterpillars can spin silken threads which catch the wind and transport the caterpillars to a new plant. Feeding through the maize whorl can cause a line of irregular "shot" holes, when the leaf unfurls and moist sawdust- like frass near the funnel and upper leaves of crops like maize. Feeding through the maize whorl can cause a line of irregular "shot" holes, when the leaf unfurls and moist sawdust- like frass near the funnel and upper leaves of crops like maize.

***Management Strategies of Fall Armyworm, S. frugiperda***

***Cultural measures***

- ✓ Deep ploughing is recommended before sowing. This will expose FAW pupae to predators. Timely and uniform sowing over a large area is advised. Avoid staggered sowings.
- ✓ Intercropping of maize with suitable pulse crops of particular region. (eg. Maize + pigeon pea/black gram /green gram).
- ✓ Erection of bird perches @ 10/acre during early stage of the crop (up to 30 days).
- ✓ Sowing of 3-4 rows of trap crops (eg. Napier ) around maize field and spray with 5% NSKE or Azadirachtin 1500 ppm as soon as the trap crop shows symptom of FAW damage.
- ✓ Clean cultivation and balanced use of fertilizers.
- ✓ Cultivation of maize hybrids with tight husk cover will reduce ear damage by FAW.

***Mechanical measures***

- ✓ Hand picking and destruction of egg masses and neonate larvae in mass by crushing or immersing in kerosine water.
- ✓ Application of dry sand in to the whorl of affected maize plants soon after observation of FAW incidence in the field.
- ✓ Application of Sand + lime in 9:1 ration in whorls in first thirty days of sowing.
- ✓ Mass trapping of male moths using FAW specific pheromone traps @ 15/acre.

***Biological measures***

- ✓ In situ protection of natural enemies by habitat management: Increase the plant diversity by intercropping with pulses, oil seeds and ornamental flowering plants which help in build-up of natural enemies.
- ✓ Augmentative release of egg parasitoid *Trichogramma pretiosum* or *Telenomus remus* @ 50,000 per acre at weekly intervals or based on trap catch of 3 moths/trap.

- ✓ Bio-pesticides: If infestation level is at 5% damage in seedling to early whorl stage and 10% ear damage, then use following entomopathogenic fungi and bacteria (*Metarrhizium anisopliae, Metarrhizium rileyi (Nomurea rileyi), Beauveria bassiana, Verticilium lecanii* - $1 \times 10^8$ cfu/g @ 5g/litre whorl application. Repeat after 10 days if required).
- ✓ *Bacillus thuringiensis v. kurstaki* formulations @ 2g/l (or) 400g/acre.

***Chemical measures***

- ✓ Seed treatment: Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed will be effective for 15-20 days.
- ✓ First Window (seedling to early whorl stage): To control FAW larvae at 5% damage to reduce hatchability of freshly laid eggs, spray 5% NSKE / Azadirachtin 1500ppm @ 5ml/l of water.
- ✓ Second window (mid whorl to late whorl stage): To manage 2nd and 3 rd instars larvae having more than 10% foliar damage the following chemicals may be used upto early tasselling stage: Spinetoram 11.7% SC or Chlorantraniliprole 18.5% SC or Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% ZC.
- ✓ Poison baiting: Poison baiting is recommended for late instar larvae of second window. Keep the mixture of 10 kg rice bran + 2 kg jaggery with 2-3 litres of water for 24 hours to ferment. Add 100g Thiodicarb or just half an hour before application in the field. The bait should be applied into the whorl of the plants.
- ✓ Third Window (8 weeks after emergence to tasseling and post tasseling): Insecticide management is not cost effective at this stage. Bio-pesticides as recommended above to be applied. Hand picking of the larvae is advisable.

(**Note:** All the sprays should be directed towards whorl and either in the early hours of the day or in the evening time) (Source: http://ppqs.gov.in/).

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# Fruit cracking

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### *Introduction*

Fruit cracking can be defined as the cracks or fractures in the cuticle or peel or fruit surface. It is a major problem in cherry (up to 75%), litchi, pomegranate, apple, citrus, mango, *etc.*

**Fig. 1**: Fruit cracking in citrus and litchi

### *Types of Fruit Cracking*

Generally, there are three types of fruit cracking

### *Peel Cracking*

It is also known as "checking", "lenticels cracking" or "cuticle cracking". Peel cracking may be characterized by the presence of numerous minute superficial cracks on fruit surface followed by gradual "peeling off" of the peel in patches as in apple. It may also occur in the form of short to large cracks as in litchi.

### *Star cracking*

Star-shaped cracks near the calyx or on the sides of the peel of the fruit are seen. The affected fruits may also appear russetted and irregular in shape. e.g. apple, pear.

### *Splitting*

It is also known as "flesh or pulp cracking". It is an extreme form of cracking in which both the peel and the pulp ruptures/ cracks and there is gross exposure of the internal tissues of the fruit to the atmosphere. e.g. lemon, mango, *etc.*

### *Nature of Fruit Cracking*

Generally, four types of cracking are observed in fruits.

### *Radial cracking*

It is also known as longitudinal cracking. In this the cracks occur lengthwise on the fruit extending from the proximal end to the distal end of the fruit. It is the most common type of cracking causing severe damage to the crops. e.g. in litchi, mango, citrus, cherry, pomegranate, *etc.*

***Transverse cracking***

In this type of cracking, the cracks occurs along the circumference of the fruit. e.g. in lemon, mango, pomegranate, litchi, *etc.*

***Oblique***

In this type of cracking slant cracks appear on the fruit skin. e.g. in pomegranate, litchi, *etc.*

***Mixed***

When two or more types of the above cracking's appear simultaneously on the fruit, then is called as mixed type of cracking. E.g. in cherry, lemon, mango, *etc.*

***Effects of cracking on fruits***

Cracking of fruit mostly alters the structural integrity of the fruits and thus results in the following changes:

- Cracking of the fruits lower down the mechanical strength of the fruits.
- It facilitates rapid moisture loss and excessive shrivelling of fruits.
- Fruits become more prone to chemical injury.
- It permits the infection by microbes- *Aspergillus, Penicillium, etc.* and insects.

Therefore, we can say that cracking of fruits results into unmarketability of the fruits as such fruits are not acceptable in the market and are not purchased by the consumers. Thus, fruit cracking leads to huge economic loss to the growers.

**Mechanism of fruit cracking**

Prolonged dry spell (during summer season)

↓

Xylem & phloem strengthen and loose ability to divide & enlarge

↓

Later, sudden & excess water supply either by irrigation or by rainfall (Up taken by roots)

↓

Meristematic tissues resume growth but not the xylem & phloem

↓

This differential rate in growth results in cracking of fruits

↓

High temperature & low humidity (sometimes hot dry and desiccating winds also)

↓

Peel becomes hard & inelastic

↓

Followed by heavy rain/ irrigation

↓

Internal tissues grow at faster rate than peel

↓

Cracking of inelastic peel takes place

***Causes***

***1. Biotic factors***

Living organism are sometimes found associated with fruit cracking. E.g. In apple- false sting (viral) & star cracking (viral). In citrus, cracking is associated with the diseased tissues, such as lesions. These diseased tissues absorb water exceptionally when water supply is plentiful and causes ruptures through abnormal swelling.

***2. Varietal factors***

Different varieties show differential response. So, susceptibility to fruit cracking is considered to be under genetic control. Lemon varieties showed different level of cracking- Kagzi Kalan (48.2%), Pant lemon-1 (43.97%), Nepali Oblong (12.5%)

**4. *Rootstock***

Various types of rootstocks effects are seen on commercial varieties grafted on them. E.g. In cherry, more fruit cracking was observed when Mahaleb was used as a rootstock than Mazzard.

***4. Environmental factors***

A) *Soil moisture*- It is one of the major factors responsible for fruit cracking. Moisture stress followed by sudden upsurge of soil moisture content (from irrigation or rainfall) leads to cracking of the fruits. e.g. litchi, pomegranate, cherries, lemon, apple, *etc.*

B) *Relative humidity*- Low humidity accentuates cracking as it causes more evaporation from the fruit surface. e.g. In Litchi (<60% RH causes cracking), Pomegranate, *etc.*

C) *Rainfall*- More cracking is seen when peel comes in contact with rain water or mist as peel absorbs the water from the micropores on the surface leading into increased turgor pressure from inside, thus, resulting into macro cracks on the fruit surface. e.g. Cherry, apple, peach, *etc.*

D) *Temperature* - Fluctuation in day and night temperature. e.g. in Litchi (>38˚C causes cracking), Cherry, apple, *etc.*

***5. Hormonal factors***

Auxins, cytokinins and ABA play important role in regulating fruit cracking. Skin and seeds of cracked fruits of Litchi had lower level of auxins.

***6. Nutritional status***

Nutritional status of the tree and fruit has been suggested to account for the differences in the susceptibility to cracking of fruits on different trees, or even on the same tree. Deficiency of Zn, Ca, B & excess of N is found associated with cracking in many fruits.

***7. Chemical sprays***

Lead arsenate, phosdrin spray are reported to cause distortion and cracking in developing fruits. Surfactants like Tween-20 along with pesticides cause cracking by increasing uptake of water.

***Management***

***1. Moisture management-*** Irrigation (for dryer season) as well as drainage (for rainy season) facilities in the orchard should be present to prevent imbalance of water in the plant system.

Sprinkler irrigation during fruiting time minimized the fruit cracking in litchi. Drip irrigation facilities have also shown very good results in many crops.

***2. Foliar spray of nutrients* -** Spray of boron @0.2% can be used to control fruit cracking in pomegranate.

***3. Pruning & top working-*** Regular pruning of trees is useful in reducing the incidence of cracking. Top working of affected trees with cultivars less prone to cracking can overcome the problem**.**

***4. Use of rootstocks-*** Different rootstocks have different influences on different varieties. Less fruit cracking was observed on cultivars grafted on sour orange than that of Carrizo citrange rootstock (Agusti *et. al.,* 2003).

***5. Cuticle Protectants* -** Reduce fruit cracking due to rain water absorption by fruit surface up to 50%. e.g. Rain guard, Parka. In cherry rain guard spray – 1$^{st}$ spray 4 week prior to harvest and then at 7-10 Days interval was found effective.

***6. Retractable Row Covers-*** These are highly effective but are costly and labour intensive. Mostly used in Cherry in European countries.

***7. Selection of variety –***

| S.No. | Crop | Susceptible varieties | Free from / less cracking |
|---|---|---|---|
| 1. | Litchi | Dehradun, Muzaffarpur | Seedless Late, Swarna roopa |
| 2. | Lemon | Kagzi Kalan,Italian lemon, Eureka, Pant lemon-1 | Nepali Oblong, Genoa |
| 3. | Mango | Dashehri | Langra, Neelum, Amrapali |
| 4. | Guava | Thai | Allahabad Safeda |

***Conclusion***

Cracking of fruits alters the structural integrity of the fruits which further results in various changes and make the fruits unmarketable. There are various causes which can lead to fruit cracking like biotic factors, hormonal factors *etc.* Therefore, management of fruit cracking is must and various measures have been adopted in order to manage and reduce this physiological disorder.

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# Bioremediation: A potential tools for Microplastic degradation in global concern

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***Introduction***

Microplastics become a contaminant and gradually increasing concern in soils and terrestrial ecosystem globally which was estimated that the contamination on land might be 4 to 23-fold higher than that in the ocean, could account for as high as 7% of soil weight (et al., 2016; Rillig *et al.,* 2017). Many researchers are reported that agricultural soils might be the important microplastic sink (Rillig, 2017) because of the most prominent use of sewage sludge as fertilizer and second microplastics yielded from plastic mulching degradation (Nizzetto *et al.,* 2016). It can be found throughout the globe including in remote locations, such as sub-Antarctic islands or deep seas, transfer from discharge areas to deposition zones. It is a great challenge now in our future generation for these ecological threats, we have to find out a solution with the sustainability property of the environment, therefore bioremediation is the potential tools for the degradation which is the global concern toward the remediation (degradation) of microplastic.

***Microplastic***

National Oceanic and Atmospheric Administration (NOAA) define Microplastics, according to them, plastic particles with a diameter of 5mm, while those 1 μm called microplastics (GESAMP, 2015; NOAA, 2015). It can be classified according to their origin as either primary or secondary microplastics where in the form of pellets, plastic-based granulates in the cosmetics industry, vector for drugs in medicine are called primary and fragmentation of larger plastic particles including macro and mesoplastics such as glass bottles and plastic bags are secondary. Microplastics have a higher specific surface area with their small size, ability to adsorb pollutants becomes stronger that makes the toxicological effects of microplastics more complicated.

***Bioremediation a potential tool without misbalancing the ecology***

It is defined as the process used to treat contaminated media including water, soil and subsurface material, by altering environmental conditions to stimulate growth of microorganisms and degrade the target pollutants. In some cases it is less expensive and more sustainable than other remediation alternatives. Biodegradation capacity generally define as strains of microorganisms to utilize a synthetic polymer as the sole source of carbon and energy where some types of plastics such as polyhydroxyalkanoates (polyhydroxy butyrate PHB), and polylactic acid (PLA) are highly biodegradable, while synthetic polymers such as polyethylene (PE) polycaprolactone (PCL) , polystyrene (PS) have low biodegradability. It is the technologies utilize naturally occurring microorganisms, such as bacteria, fungi, and yeast to degrade hazardous substances into non-toxic or less toxic substances. The microbial degradation of plastics has been reported by some studies where they have addressed the abiotic and biotic (microbial) degradation of a wide array of synthetic polymers. Fungus like *Theactinomycete*, *Rhodococcus ruber* and the *Penicillium simplicissimum* was shown to produce extracellular enzymes which are able to degrade PE, PHA, mostly belong to Basidiomycetes, Deuteromycetes (Penicillium and Aspergillus). It is also observed that fungal strains of *Fusarium moniliform* and by *Penicillium roqueforti* are easily degraded

Polycaprolactone (PCL) synthetic polyester as compared to other polymers. Polyurethane is degraded by several fungal species whereas *Fusarium solani, Aureobasidium pullulans* sp., although its biodegradation is frequently faster than other spp, but Polyvinylchloride (PVC) is degraded by the bacterium *Pseudomonas putida*, polystyrene by the actinomycete *Rhodococcus ruber*. Bacterial species like *Brevibacillus parabrevis* (PL-1), *Acinetobacter baumini* (PL-2, PL-3) and *Pseudomonas citronellolis* (PL-4) have ability to degrade the resistant LDPE. The mechanisms involved in the plastic degradation are explored in which there are two different processes a direct action, where the deterioration of plastics provides a tropic resource for microbial growth another is indirect action, in which metabolic products of microorganisms affect the plastic structure. Microorganisms with their degradative pathway are involved in polymer degradation that is depending on environmental condition enzyme secretion and the ecological interaction.

***Conclusion***

- Microbial degradation of plastic is a promising eco-friendly strategy that is represents a great opportunity to manage e-waste
- It provides potential ability that could help the natural bioremediation processes in favouring the natural ecosystems.
- It create a opportunity through the advances of biochemistry and biotechnological fields that could offer new perspectives of bioremediation where plastic contamination and should be encouraged to select the most active microbial consortia in the plastics degradation process.

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# Role of Native Strains of Rhizobium in pulse Production

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The world today faces a tough challenge, for ensuring food security with provision of balance diet for everyone. Overcoming hunger and malnutrition in the 21$^{st}$ century means increasing food quantity as well as quality, while making sure we produce food sustainably and efficiently. Pulses have been a secondary choice, mostly confined to the rainfed ecology. Over the last four years, the on-going National Food Security Mission (NFSM) has been converged with multi–pronged strategies to enhance the production and productivity of pulses in the country. Thanks to government's comprehensive policy, there has been a leap frog in production since 2016-17, where in 'Five Year Roadmap' was adopted. The production of pulses to the tune of 25.23 million tonnes during 2017-18 is close to self-sufficiency in pulses (Annual report on pulses, 2016-2017). The country is now confident of meeting the projected demand of 35 million tonnes by 2030. An improvement in pulses production technology can reduce the cost of production and ensure higher productivity resulting in affordable prices to consumers.

To achieve this target the consumption of nitrogenous fertilizer is increasing., Between 1960 and 2009 global fertilizer consumption increased tenfold by 10.8 Mg (metric tons) per year to 113 million Mg per year. Nitrogenous fertilizer applied through inorganic sources results in increase in yield but simultaneously promote sizable nitrogen loss, while addition of nitrogen through biological processes enhance more soil available nitrogen as well as crop yield. The biofertilizers, when applied as seed or soil inoculants, multiply and participate in nutrient cycling and leads to crop productivity. Generally, 60% to 90% of the total applied fertilizer is lost and the remaining 10% - 40% is taken up by plants. Hence biofertilizers can be important component of integrated nutrient management systems for to sustaining agricultural productivity and a healthy environment. The application of N fertilizer quickly inhibits both the formation and N fixation activity of nodules. Many agricultural soils contain a high level of residual N which limits legume nodulation and N fixation. Furthermore, farmers frequently apply N fertilizer to the seed bed of legumes to help with crop establishment. This practice is likely to inhibit legume nodulation until the soil N supply has been depleted. Therefore, understanding of how legumes sense and signal their N supply status to regulate nodulation is of fundamental importance for developing more sustainable agriculture using lower inputs of chemical fertilizer. In leguminous plants, bioinoculation with *Rhizobium* as a substitute for costly N fertilizer contributed for crop growth stimulation. Thus, emphasis should be given for establishment of efficient symbiotic $N_2$ fixation in legume. Different field studies indicated that the legume seed, inoculated with *Rhizobium* culture increased the crop yield from 20-80% and the beneficial effect on the subsequent crop yield also observed significantly. On a global basis these symbiotic association between legume and *Rhizobium* may reduce about 70 million tons of atmospheric nitrogen to ammonia per annum.

The utilization of native *Rhizobium* as inoculants promote ecologically sustainable management of agricultural ecosystem and enhance legume production due to their growth promoting traits and adaptability to soil and environmental stress .Furthermore, crop production using inoculants could be cheaper and more affordable to the resource – poor smallholder farmer. The ability of native strains to interact positively with the resident soil micro biota and their adaptability to the local agroecological climatic conditions often elucidates their superior performance over the exotic commercial strains. The present study contributes to the understanding of the native rhizobial population diversity nodulation. This will contribute to the development of future course of action for cultivation technology so as to enhance production and improve grain quality of such an important pulse crop. The study also provides important information regarding the nodulation patterns, presence or absence of root nodulating bacteria in agricultural soils and suitable strains for augmentation in rhizobia deficient soils.

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# Space Foods: The Food for Zero Gravity

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### *Introduction*

Space Foods, which are processed to prepare for consumption by astronauts in outer space or in zero gravity during a space mission. Space foods poses specific features which provide balanced nutrition, easy to store (long shelf life), safe to consume in weightless environment. This makes a challenge for food scientists/ developers to prepare food which have to be eaten in zero gravity. Food product in form of crumbs are not allowed, as they can float around the cabin and can cause accident by hitting someone's eye or nose or clog air ventilation. Waste is another main challenge for the food scientists/ developers. Astronauts consume meal thrice a day: breakfast, lunch and dinner. The food astronauts consume, should provide them a balanced supply of vitamins and minerals. Calorie requirements differ for astronauts. For example, a small woman would require only about 1,900 calories a day, while a large man would require about 3,200 calories. In recent years, space food has been used by various nations engaging on space programs represents their cultural identity and facilitate intercultural communication. Although astronauts consume a wide variety of foods and beverages in space. Astronaut can choose from many types of foods such as fruits, nuts, peanut butter, chicken, beef, seafood, candy, brownies, etc. Available drinks include coffee, tea, orange juice, fruit punches and lemonade. Eating in Space, provided cooking a new peak on earth as well as in outer space. With enthusiasm of space technology, astronauts today are able to take in a variety of tastes and textures that please their palates and satisfy their stomachs while orbiting hundreds of miles from earth.

### *History*

Explorers and travellers throughout history needed, to develop methods for preserving food and carrying enough food for their journeys. More recently, refrigeration and canning methods have been developed to solve the problem of food preservation. However, space travel required new methods to be devised for keeping foods edible. Space foods must be light-weight, compact, tasty and nutritious. They must also keep for long periods without refrigeration. Early space foods were basically composed of bite-sized cubes, freeze-dried powders, and thick liquids stuffed in aluminium tubes. Eventually, the tubes were discontinued, the powders made easier to re-freeze, and the cubes were coated in Gelatine to prevent crumbling on the equipment. John Glenn was the first American to eat in space aboard Friendship 7 in 1962. At that time, it was not known if ingestion and absorption of nutrients were possible in a state of zero gravity. Glenn's consumption of applesauce, packed in a tube, and xylose sugar tablets with water, demonstrated that people could eat, swallow, and digest food in a weightless environment. There were many space mission's like Gemini, Apollo, Apollo 11, Skylab, Inter- kosmos etc organised by NASA, in which development of processed food took place. They used foods such as: shrimp cocktail, chicken and vegetables, toast squares, butterscotch pudding, and apple juice in Mission Gemini and Apollo; Menu in Skylab mission included 72 items; for the first time about 15% was frozen. Shrimp cocktail and butter cookies were consistent favourites; Lobster Newberg, fresh bread, processed meat products. The food provided in Soyuz-19 were canned beef tongue, packaged Riga bread, and tubes of borscht (beet soup) and caviar. And in Interkosmos mission food provided were tarator, sarma, musaka, lyutenitza, kiselo mlyako, dried vegetables and fruits, etc.

***Classification***

Space foods are classified on the basis of processing, the food undergoes.it is classified as follows:

| Sr.No. | Type of Food | Example |
|---|---|---|
| 1 | Beverages(B) | Freeze dried drink mixes, flavoured drinks |
| 2 | Fresh Foods (FF) | Fresh fruits, vegetables, and tortillas |
| 3 | Irradiated (I) Meat | Beef steak |
| 4 | Intermediate Moisture (IM) | Foods that have some moisture but not enough to cause immediate spoilage |
| 5 | Natural Form (NF) | nuts, cookies, and granola bars that are ready to eat. |
| 6 | Rehydratable (R) Foods | Foods which have been dried and can be rehydrate later |
| 7 | Thermostabilized (T) | Foods which Stabilized by thermal process |
| 8 | Extended shelf-life bread products | Scones, waffles, and rolls |
| 9 | Shelf Stable Tortillas | Tortillas that have been heat treated and specially packaged in an oxygen-free nitrogen atmosphere to prevent the growth of mould. |
| 10 | Condiments | Liquid salt solution, oily pepper paste, mayonnaise, ketchup, and mustard. |

***Packaging***

Many of the foods used for the Shuttle and ISS are freeze dried and packaged into rehydratable containers. Beverages are packed by inserting septum with nitrogen flushing. Modified atmospheric packaging are used for packaging of bit size foods. Commercial pouches are used for thermostabilized and irradiated food. As with all freeze-dried foods, eggs are stored in metal cans or foil packages and egg's stored in metal cans under nitrogen at 40 ° F with shelf life of two years old.

*Apollo Space Food- Beef Hash*

*Apollopace Food -Spiced Fruit Cereal*

***Space Foods at Present***

At present, Astronauts have a wide range of foods to be eaten in outer space at zero gravity atmosphere. Chinese have yuxiang pork, Pao chicken, Eight Treasures rice, Chinese herbal tea. Italian commercial firms Lavazza and Argotec developed an espresso machine, called ISSpresso, for the International Space Station, which can brew hot coffee, tea and broth. Japanese have ramen, sushi, soups, and rice with ume. Korean have their national dish Kimchi. Russian have a range of 300 dishes like for breakfast: curds and nuts, mashed potatoes with nuts, apple-quince chip sticks, sugarless coffee, and vitamins. For lunch: jellied pike perch, borscht with meat, goulash with buckwheat, bread, black currant juice, sugarless tea. For supper: rice and meat, broccoli and cheese, nuts, tea with sugar. For second supper: dried beef, cashew nuts, peaches, grape juice.


*Apollo Space Food Pineapple Fruitcake*


*Apollo Space Food Chocolate Pudding*

### *Conclusion*

As space food is very important for astronauts. There are many upcoming space projects which will require greater energy, provides a great future scope for food scientists or developers. NASA plans to grow fruits and vegetables on space farms by creating green house and are temperature controlled. Despite of having a lot of limitations in development of space food, it provides a golden opportunity to enhance career in food science.

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# Effect of Medicinal Plants on Human Health

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## *Introduction*

The word 'herb' has been derived from the Latin word "Herba" and an old French word "herbe". It refers to any part of plant like fruit, seed, stem, bark, flower, leaf, stigma or root as well as non-woody plant and the term "Medicinal plant" include various types of plant used as herbal medicines. It is the use of plants for curing and treatment of disease. These plants are used as food, flavonoid, medicine and also can be used in spiritual activities. Traditional medicinal plants continue to be widely practiced in India since Ancient Civilization. As population rises day by day and the people living in India are of different community, so inadequate supply of drugs and cost of treatments and also side effects of synthetic drug for infectious disease has led to increase emphasis on the use of plant material as a source of herbal medicine for a wide variety of human Ailment. About 8000 herbal remedies have been codified in AYUSH System in India. Recently WHO (World Health Organization) estimated that 80% of people worldwide rely on Herbal medicine obtained from Herbal Medicinal plants for their primary health care needs. According to WHO 21,000 plant species have the potential for being used as medicinal plants. Treatment with herbal medicinal plants is considered to be safe has no or minimal side effects and the biggest advantage is that they are the remedies sync with the nature. The golden fact is that the use of herbal treatment is independent of any age group. So, it is very helpful in various common Ailment and other diseases.

## *History*

In the written record the study of herbs dates back over 5000years. It has been seen since Aryans time, people were worshipping natural resources like plants, water, forest, fire and earth etc. In Vedas, it has been discussed, like, Yajurveda has dealt with many plants that are used in rituals. Atharva Veda has mentioned the role of medicinal plant in treating diseases. Ayurveda is the most ancient and has been scientifically treating disease and is a branch of Atharva Veda. The fifteenth, sixteenth and seventeenth centuries were the great age of many herbals. The use of herbal medicinal plants to treat disease is almost universal among societies.

## *Some Common Herbal Medicinal Plants and heir Effects*

### *1. Holy Basil*

This is commonly known as 'Tulsi'. Holy Basil was first used in the Greco Roman world to repel insects. It is known for their antiviral and antioxidant properties. This is very effective against indigestion, headache, hysteria, cholera, also helpful in curing malaria. Juice of leaves gives relief in cold, fever, bronchitis and cough. In some people basil can cause low blood sugar. The basil or its oil contain estragole, a chemical that might increase the risk of getting liver cancer.

***2. Neem***

Neem has anti-microbial effect and are very effective. It has anti-malarial properties. Neem leaf is used for leprosy, eye disorders, bloody nose, loss of appetite, skin ulcers & some cardiovascular disease, fever, diabetes and liver problems. The leaf is also used for Birth Control and to cause Abortions. Neem oil and Neem bark are unsafe when taken during pregnancy, it can cause miscarriage. It removes toxins from our blood and enhance activity of free radical scavenging.

***3. Peppermint***

It is a popular traditional remedy. It is used to treat flatulence, menstrual pains, common cold, diarrhoea, nausea, depression related anxiety etc. Peppermint oil used to reduce spasms in the digestive tract. It also held to cool the skin and relief Itching. Today, it has been used as a dietary supplement for irritable bowel syndrome and headache also. It has antiviral, antibacterial, anti-inflammatory, antispasmodic properties.

***4. Ashwagandha***

It is an evergreen shrub that grows in India. Its roots and orange red fruit have been used for medicinal purpose. This is also called Indian Ginseng or winter cherry. It is used to treat anxiety, arthritis, heart heath also, treat chest pain, high blood pressure, high cholesterol and cancer also. This ancient herb, Ashwagandha is best known for Stress reduction, Neural protection.

***5. Lavender***

It has been recognized for its sweet perfume, Lavender also boosts medical benefits as a nervine and mild anti-depressant. This is also used to treat sunburns and acne. It has a variety of therapeutic and curative properties. A current survey has clinical state of knowledge about the effect of Lavender of the Nervous System. This herb is highly used for skin and beauty and is commonly used for fragrances. Lavender oil also has antiseptic and anti-inflammatory properties. That's why, these herbal medicinal plants are very helpful and can be available.

***Conclusion***

The most effective and safe treatment option to use herbal products given by nature. By promoting good health, it can give healthy lifestyle too. Today, these herbal plants are the symbol of safety in contrast to the synthetic drugs, as they are regarded as safe for Human Beings.

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# Gene disruption technology for management of stored grain insect pest

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***Introduction***

After crop harvesting agricultural products are to be stored for various future uses like seed, feed, grain, industrial raw material and for processing as valuable products so during storage period these agricultural products can be attacked by various stored grain insect pests which results in significant losses to the farmers. The infestation of insect pest while storage leads to deterioration in quantity and quality of stored product as well as causes reduction in percentage germination in seeds. In India, the traditional methods of management like sun drying, application of vegetable oil and mixing of botanical material is commonly used practices. All these methods were cheap, easy and eco-friendly but results are slow as compare to synthetic insecticide and fumigants. The fumigation method was most extensively used for preventing insect pests in storage because it gives quick as well as maximum prevention against all the stages of insect pests. The commonly used fumigants are phosphine, methyl bromide, cyanogens, sulfuryl fluoride. The main limitations with these fumigants where they leave residue, develop resistance and adverse effect on environment and human health. Keeping in view the limitation of traditional as well as synthetic insecticides, the new gene disrupting technology such as RNA interference (RNAi) and Clustered Regulatory Interspaced Short Palindromic Repeat (CRISPR) were used as effective tool for management of storage insect pest.

***Major insect pest of storage grain***

| Common name | Pest | Family | Order |
|---|---|---|---|
| Rice weevil | *Sitophilus oryzae, S. zeamais, S. granarius* | Curculionidae | Coleoptera |
| Lesser grain borer | *Rhyzopertha dominica* | Bostrychidae | Coleoptera |
| Angoumois grain moth | *Sitotroga cerealella* | Gelechiidae | Lepidoptera |
| Pulse beetle | *Callosobruchus chinensis, C. maculatus* | Bruchidae | Coleoptera |
| Cigarette beetle | *Lasioderma sericorne* | Anobiidae | Coleoptera |
| Drug store beetle | *Stegobium paniceum* | Anobiidae | Coleoptera |
| Tamarind Beetle | *Pachymeres gonagra* | Bruchidae | Coleoptera |
| Sweet Potato weevil | *Cylas formicarius* | Anobiidae | Coleoptera |
| Potato tuber moth | *Phthorimoea operculella* | Gelechiidae | Lepidoptera |
| Arecanut beetle | *Araecerus fasciculatus* | Anthribidae | Coleoptera |
| Red flour beetle | *Tribolium castaneum, Tribolium confusum* | Tenebrionidae | Coleoptera |
| Indian meal moth | *Plodia interpunctella* | Phycitidae | Lepidoptera |
| Fig moth or almond moth | *Ephestia cautella* | Phycitidae | Lepidoptera |
| Rice moth | *Corcyra cephalonica* | Galleriidae | Lepidoptera |
| Khapra beetle | *Trogoderma granarium* | Dermestidae | Coleoptera |

Most of the available publication on gene disruption in the agricultural field has focused on the red flour beetle, *Tribolium castaneum*, the current genetic model for coleopteran stored grain pests [13]. Therefore, in this article, we will focus on *T. castaneum*, and the advances made for potential agricultural use of two gene disruption technologies, RNAi and CRISPR.

***RNA interference (RNAi)***

In nature, RNAi initiates when long double stranded RNA (dsRNA) is introduced into an organism via infection. Once the dsRNA is introduced, the endoribonuclease Dicer cleaves the dsRNA into 21–23 nucleotide fragments, which known as short interfering RNA (siRNA). The unwound single-stranded guide strand of the siRNA is incorporated into an RNAi-induced silencing complex (RISC) that targets and degrades RNA with complementary sequence. It was first discovery in *Caenorhabditis elegans* [10], whereby the induced dsRNA moves from cell to cell throughout the entire body via a systemic response. The successful RNA knockdown is dependent on factors like length and concentration of the dsRNA fragment, nucleotide sequence specificity, life stage and genetic background of the test organism [14,11]. In *T. castaneum,* directly injecting dsRNA at any life stage can result in gene silencing [12].

***CRISPR***

CRISPR and the endonuclease CRISPR-associated protein 9 (Cas9) system (CRISPR-Cas9) originated from the innate immune system of bacteria. Unlike RNAi, which disrupts gene expression, CRISPR-Cas9 is a effective DNA editing technology that not only disrupts gene expression, but also alters or even inserts coding sequences. In bacteria, foreign DNA sequences integrated into DNA are targeted by the CRISPR-Cas9 system as part of a defense mechanism that enables bacteria toward off infections from viruses and bacteria [7]. CRISPR-Cas9 uses a guide RNA (gRNA) to detect and form base pairs with a DNA target sequence, and binds the Cas9 endonuclease which cuts the double stranded DNA (dsDNA) very precisely (Fig 1) [6,8,9]. The DNA break is repaired by non-homologous end joining (NHEJ) or homology-directed repair (HDR) by endogenous cellular machinery. When dsDNA breaks are repaired by NHEJ, a single or multiple nucleotide insertion or deletion (INDELS) often occurs, and can shift the reading frame of the gene sequence, effectively turning the gene off. When no INDELS occur, the DNA is restoring to its original state and no change occurs. HDR needed the incorporation of an additional template component containing the desired altered sequence, flanked by sequences homologous to either side of the cut site. In HDR, homologous recombination is utilized to incorporate new sequences to repair or introduce genes. CRISPR genome editing is simpler, more cost effective, faster, and easier to use than already existing genome editing technologies, like transcription activator-like effector nucleases (TALEN) and zinc finger nucleases, and facilitates precise and efficient targeting, editing, modification, and regulation of cells and organisms [1].

CRISPR technology holds gene-editing promise for insect model organisms such as *T. castaneum* [4]. The first and only report of CRISPR technology utilized in a stored product pest was in *T. castaneum* for gene targeting and transgene replacement [5], with more reports anticipated to follow. The development of a system that uses the *T. castaneum* U6 promoter (or other more effective promoters) for expression in plasmid delivery systems will further advance CRISPR studies in *T. castaneum.*

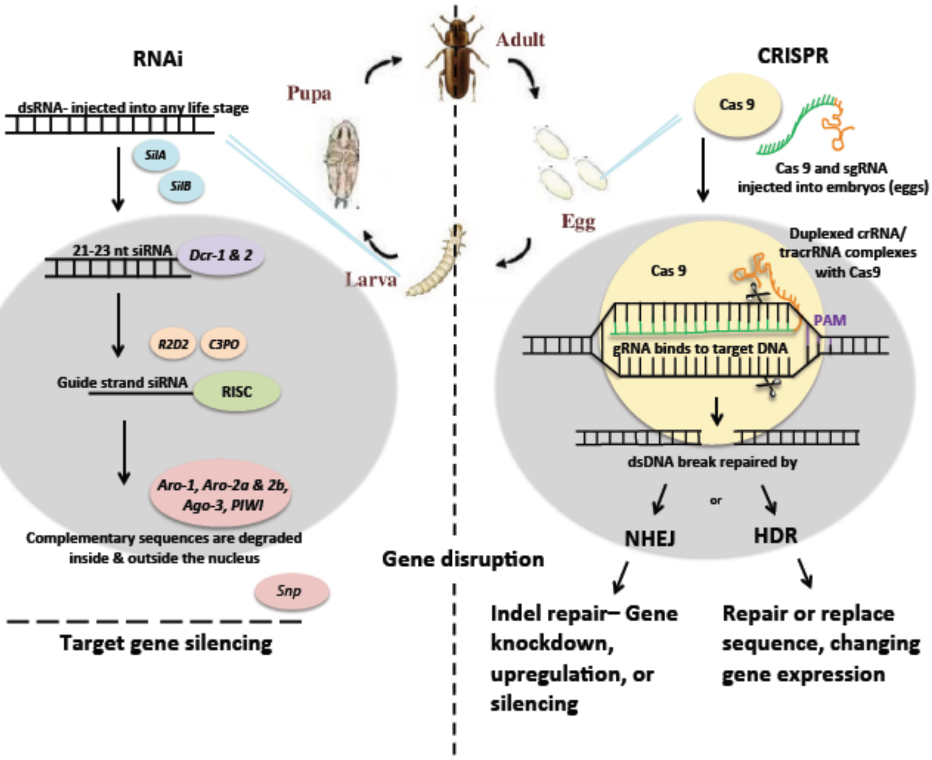


**Fig 1:** Diagrammatic representation of RNA interference (RNAi) and CRISPR-Cas technology in *T. castanem.*

### *Difference between RNAi and CRISPR*

CRISPR edits the DNA of the cell, thereby changing gene expression permanently if it is a stable transformation. RNAi interferes with existing gene expression and has diminishing effects unless dsRNA is continuously administered, while in some cases a parental RNAi effect has been reported [2]. A modification of the RNAi technology called CRISPR interference (CRISPRi) has reversible effects, but targets DNA instead of RNA. CRISPRi uses a catalytically deactivated Cas9 (dCas9) that reversibly binds to target DNA to inhibit gene expression [3]. CRISPR does not interfere with the endogenous cellular machinery, which is limitation of siRNAs or short hairpin RNAs (shRNA) that may cause cell death [1]. While there are advantages of CRISPR for permanent gene alteration, RNAi has advantages in applied use, whereas CRISPR technology has thus far been restricted by delivery methods as well as biosafety containment considerations. RNAi and CRISPR gene disruption technologies supplement each other in gene function research.

### *Conclusion*

RNAi and CRISPR both are new molecular based technology for insect pest management. These technologies are target specific so don't have any adverse effect on humans and environment. The new gene disruption techniques succeed in dealing with major limitation of traditional methods and synthetic insecticide used for management of stored grain pests. RNAi and CRISPR technologies have generated the potential for novel and yet unpractised stored product pest control methods, gene expression modification, gene editing, and gene modification. These gene disruption technologies also show compatibility with integrated pest management technology.

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# Fortification: A remedy against hidden hunger in India

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### *Introduction*

Globally, an estimated two billion people suffer from a chronic deficiency of essential vitamins and minerals (micronutrients), a condition known as hidden hunger. The Hidden Hunger Index provides the global health and development community with evidence to inform where to focus national strategies and programs, and on which micronutrients. The options to fulfil these requirements are through medicine (expensive, problem of monitoring for quality of medicine), diet diversification (expensive and unaffordable for many) and fortification. Fortification is the addition of key nutrients to staple foods either preharvest operations (Biofortification) and postharvest operations (food fortification). Fortification is a globally proven intervention to address the much prevalent micronutrient deficiencies in the population. Fortification is required because; out of 129 countries, 57 countries have severe levels of under- nutrition and adult overweight (Anonymous, 2018); out of world population of 7 billion, 2 billion suffer from micronutrient deficiencies; South Asia is home to more than 35% of the world's poor and 21.9% of the population of India lives in poverty; India is home to world's highest under-nourished people (194.6 million), where 38.4% of the children (<5 years) are stunted and 35.7% are underweight; annually India losses over US$12 billion in Gross Domestic Product to vitamin and mineral deficiencies (FAO, 2017); considerable loss of nutrients during the processing of food.

The various benefits of fortification of foods (Anonymous, 2020); nutrients are added to staple foods since they are widely consumed. Thus, this is an excellent method to improve the health of a large section of the population, all at once; It is a safe method of improving nutrition among people. The quantity added is small and well under the Recommended Daily Allowances and are well regulated as per prescribed standards for safe consumption; it is a cost-effective intervention and does not require any changes in eating patterns or food habits of people; it is a socio-culturally acceptable way to deliver nutrients to people; it does not alter the characteristics of the food like the taste, aroma or the texture of the food.

### *Types of fortification*

***Market driven fortification***: In the accessing of promoting public health by adding essential nutrients to foods the market driven fortification lowering the onset of micronutrient insufficiency as per regulations set by the government. These type of fortification interventions on public health are performed in most developing countries in a limited way.

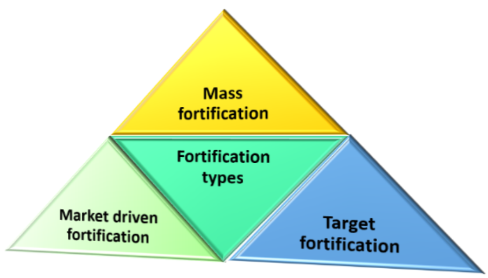


**Figure 1: Fortification and its types**

***Mass fortification***: An unacceptable public health risk is quite common and this can be mainly required adequate micronutrients in definite quantity (Dary and Hurrell, 2006). These types of fortifications are also known as free market fortification as the population may not actually be deficient, but it may benefit from strengthening and mainly depend on normal biochemical or dietary standards.

***Target fortification*:** These fortification interventions focusing on a particular food for a defined population and thus, increases the intake for that selected group not by following mass groups of people. Daily micronutrient requirements framed and according to this foodstuff has to be supplied to the target group.

**Methods of fortification**

***Biofortification***

Biofortification, the process of maximizing the bioavailability of essential micronutrients in consumable part of the plants using various agronomic interventions methods in order to eradicate the mitigations of hidden hunger (Singh *et al.,* 2016). Howarth E. "Howdy" Bouis in 1990 developed a process called biofortification which reduces micronutrient malnutrition, also known as hidden hunger. The selection of target crops is divided into two phases; phase-I includes the staple crops to the particular zones such as wheat, rice, maize, sweet potato, beans and pearl millet and phase-II are potato, sorghum, banana, lentils and groundnut which has special attention in the diet other than staple foods. The main aim of the biofortification is to enhance the quality of micronutrients of crops at edible portion. Singh *et al.,* 2016 notify several methods through which biofortification has been carried out such as; plant breeding, conventional plant breeding, mutation breeding, molecular breeding, genetic engineering and tissue cultures. Some of the biofortified crops in grown in India are shown in Table 1.

***Food fortification***

Food fortification is a postharvest process which includes the adding of micronutrients (essential trace elements and vitamins) to food. It can be carried out by food manufacturers, or by governments as a public health policy which aims to scale down dietary deficiencies of the people within the population. Globally, these are the cheapest practices to rectify the micronutrients malnutrition issues now a days. As we are familiar with the iodization of salt in which iodine part is added which decline the cases of goitre (Gomez-Galera *et al.,* 2010).

Food Safety and Standard Authority of India (FSSAI) has established Food Fortification Resource Centre (FFRC) on October 16, 2016 in collaboration with Tata Trusts and various International NGOs working in the field of nutrition as a resource centre to promote large-scale fortification of food (Anonymous, 2020). The FFRC is a Resource and Support Centre to promote large-scale fortification of food across India. It is a resource hub which provides information and inputs on standards and food safety, technology and processes, premix and equipment procurement and manufacture, quality assurance and quality control for fortification of foods. On August 22, 2017 India FSSAI announced that the fortification logo (+F logo) is now a mandatory labelling requirement on all fortified food products.

*Table 1: Some of the biofortified crops in India (Yadava et al., 2017)*

| Crop variety | Developed by, year of release | Specifications | Adaptations |
|---|---|---|---|
| **Rice: CR Dhan 310** | ICAR-NRRI, Cuttak, 2016 | Protein (10.3%) in polished grain as compared to 7.0-8.0% in popular varieties | Odisha, Madhya Pradesh and Uttar Pradesh |
| **Rice: DRR Dhan 45** | ICAR- IIRR, Hydrabad, 2016 | High in zinc content (22.6 ppm) in polished grains in comparison to 12.0-16.0 ppm in popular varieties | Karnataka, Tamil Nadu, Andhra Pradesh and Telangana |
| **Wheat: WB 02** | ICAR- IIWBR, Karnal, 2017 | Rich in zinc (42.0 ppm) and iron (40.0 ppm) in comparison to 32.0 ppm zinc and 28.0 32.0 ppm iron in popular varieties | Punjab, Haryana, Delhi, Rajasthan, Jammu and Kashmir, Himachal Pradesh and Uttarakhand |
| **Pearl millet: HHB 299** | CCS, HAU, Hisar-ICRISAT, 2017 | High iron (73.0 ppm) and zinc (41.0 ppm) as compared to 45.0-50.0 ppm iron and 30.0-35.0 ppm zinc in popular varieties/hybrids | *Kharif* season in Haryana, Rajasthan, Gujarat, Punjab, Delhi, Maharashtra and Tamil Nadu |
| **Maize: Pusa Vivek QPM9 Improved** | ICAR- IARI, New Delhi, 2017 | High provitamin-A (8.15 ppm), lysine (2.67%) and tryptophan (0.74%) as compared to 1.0-2.0 ppm provitamin-A, 1.5-2.0% lysine and 0.3-0.4% tryptophan content in popular hybrids | *Kharif* season in Jammu and Kashmir, Uttarakhand (Hill region), North Eastern states, Maharashtra, Karnataka, Telangana and Tamil Nadu |
| **Lentil: Pusa Ageti Masoor** | ICAR-IARI, New Delhi, 2017 | Contains 65.0 ppm iron as compared to 55.0 ppm iron in popular varieties | Uttar Pradesh, Madhya Pradesh, Chhattisgarh |
| **Mustard: Pusa Mustard 30** | ICAR-IARI, New Delhi, 2013 | Contains low erucic acid (<2.0%) in oil as compared to >40% erucic acid in popular varieties | Uttar Pradesh, Uttarakhand, Madhya Pradesh and Rajasthan |
| **Mustard: Pusa Double Zero Mustard 31** | ICAR-IARI, New Delhi, 2016 | Low erucic acid (<2.0%) in oil and glucosinolates (<30.0 ppm) in seed meal as compared to >40.0% erucic acid and >120.0 ppm glucosinolates in popular varieties | Rajasthan (North and Western parts), Punjab, Haryana, Delhi, Western UP, Plains of Jammu and Kashmir, Himachal Pradesh |
| **Cauliflower: Pusa Beta Kesari 1** | ICAR-IARI, New Delhi, 2015 | Contains high β-carotene (8.0-10.0 ppm) in comparison to negligible β-carotene content in popular varieties | Nation Capital Region of Delhi |
| **Sweet potato: Bhu Sona** | ICAR-CTCRI, Thiruvananthapuram 2017 | High β-carotene (14.0 mg/100 g) content as compared to 2.0-3.0 mg/100 g β- carotene in popular varieties | Odisha |

***Table 2: Selected vehicles for carrying the micronutrients by food fortification resource centre (Anonymous, 2020)***

| Food | Micronutrients and recommended levels |
|---|---|
| Edible oil | • Vitamin A: 25 IU/g of oil (Retinyl acetate, Retinyl palmitate and Retinyl propionate)<br>• Vitamin D2: 4.5 IU/g of oil (Ergocalciferol, Cholecalciferol) |
| Milk | • Vitamin A (Retinyl acetate, Retinyl palmitate and Retinyl propionate): 770 IU/litre of milk<br>• Vitamin D2 (Ergocalciferol, Cholecalciferol): 550 IU/ litre of milk |
| Double fortified salt | • Iodine (Potassium Iodate): Manufacture level (not less than 30ppm on dry weight basis); Distribution level (not less than 15ppm on dry weight basis)<br>• Iron (Ferrous sulphate or Ferrous fumarate): 850-1100 ppm |
| *Rice | • Iron (Ferric pyrophosphate: 28-42.5 mg/kg; Sodium Iron (III) EDTA: 14-21.25 mg/kg<br>• Folic acid: 75-125 µg/kg<br>• Vitamin B12 (Cyanocobalamine or Hydroxycobalamine): 0.75-1.25 µg |
| *Wheat flour | • Iron (Ferrous citrate or lactate or ferrous sulphate or ferric pyrophosphate or electrolytic iron or ferrous fumarate or ferrous BisGlycinate): 28-42.5 mg/kg; Sodium Iron (III) EDTA: 14-21.25 mg/kg<br>• Folic acid: 75-125 µg/kg<br>• Vitamin B12 (Cyanocobalamine or Hydroxycobalamine): 0.75-1.25 µg/kg |

*Also, can be fortified with Zn, vitamin A and vitamin B (B1, B2, B3 and B6) singly or in combination.

***Conclusions***

Indian Council of Agricultural Research (ICAR) has initiated biofortification in crops as a sustainable and cost-effective solution to alleviate malnutrition. National Nutrition Strategy' by the NITI Aayog, Govt. of the India, also provide impetus to utilize these biofortified varieties more effectively towards achieving *'Kuposhan Mukt Bharat'*. The Food Fortification Resource Centre also initiated the post fortification practices and initiate novel techniques to fortify foods at fast scale. The benefits of fortification positively impact the entire life cycle of mankind by fighting against hidden hunger. It is one of the most effective way to overcome malnutrition, especially in children and pregnant women and preventing the birth of intellectually impaired children with malformations or deficiencies.

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# Space Debris, A Threat to Environment

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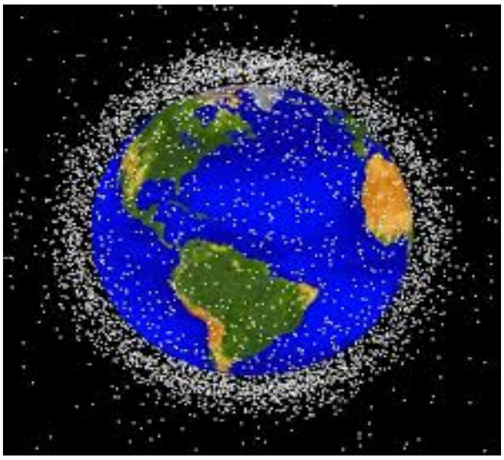
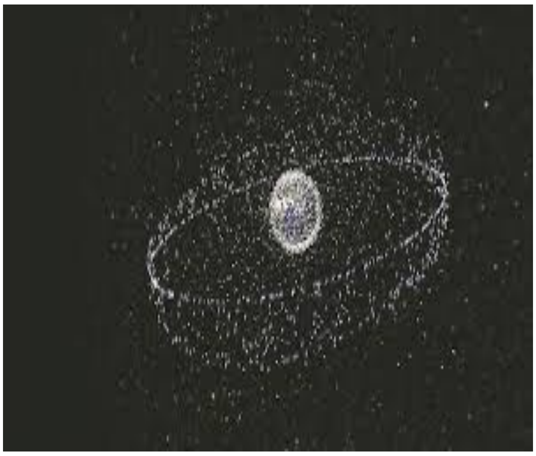
***Introduction***

Space debris include both natural & man-made orbital debris components of space environment. It is more concern due to its very high speed in orbit even a small piece can damage or destroy satellite in collision. Since debris at high altitude can stay in orbit for decades or layer, it accumulates as more is produced & risk of collisions with satellite grows. Since currently there is no effective way to remove large amount of debris from orbit. The 62 years of space activity since the launch of Splitnik-1 has resulted over half a million pieces of orbiting debris longer than 1cm in size. They can be stay for a very long time but if they get de-orbited, they move in a very uncontrolled manner, if they are small in size they vaporizes but if not then it come & hit in a city or village & it can be life threatening. The rising population of space debris increase the potential danger to all the space vehicles as especially to International space station, space shuttles & other space craft with human abroad.

**Space Debris From Spacecraft And Satelite, respectively, NASA.**

***Categorization of Debris***

Three categories of space debris depending on their size –

- Category 1 (<1cm)
  It make significant damage to vulnerable part of satellite.
- Category II (1-10cm)
  Seriously damage or destroy a satellite in a collision.
- Category III (>10cm)
  Destroy a satellite in a collision and can be traced.

***Reason behind Space Debris***

- In space technology many countries have lack of control.
- Cleaning up the trash in the space cost very high which is not accountable.
- Countries are launching satellite into space continuously.

***Consequences of Space Pollution***

- Broken down of space craft due to collision which poses a threat to return of space scientist.

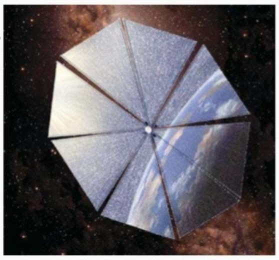
- It poses hazard to the surface of earth.
- When it gets de-orbited they come & hit in the city or village which can be a life threat.
- It can also affect's future space missions.

***Methods to control***

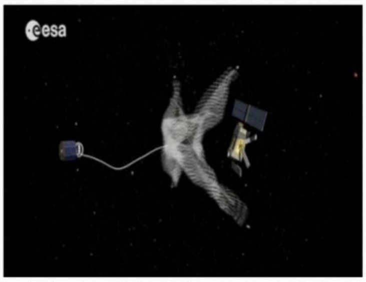
***Tug like Satellites***

It drags the debris to a safe altitude in order to burn up in the atmosphere. It creates an electron emission to create a difference in Potential between the debris as negative & itself as positive, then satellite uses its own thrusters to propel itself along with the debris to a safer orbit.

***Solar Sails-*** The Solar Sails uses the pressure from sunlight to navigate out of orbit & burn into the atmosphere.



***Space Nets-*** Space net are satellites which eject a huge net that fishes of collects the debris & is later disposed of into a graveyard orbit.




***Collector Satellites***- It has two extended arms which collect the debris as it is in action.

***Measures***

- Use of reusable technology for many space applications.
- Track the non-working satellite back to earth.
- Utilize intelligent design practices to minimize the effect of debris impact.

***Conclusion***

Space debris has an ever-growing impact on space flight & travel. It must be careful because even the smallest loose nut or bolt lost on space walking repair missions could cause a cascade of debris. This problem might look unimportant & being realised by the people, but it is a great concern for the development in Space technology.

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# Medicinal and nutritional importance of Greengram

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***Introduction:***

Greengram (*Vigna radiata* L.) is an important pulse consumed all over the world, especially in Asian countries, and has a long history of usage as traditional medicine. The greengram is also known as mung bean, is a plant species in the legume family. It is short duration legume crop grown mostly as a fallow crop in rotation with rice. It looks like a small, green seed and can be cooked in the same way as lentils. It's widely consumed in Southern Europe and in Asian countries, and can be purchased whole or as split seeds. Similar to the leguminous pulses, green gram, enriches soil nitrogen content. Many specialty stores sell mung bean bran and processed foods, such as noodles, pasta and flour made from mung beans. Mung beans are easy to digest.

Mung beans are a filling food. The high fibre and protein levels produce longer satiety times. Mung beans keep free radicals under control. These free radicals can be an outcome of anything like pollution, stress unhealthy snacking and toxicity in body. Green gram is also good for a detox diet. It contains silica which rebuilds the skins connective tissues. It also effectively removes toxins from your body that will seep inside your bloodstream leading to a lifeless and dull complexion.

Green gram has been known to be an excellent source of protein, dietary fiber, minerals, vitamins, nutritional values which includes Vitamins Folate, Niacin, Pantothenic acid, Riboflavin and significant amounts of bioactive compounds, including polyphenols, polysaccharides, and peptides, therefore, becoming a popular functional food in promoting good health. One cup of green gram contains 15 grams of fibre, it fills you up and keeps you satisfied for a longer period of time. When people add fibre to their diet, they automatically eat lesser calories. This increases your chances of losing weight. Moreover, the present paper aims to show the potential action mechanisms of the mung bean on its Medicinal and nutritional importance.

***Medicinal importance of Greengram***

***1. Helps Prevent Diabetes***

Moong dal has a low glycemic index. It helps bring down the insulin, blood glucose and fat levels in the body. In turn, this helps keep blood sugar levels under control, and diabetes in check.

***2. Improves Digestive Health***

The consumption of moong dal helps produce a fatty acid called butyrate in the gut. This helps maintain the health of the intestinal walls. The dal has anti-inflammatory properties that prevent and accumulation of gas. In addition to that, moong dal has also been proven to be easy to digest, making it good for digestion as well.

***3. Boosts Blood Circulation***

Iron helps in the proper production of red blood cells. This, in turn, prevents anaemia and improves the overall blood circulation in the body. The proper circulation of blood helps supply oxygen to various organs and cells in the body, and in the process, optimises their performance.

***4. Lowers blood pressure***

It is a proven fact that mung beans are fat controllers and regulators. Moreover, the presence of large amount of magnesium makes it a very potent BP regulator. It maintains the level of magnesium in the blood. Magnesium eases blood vessels and lowers hypertension. This, in turn, keeps the blood pressure of the body under control.

***5. Controls cholesterol and heart disease risk***

By preventing oxidation of LDL, mung beans keep the arteries clear and improve blood circulation. Not only does this reduce inflammation, it reverses damage to the blood vessels. By preventing deposition of plaque the risk of heart attack & stroke is reduced as well.

***6. Help fight cancer***

Mung beans keep free radicals under control. These free radicals can be an outcome of anything like pollution, stress, unhealthy snacking and toxicity in body. They have the ill-fate of interfering with normal cell growth. Abnormal cell growth can even lead to cancer. Mung bean, which is a natural suppressor of free radicals, is a good option to keep cancer at bay.

***7. Improves skin health***

Green gram adds shine and radiance to human skin. The presence of copper increases its use in various face packs and face creams. Using mung bean as a scrub is also a good option. It is very easy to make a natural exfoliating face pack using mung beans at home. To Make Mung Bean Natural Face Pack at home;Grind mung beans to form fine powder, then add lukewarm water to the powder to make a paste. Apply the paste on the face and leave to dry for 10 minutes. Then Scrub for next 10 minutes. This results in cleaner and reduced pores. This deep exfoliating face scrub is an ultimate killer of tan, blackheads, excessive oil and unnatural glare. Undoubtedly, it is one of the best natural scrubs one can use to make their skin radiant!

***8. Anti-Toxic Benefits***

Toxicity is a serious problem and can have long lasting side-effects including ulcers and cancer. Consumption of mung beans helps to keep your body free of toxins. It maintains the circulatory health of the body as well. It flushes out toxins from the body easily and keeps the formation of free radicals under check.

***9. Decreases PMS Symptoms***

The various B complex vitamins, especially folate & B6, and magnesium help regulate hormonal fluctuations which cause these PMS symptoms.

***10. Helps Reduce Weight and Fights Obesity***

Mung beans are a filling food. The high fibre and protein levels produce longer satiety times due to the double increase of the satiety hormone cholecystokinin as compared to meals that are devoid of these beans. Therefore consuming mung beans on a regular basis helps decrease food intake, thus lower weight and aid in fighting obesity.

***11. Boosts Immunity & Protects Against Infections***

The wide variety of phytonutrients in mung beans is not only anti - inflammatory but anti - microbial as well. These helps fight harmful bacteria & viruses, maintain healthy gut bacteria and raise immunity levels. They ensure optimal digestive tract health and thus promote optimum nutrient absorption.

***12. Keep Your Cholesterol Levels Low***

Rich in fibre and antioxidants, mung beans protect your heart and reduce bad (LDL) cholesterol levels. Hypercholesterolemic mice fed with fermented mung beans experienced a greater reduction in triglycerides, total cholesterol and LDL cholesterol levels than those treated with medications.

***13. Improves Heart Health***

This yellow dal is rich in potassium and iron. The former helps lower blood pressure and protects against muscle cramping. It also helps protect the body against an irregular heartbeat. Its light and easy-to-digest nature make it a great food for those suffering from hypertension.

***Nutritional importance of Greengram***

Green beans consists of nutritional values which includes Vitamins Folate, Niacin, Pantothenic acid, Riboflavin, Thiamine, Vitamin A, Carotene beta, Vitamin B12, Vitamin B6, Vitamin C, Vitamin D, Vitamin E, Vitamin K. It consists of minerals, which includes Calcium, Copper, Iron, Magnesium, Manganese, Phosphorus, Potassium, Selenium, Sodium, and Zinc.

Moong dal is a nutrient-rich food. They're packed with minerals like potassium, magnesium, iron, and copper. In addition to this, they also contain folate, fibre, fibre, and vitamin B6, apart from loads of high-quality protein. Rich in B-complex vitamins, moong dal helps your body break carbohydrates down to glucose, and produce usable energy for your body. The folic acid present in it also helps maintain healthy brain function and in the production of DNA. Moong dal also contains some amounts of vitamin E, C and K.

Moong dal is particularly rich in dietary fibre. A single cup serving can provide between 40.5 and 71 percent of the recommended daily intake of the nutrient. This dietary fibre content helps reduce blood cholesterol levels, while also preventing dietary complications. A high fibre intake also reduces the risk of overeating thanks to its ability to make one feel full. The body requires relatively large amounts of protein, making it a macronutrient. The high protein content in moong dal makes it a great source of the nutrient for vegetarians. Moong Dal sprouts contain Globulin and Albumin as the main storage proteins. They make up over 85% of the total amino acids found in these sprouts. Make them complete protein by eating moong dal with a cereal like rice, roti, or millet.

The high protein content contributes to building and repairing tissues, while also being a building block of muscles, bones, cartilage, blood, and skin. As you see, the green gram isn't just healthy and nutritious, but diet-friendly too. When consumed regularly, it can boost your vitamin and mineral intake, prevent deficiencies and ward off chronic diseases. A cup of cooked mung beans has only 212 calories, 23.3 grams of net carbs and less than 1 gram of fat. It also delivers 14.2 grams of protein and large doses of micronutrients, including:

- 80 percent of the DV (daily value) of folate
- 22 percent of the DV of thiamin
- 3 percent of the DV of vitamin C

- 7 percent of the DV of vitamin K
- 30 percent of the DV of manganese
- 24 percent of the DV of magnesium
- 15 percent of the DV of potassium
- 11 percent of the DV of zinc
- 20 percent of the DV of phosphorus
- 16 percent of the DV of iron
- 18.2 milligrams of omega-3

***Mung Beans Support Female Health***

- These legumes are packed with thiamin, riboflavin, folate and other B vitamins that are particularly good for women. ***Folate***, for example, may reduce the risk of neural tube defects, autism, stroke and heart disease. ***Thiamin*** plays a vital role in growth and development. This water-soluble vitamin also protects against metabolic problems that may affect the placenta and fetus during pregnancy.
- ***Riboflavin***, one of the abundant B vitamins in mung beans, is essential for moms-to-be. According to the National Institutes of Health, preeclampsia (high blood pressure) and birth defects are more common in women with riboflavin deficiency.
- Green gram is also a good source of ***calcium***. This mineral support blood clotting, muscle contraction and bone growth. It also keeps your bones strong, which in turn, may help prevent osteoporosis, a disease that affects one in three women over 50 years old.

***Conclusion***

Green gram contains protein in abundance. The high protein content contributes to building and repairing tissues, while also being a building block of muscles, bones, cartilage, blood, and skin. This not only helps you lose more weight but also helps you build leaner muscles. As you see, the green gram isn't just healthy and nutritious, but diet-friendly too. Mung bean, which is a natural suppressor of free radicals, is a good option to keep cancer at bay. However, there are still important gaps in our knowledge regarding the bioactive compounds and biological activities of the mung bean. Given their health and nutritional benefits, the consumption of mung bean-based functional products, as well as nutraceuticals, could be considered an alternative food, not just in Asian countries but also in other countries.

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