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## 1. AGRONOMY- CROP PRODUCTION

# Technologies for Dryland Farming

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### Introduction

Dry land agriculture refers to cultivation of crops entirely under natural rainfall without irrigation. It is a form of subsistence farming in the regions where deficit of the soil moisture retards the growth of water consuming crops like rice, sugarcane etc. Dry land agriculture is important for the economy as most of the coarse grain crops, pulses, oilseeds, and raw cotton are grown on these lands. One hundred and twenty eight districts in India have been recognized as dryland farming areas. Of these, 91 districts are spread in the states of Madhya Pradesh, Chhattisgarh, Uttar Pradesh and Tamil Nadu, representing typical dry farming tracts.

### Dry land Farming

Cultivation of crops in areas receiving rainfall above 750 mm is known as dry land farming. Dry spell during crop duration occurs, but crop failures are less frequent. Semi-arid regions are included under this category.

### Components of a successful dry land farming system:

- Retaining the precipitation on the land
- Reducing evaporation from the soil surface to increase the portion of evapotranspiration used for transpiration, and
- Utilizing crops that have drought tolerance and that fit the precipitation patterns.

### Crop selection criteria:

The selection of crop varieties are very important in dry land farming. The selection of varieties have to prove excellent in irrigated or high rainfall areas are generally unsuited for dry land conditions. The selected variety need to have the following features

- Short-stemmed varieties with limited leaf surface minimize transpiration.
- Deep, prolific root systems enhance moisture utilization.
- Quick-maturing varieties are important in order that the crop may develop prior to the hottest and driest part of the year and mature before moisture supplies are completely exhausted.
- Dwarf plant type with lesser number of erect leaves to withstand lodging
- Effective photosynthetic behavior with greater sink capacity
- Moderate tillering to minimize competition

### Suitable crops for Dryland

Major dry farming crops are millets such as Jowar, Bajra, Ragi, oilseeds like mustard, rapeseed and pulses crops like pigeon pea, gram and lentils.

In India, almost 80 percent of maize, 90 percent of Bajra, 95 percent of pulses and 75 percent of oilseeds are obtained from dryland agriculture.

### Seed hardening methods in various crop

The process of **hydrating** the seed to initiate the pre-germinating metabolism followed by dehydration which fixes the biochemical events. It will increase the speed of germination and germination percentage, increases the seedling vigour, uniformity in emergence, increases the root growth, flowering occurs 2-3 days earlier, uniform seed set & maturity, increases the yield.

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| Crop | Chemical and concentration | Methodology |
|---|---|---|
| Pearl millet | 2 % Potassium chloride | Dissolve 20 gm of salt in 1000 ml of water. Soak 1 kg of seed in 650 ml of this solution for 10 hours and dry back to original moisture. |
| Sorghum | 2% Potassium dihydrogen phosphate | Dissolve 20 g of salt in 1000 ml of water. Soak 1 kg of seed in 650 ml of the solution for 16 hours and dry back to original moisture or weight. |
| Cotton | 2 % Potassium chloride | Dissolve 20 g of salt in 1000 ml of water. Soak 1 kg of seed in 650 ml of the solution for 10 hours and dry back to original moisture or weight. |

## Pulses production in Dryland farming

Among the cultivated food crops, pulses requires less amount of water (200 to 250 mm) compared to others and are generally tolerant to drought

- **Black gram:** Vamban 4,5,6, CO 5, ADT 5
- **Green gram:** Vamban 3, CO 6, ADT 3, CO 8
- **Red gram:** Vamban 2, 3, CO 7, APK. 1 varieties can be chosen which is suitable dryland and rainfed situation.

## Seed rate and seed treatment: 8 - 10kg/acre.

Pseudomonas 10 g and Trichoderma 4 g mixed with per Kg of seed and also one packet of Rhizobium and Phosphobacteria mixed and shade dried for sowing.

**Integrated nutrient management**: Before sowing, basal application of 5 to 10 tonnes of manure or compost or coir waste or vermicompost has to be applied and sowing can be taken. Each five kg of nitrogen and potash along with Gypsum applied as basal and phosphorus is an important major nutrient for pulses growth and grain development.

In red soils, phosphorus being precipitated by Iron and Aluminum ions and this will lead to unavailable form to plants. To overcome this 10 kg of phosphorus mixed with 750 kg of farm yard manure and keep it for 30-40 days and applied as enriched farm yard manure. This treatment fixes phosphorus into the soil and made available to the plants.

**Integrated pest management:** Major pests are helicoverpa, spodoptera, pod borers and Aphids.

**Biological** - Helicoverpa can be managed by application of NPV. And also severity infestation will be mininimised by avoiding excess application of fertilizer application.

**Chemical pesticide-**When economic threshold level exceeds 10% pod borers can be controlled by spraying Profenophos 2 ml mixed with water. Neem seed extract 5litre or neem oil 3 litre can be sprayed to control the pod borers.

## Other Dryland farming technologies:

1. Timely preparatory and seeding operations including conservation of stored soil moistures.
2. The use of improved crop varieties should be done which can withstand stress.
3. Conjunctive use of rainfall, surface and ground water. Watershed a natural hydrological unit is a good device for water harvesting.
4. Soil conservation by contour bunding, terracing, land leveling and also by practicing conservational tillage (zero tillage and minimum tillage)
5. Practice of drip irrigation, lining of canals to minimize the water loss.
6. Agronomic practices like mixed cropping, integrated pest management, integrated weed management, and crop rotation should be followed for increase the yield and maintain the soil fertility.
7. About 60 to 75 per cent of the rainfall is lost through evaporation. The evaporation losses can be reduced by mulches. Application of mulches results in additional benefits like soil conservation, moderation of

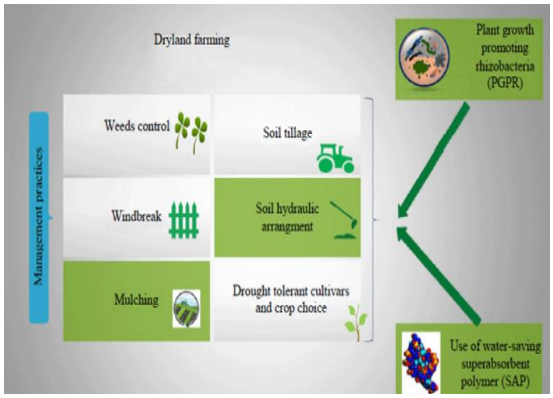
temperature, reduction in soil salinity, weed control and improvement of soil structure.

8. About 99 per cent of the water absorbed by the plants is lost in transpiration. It can be controlled by antitranspirant. Antitranspirant is any material applied to transpiring plant surfaces for reducing water loss from the plant.

**Modern Dryland Management Practices**

The conventional approach which involves in establishing drought tolerant cultivars through breeding has not yet been able to solve the problem. The world of scientific research to increase production in drought environments in recent years is moving in two up –and-coming areas :

- The use of Plant Growth Promoting Rhizobacteria (PGPR)
- The use of water-saving Superabsorbent Polymer(SAP),both of these opportunities in these last year seem to give great chance for success.




**Conclusion**

Improvement in dry farming would raise the economic status of farmers thus helping in poverty elimination. Dryland areas constituting more than two-third of total arable lands in India are the chief contributor of pulses, oilseeds, coarse grain crops and cotton. Drylands also contribute significantly to wheat and rice production. Therefore, it is the need of the hour to adopt and practice the available dryland technology to maximum extent for the enhancement of agricultural production in these areas which would not only boost the food grain production of the country but would also improve the economic status of farmers in these areas.

## 2. AGRICULTURAL SCIENCES

# Asexual Fructifications

**A.Sudha**

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In fungi conidiophores are grouped together to form specialized structures such as synnemata (sing. synnema) and sporodochia (sing. sporodochium) or produced in fructifications known as pycnidia (sing. pycnidium) and acervuli (sing. acervulus).

**a. Synnema or coremium**

Synnema or Coremium (pl. coremia) Consists of a group of conidiophores often united at the base and part way up the top. Conidia may be formed along the length of the synnema or only at its apex. The conidiophores comprising a synnema are often branched at the top with the conidia arising from the conidiogenous cells at the tips of the numerous branches. e.g. Deuteromycotina (Arthrobotryum sp (Fig), Penicillium claviforme, Doratomyces stemonitis, Ceratocystis ulmi. synnema: (pl. synnemata; syn. coremium) compact or fused, generally upright conidiophores, with branches and spores forming a headlike cluster

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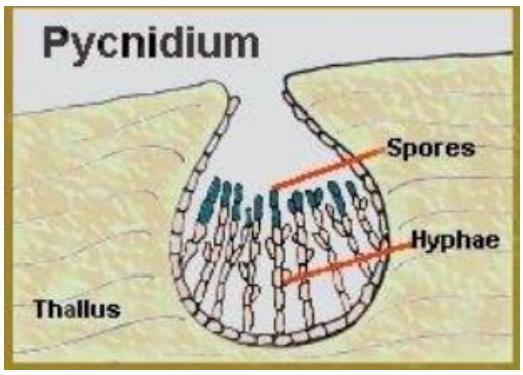
**b. Sporodochium**

Sporodochium is a fruiting body in which conidiophores arise from a central cushion-like aggregation of hyphae. The conidiophores are packed tightly together and are generally shorter than those composing a synnema. e.g. Epicoccum, Nectria. sporodochium: (pl. sporodochia) Superficial, cushion-shaped asexual fruiting body consisting of a cluster of conidiophores

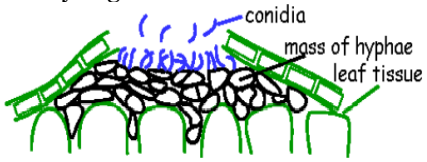
**c. Pycnidium**

Pycnidium is a globose or flask-shaped body, which is lined on the inside with conidiophores. e.g. Septoria ,Phoma, Ascochyta, Leptosphaeria. Pycnidia may be completely closed or may have an opening. The opening or mouth of pycnidium is called ostiole (L. ostiolum = little door). They may be provided with a small papilla or with a long neck leading to the opening. Pycnidia vary greatly in size, shape, colour and consistency of the pseudoparenchymous wall. The wall of pycnidium is called peridium (pl. peridia; G. peridion=small leather pouch) and it is composed of multicellular layer, as fungal tissues. Pycnidia may formed superficially or sunken in the substratum. They may be formed directly by the loose mycelium or may be definitely stromatic.




**d. Acervulus**

Acervulus (pl. acervuli) is a fruiting structure commonly found in the order Melanconiales (Deuteromycotina). It is typically a flat or saucer-shaped mass of aggregated hyphae bearing short conidiophores in a compact layer. Intermingled with the conidiophores, setae (sing. seta; L. seta = bristle) are found. Setae are long, pointed, dark coloured, sterile structures. In nature acervuli are produced on plant tissues subepidermally or subcuticularly and becomes erumpent on maturity. e.g. Colletotrichum.




**Sorus**

Sorus (pl. sori; Gr. Soros = heap) is a little

heap of sporangia or spores. It may be naked or covered by a thin false membrane, as in smuts, or protected by the epidermis as in rust diseases or white blister or white rust (Albugo spp.). The structures break open at maturity and release the spores within, in the form of rust, which is characteristic of these diseases.

## 3. HORTICULTURE: POMOLOGY

# Eco Friendly Natural Farming Practices for Sustainable Fruit Production

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### Introduction

In modern agriculture, excess use of synthetic inputs leads to environmental degradation and agro ecological imbalances. Persistently higher usage of chemical fertilizers and pesticides has left residues in food produce and cause pollution of soil and water bodies besides reduced input efficiency. With ill effects of higher usage of synthetic chemicals and chemical fertilizers, farmers are looking for alternate farming practices which are ecofriendly, affordable and enhance or maintain the productivity sustainably.

'Natural farming' means farming with nature and without the use chemicals. In ZBNF mulching, soil protection techniques, natural pesticides and plant nutrition through natural means are practiced. The principal methods of ZBNF include crop rotation, green manures and compost, biological pest control, and mechanical cultivation. There are four pillars of zero budget natural farming *i.e.* Jeevamrutha (microbial culture), Beejamrutha (seed treatment), Achhadana (Mulching) and Wapasa (the condition where there exist both air molecules and water molecules in the soil in equal proportion) and also gave the pest management practices using plant and cow based extracts.

### Jeevamrutha application

Jeevamrutha (fermented microbial culture) is an important input in NF which is prepared from available farm wastes like cattle dung and cattle urine along with other ingredients like jaggery, pulse flour and water. It is an important organic liquid formulation which provides a congenial environment to microorganisms upon its application to soil which helps in making essential nutrients (nitrogen, phosphorus and potassium) available for plant growth and development.

**Procedure for Preparation of Jeevamrutha**: Jeevamrutha was prepared by mixing 10 kg desi cow dung, 10 litre desi cow urine, 2 kg local organic jaggery, 2 kg pulse flour and handful of soil collected from native farm. All these inputs were put in 250 litre capacity plastic drum and mixed thoroughly and volume was made up to 200 litre with water. The mixture was stirred well in clock wise direction and kept in shade covered with wet jute bags. The solution was regularly stirred in clockwise direction in the morning and in the evening continuously and can be used for 3 to 5 days of preparation during summer and 5-7 days of preparation in winter season for soil application.(Palekar, 2006). Jeevamrutha was applied as per the treatments and schedule at regular intervals.

### Ghanajeevamrutha application

Ghanajeevamrutha is another input in NF which also works on the same principle like jeevamrutha but, it is in solid form. When applied to the field, in similar manner as that of organic manure application, it enriches the soil and plant health besides providing all the nutrients required for growth of the plant. Ghanajeevamrutha is usually recommended for dry land/rainfed areas where there is a scarcity of water and labour to prepare liquid jeevamrutha and it can be used as a substitute for farm yard manure in such areas. It is a rich source of

nitrogen and valuable micro-organisms which naturally enhances soil fertility.

### Procedure for Preparation of Ghanajeevamrutha:

Ghanajeevamrutha was prepared by spreading 100 kg of desi cow dung on ground uniformly in the form of layer and add 2 kg powdered organic jaggery, 2 kg pulse flour, required quantity of cow urine (for easy mixing) and handful of soil from the farm bund soil (undisturbed soil) and mix it properly. Now, make a heap of treated cow dung and cover it using jute bag for 48 hours allow it for fermentation then spread on the floor, dry in the shade. After drying is completed, store it in jute bags in the room. Ghana jeevamrutham can be stored for 6 months (Palekar, 2006).

### Beejamrutha application

Beejamrutha is another important input in natural farming which is prepared using fresh cow dung, Cow urine, lime and water. It was used for seed treatment and to treat seedlings and cuttings as a germination enhancer and to reduce the incidence of soil and seed born pests.

### Achhadana (Mulching)

Mulching with organic residues or crop waste residues was practiced by the farmers since ancient times. Mulching had a various advantages like suppression of weeds, maintaining the soil moisture, maintaining soil temperature, reduces excess soil evaporation, reduced leeching and runoff losses of nutrients and also adds organic matter in to the soil upon decomposition.

### Wapasa

Wapasa is the condition where there exist both air molecules and water molecules in the soil in equal proportion which helps in proper aeration of soil and also provide congenial condition for biological activities in the soil.

### Conclusion

Adoption of natural farming principles in fruit production, not only help enhance the yield and quality of the produce but also help in enriching soil physico-chemical and biological properties besides managing the diseases and pests by natural means.


## 4. SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

# Functions and Deficiency Symptoms of Ca, Mg and S

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### Introduction

Plants, like all other living things, need food for their growth and development. Plants require 16 essential elements. Carbon, hydrogen, and oxygen are derived from the atmosphere and soil water. The remaining 13 essential elements (nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, zinc, manganese, copper, boron, molybdenum, and chlorine) are supplied either from soil minerals and soil organic matter or by organic or inorganic fertilizers. For plants to utilize these nutrients efficiently, light, heat, and water must be adequately supplied. Cultural practices and control of diseases and insects also play important roles in crop production. Each type of plant is unique and has an optimum nutrient range as well as a minimum requirement level. Below this minimum level, plants start to show nutrient deficiency symptoms. Excessive nutrient uptake can also cause poor growth because of toxicity. Therefore,

the proper amount of application and the placement of nutrients is important. Soil and plant tissue tests have been developed to assess the nutrient content of both the soil and plants. By analyzing this information, plant scientists can determine the nutrient need of a given plant in a given soil. In addition to the levels of plant-available nutrients in soils, the soil pH plays an important role in nutrient availability and elemental toxicity. This chapter describes the essential nutrients, the chemical forms in which they are available to plants, their function in plants, symptoms of their deficiencies and recommended nutrient levels in plant tissues of selected crops.

## Calcium

Symbol: Ca; available to plants as ion $Ca^{+2}$.

### *Nutrient functions*

- Ca has a major role in the formation of the cell wall membrane and its plasticity, affecting normal cell division by maintaining cell integrity and membrane permeability.
- Ca is an activator of several enzyme systems in protein synthesis and carbohydrate transfer.
- Ca combines with anions including organic acids, sulfates, and phosphates. It acts as a detoxifying agent by neutralizing organic acids in plants.
- Ca is essential for seed production in peanuts.
- Ca indirectly assists in improving crop yields by reducing soil acidity when soils are limed.

### *Deficiency symptoms*

- Ca is not mobile and is not translocated in the plant, so symptoms first appear on the younger leaves and leaf tips. The growing tips of roots and leaves turn brown and die.
- Ca deficiency is not often observed in plants because secondary effects of high acidity resulting from soil calcium deficiency usually limit growth, precluding expressions of Ca deficiency symptoms.
- Without adequate Ca, which in the form of calcium pectate is needed to form rigid cell walls, newly emerging leaves may stick together at the margins, which causes tearing as the leaves expand and unfurl. This may also cause the stem structure to be weakened.
- In some crops, younger leaves may be cupped and crinkled, with the terminal bud deteriorating.
- Buds and blossoms fall prematurely in some crops.

## Magnesium

symbol: Mg; available to plants as the ion $Mg^{2+}$

### *Nutrient functions*

- The predominant role of Mg is as a major constituent of the chlorophyll molecule, and it is therefore actively involved in photosynthesis.
- Mg is a co-factor in several enzymatic reactions that activate the phosphorylation processes.
- Mg is required to stabilize ribosome particles andalso helps stabilize the structure of nucleic acids.
- Mg assists the movement of sugars within a plant.

### *Deficiency symptoms*

- Because Mg is a mobile element and part of the chlorophyll molecule, the deficiency symptom of interveinal chlorosis first appears in older leaves. Leaf tissue between the veins may be yellowish, bronze, or reddish, while the leaf veins remain green. Corn leaves appear yellow-striped with green veins, while crops such as potatoes, tomatoes, soybeans, and cabbage show orange-yellow color with green veins.
- In severe cases, symptoms may appear on younger leaves and cause premature leaf drop.
- Symptoms occur most frequently in acid soils and soils receiving high amounts of K fertilizer or Ca.

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**Sulfur**

Symbol: S; available to plants as the sulfate ion, $SO_4^{2-}$

***Nutrient functions***

- S is essential in forming plant proteins because it is a constituent of certain amino acids.
- It is actively involved in metabolism of the B vitamins biotin and thiamine and co-enzyme A.
- S aids in seed production, chlorophyll formation, nodule formation in legumes, and stabilizing protein structure.

***Deficiency symptoms***

- Younger leaves are chlorotic with evenly, lightly colored veins. In some plants (e.g., citrus) the older leaves may show symptoms first. However, deficiency is not commonly found in most plants.
- Growth rate is retarded and maturity is delayed.
- Plant stems are stiff, thin, and woody.
- Symptoms may be similar to N deficiency and are most often found in sandy soils that are low in organic matter and receive moderate to heavy rainfall.

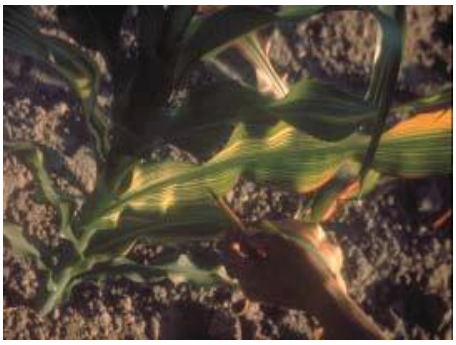
Calcium deficient tomato; young leaves become twisted and cupped.

Calcium deficient corn leaves fail to unfold.

Bean leaves have chlorotic and necrotic spots.

Magnesium deficient soybean; interveinal chlorosis of older leaves.

Magnesium deficient sweetpotato leaves become reddish-purple



Magnesium deficient corn; interveinal chlorosis of older leaves.

Sulfur deficient banana; young leaves are uniformly chlorotic.

Sulfur deficient tomato; young leaves are uniformly chlorotic.

## 5. AGRICULTURAL SCIENCES

# Plant Growth Promoting Rhizobacteria

**A.Sudha**

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Plant growth promoting rhizobacteria are bacteria that colonize plant roots, and in doing so, they promote plant growth and/or reduce disease or insect damage. There has been much research interest in PGPR and there is now an increasing number of PGPR being commercialized for crops. Organic growers may have been promoting these bacteria without knowing it. The addition of compost and compost teas promote existing PGPR and may introduce additional helpful bacteria to the field. The absence of pesticides and the more complex organic rotations likely promote existing populations of these beneficial bacteria. However, it is also possible to inoculate seeds with bacteria that increase the availability of nutrients, including solubilizing phosphate, potassium , oxidizing sulphur, fixing nitrogen, chelating iron and copper. Phosphorus (P) frequently limits crop growth in organic production. Nitrogen fixing bacteria are miniature of urea factories, turning N2 gas from the atmosphere into plant available amines and ammonium via a specific and unique enzyme they possess called nitrogenase. Although there are many bacteria in the soil that 'cycle' nitrogen from organic material, it is only this small group of specialized nitrogen fixing bacteria that can 'fix' atmospheric nitrogen in the soil. Arbuscular mycorrhizal fungi (AMF) are root symbiotic fungi improving plant stress resistance to abiotic factors such as

phosphorus deficiency or deshydratation.

The fourth major plant nutrient after N, P and K is sulphur (S). Although elemental sulphur, gypsum and other sulphur bearing mined minerals are approved for organic production, the sulphur must be transformed (or oxidized) by bacteria into sulphate before it is available for plants. Special groups of microorganisms can make sulphur more available, and do occur naturally in most soils.

One of the most common ways that PGPR improve nutrient uptake for plants is by altering plant hormone levels. This changes root growth and shape by increasing root branching, root mass, root length, and/or the amount of root hairs. This leads to greater root surface area, which in turn, helps it to absorb more nutrients.

***Disease control***

PGPR have attracted much attention in their role in reducing plant diseases. Although the full potential has not been reached yet, the work to date is very promising and may offer organic growers some of their first effective control of serious plant diseases. Some PGPR, especially if they are inoculated on the seed before planting, are able to establish themselves on the crop roots. They use scarce resources, and thereby prevent or limit the growth of pathogenic microorganisms. Even if nutrients are not limiting, the establishment of benign or beneficial organisms on the roots limits the chance that a pathogenic organism that arrives later will find space to become established. Numerous rhizosphere organisms are capable of producing compounds that are toxic to pathogens like HCN

## Challenges with PGPR

One of the challenges of using PGPR is natural variation. It is difficult to predict how an organism may respond when placed in the field (compared to the controlled environment of a laboratory. Another challenge is that PGPR are living organisms. They must be able to be propagated artificially and produced in a manner to optimize their viability and biological activity until field application. Like Rhizobia, PGPR bacteria will not live forever in a soil, and over time growers will need to re-inoculate seeds to bring back populations.

## PGPR in Research

Over the years the PGPR (plant growth promoting rhizobacteria) have gained worldwide importance and acceptance for agricultural benefits. These microorganisms are the potential tools for sustainable agriculture and the trend for the future. Scientific researchers involve multidisciplinary approaches to understand adaptation of PGPR to the rhizosphere, mechanisms of root colonization, effects of plant physiology and growth, biofertilization, induced systemic resistance, biocontrol of plant pathogens, production of determinants etc. Biodiversity of PGPR and mechanisms of action for the different groups: diazotrophs, bacilli, pseudomonads, Trichoderma, AMF, rhizobia, Phosphate solubilising bacteria and fungi, Lignin degrading , chitin degrading , cellulose degrading bacteria and fungi are shown. Effects of physical, chemical and biological factors on root colonization and the proteomics perspective on biocontrol and plant defense have also shown positive results. Visualization of interactions of pathogens and biocontrol agents on plant roots using autofluorescent protein makers has provided more understanding of biocontrol processes with overall positive consequences.

## Ways that PGPR promote plant growth

- Increasing nitrogen fixation in legumes
- Promoting free-living nitrogen-fixing bacteria
- Increasing supply of other nutrients, such as phosphorus, sulphur, iron and copper
- Producing plant hormones
- Enhancing other beneficial bacteria or fungi
- Controlling fungal diseases
- Controlling bacterial diseases
- Controlling insect pest.

## 6. AGRICULUTRAL SCIENCES

# Boom and Burst Cycle

**A.Sudha**

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In varietial improvement programmes, it is easy to incorporate the monogenic vertical resistance genes. But the success of exploiting the monogenic host resistance invariably does not last long. Whenever a single gene-based resistant variety is widely adopted, the impact would be the arrival of new matching pathotypes. These pathotypes soon build up in population to create epidemics and eventually the variety is withdrawn. This phenomenon is generally called " boom and burst". The avoid the implications of boom and burst phenomenon, use of durable host resistance is advocated in several crops. Durable resistance remains effective even though it may be widely grown ovoer a long period of time, in an environment that favours the disease. For example, oat variety, Red Rust Proof is still resistant against crown rust even after a hundred years. Wheat varieties, Thatcher and Lee have withstood stem rust for 55 and 30 years, respectively. Cappelle Desprez expresses at adult stage, a moderate resistance to yellow rust and this has been maintained for the last 20 years.

Two of the genes like Lr34 for resistance of leaf rust and Sr2 for resistance to stem rust have been recognized for durability. Wheat cultivars such as HD2189, HP1102, DL153-2, DL803-3 and DL802-2, which possess Lr34 with other gene combinations have a good degree of resistance and hae become popular with growers. So far, there is not precise way available to identify the genetic components that are associated with durable resistance. Nor does dissociation of genes for virulence totally explain the basis of varietal durability, though it is likely to be the most plausible reason Boom and burst cycle-a characteristic of vertical resistance Resistance to virus and virus vectors Resistane to plant pathogenic viruses is generally oligogenic in nature.

For example, the host pathogen reaction to the barley yellow dwarf virus (BYDV) is controlled by detectable single gene. The discovery of Yd2 gene in Ethiopial barley further confirms that against some of the viral diseases, vertical resistance is very much functional. Antiobiotics is the most common phemomenon where the host plant metabolites interfere with the normal life and growth of the insects following feeding activity.

Invariably, the adult body weight, fecundity and various facets of multiplication of the insects are adversely affected. The number of life cycles completed in a given period of time is also less. Therefore, in plants that exhibit antibiosis towards crop maturity, there is marked reduction in the level of pest infestation (virus vector population) and host damage. Mechanism of disease resistance or Nature of disease resistance Disease resistance is governed by several inbuilt mechanisms of the host, plants against infection by the pathogen. They are disease escape, disease endurance or tolerance and true resistance.

### Disease Escape

It is a prevention mechanism that causes the host to escape pathogenic infection. Early or late maturity of the crop may prevent physical contact of the pathogen with the host. Mechanical and anatomical barriers such as thick cuticle, waxy bloom on leaves and stem, stomatal regulation prevent penetration of spores. Ergot, a fungal disease of inflorescence in cereals caused by Claviceps purpurea does not affect varieties of wheat and barley in which the flowers remain closed until pollination occurs. Erect leaves of barley avoid deposition of spores of Erysiphe graminis tritici in contrast to prostrate leaves. Early maturing varieties of groundnut escape early leaf spot infection (Cercospora arachidicola) and early varieties of wheat escape rust and loose smut infection.

A change in planting season has also been successfully employed as a measure of securing escape, e.g., the leaf rust of sugarcane (Puccinia sacchari) in the canal areas of Bombay severely affects cane when planted in June, but is of minor

importance or absent in crops sown in October. Disease escape confers pseudo-resistance.

**Disease Endurance**

The host after being infected by the pathogen tolerates the infection and suffers less damage. It does not result in any substantial decrease in yield. This is brought about by influence of external factors. It is a well-known phenomenon that plants fertilized with phosphatic and potash manures are more tolerant to disease; this is the case in wheat against rust infection. Rice crops fertilized by silicates are "resistant" to blast (Pyricularia oryzae) in Japan. Wheat crops fertilized by potash and phosphatic manures are highly tolerant to mildew and rust infection. The fertilizers act indirectly to arrest vegetative growth and promote early maturity, better straw and strengthening tissues to protect the plant which form a bulwark against pathogenic invasion.

**True Resistance**

It is the ability of the host plant to resist or withstand the attack of a pathogen. True resistance is inheritable and much less subject to environmental influence. It is specific in character. The basis of resistance may be morphological, functional, structural or protoplasmic. Functional nature of resistance is determined by opening of the stomata, time of opening of flowers and time of maturity, rate of cork formation and cambial activity.

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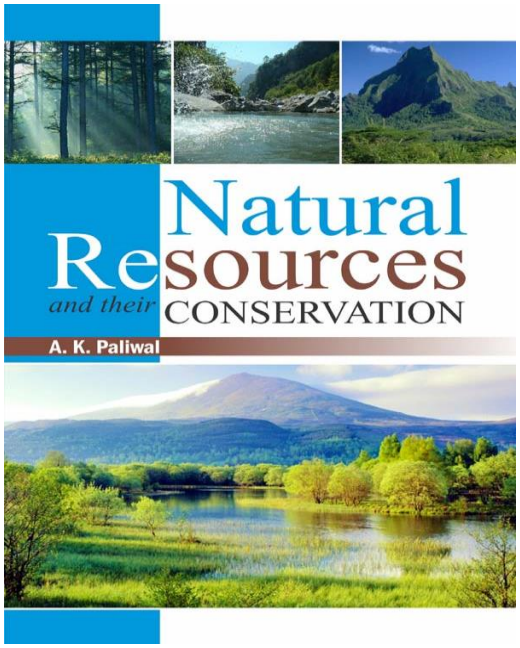


## 7. SOIL SCIENCE

# Phytoremediation: A State of Art for Cleaning Environment.

**Stephen chatragadda**

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Phytoremediation is an amalgam of the Greek Phyto-Plant and Latin remedium - restoring balance. (https://wikipedia.org). So, it is referred and defined as the use of green plants and the associated micro-organisms, (like algal example: Thalassiosira weissflogii and thalassiosira Pseudonana) to reduce the concentration or toxic effects of contaminants in Environment. Phytoremediation is widely accepted as a Cost-effective environmental restoration technology as it uses technologies like living plants to clean up soil, air, and water contaminated with hazardous Contaminants.

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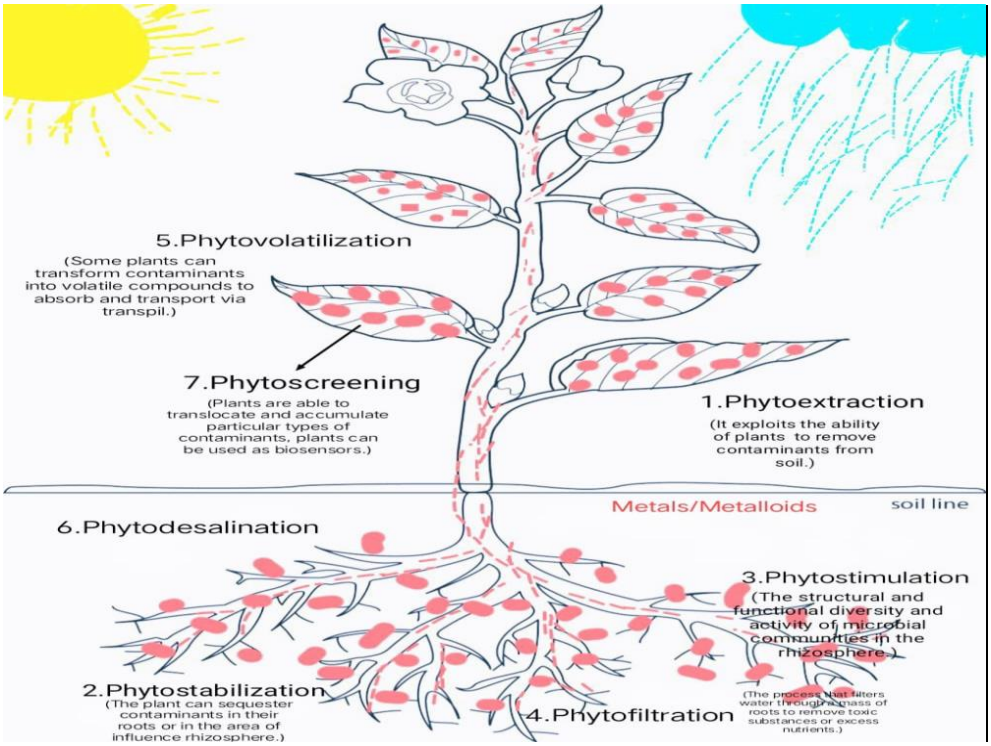


| Types | Description |
|---|---|
| 1.Phytoextraction: | It exploits the ability of plants or algae to remove contaminants from soil or water into harvestable plant biomass. The plant biomass that can uptake high amounts of contaminants are called hyperaccumulators (eg: Lupinus angustifolius, Medicago sativa). Hyperaccumulating plants are often metallophyte. This plant can be burned to produce metal-enriched ash or to obtain a bio-ore of economic value. This process is known as Phyto-mining. |
| 2.Phytostabilization: | Using diverse mechanisms the plant can sequester or immobilize contaminants in their roots or in the area of influence rhizosphere (eg: Pteris vittate, Ricinus communis). |
| 3.Phytostimulation /Phytodegradation: | Plant roots release root exudates (including enzymes) into the surrounding soil (the rhizosphere), stimulating the structural and functional diversity and activity of microbial communities in the rhizosphere that contribute to the degradation of organic contaminants (eg: Festuca rubra). |

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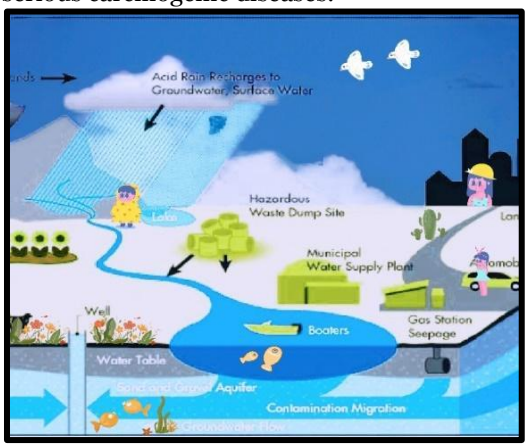
| | |
|---|---|
| 4.Phytofiltration: | A process that filters water through a mass of roots to remove toxic substances or excess nutrients. This process is often used to clean up contaminated groundwater through planting directly in the contaminated site (eg: Secale cereale). |
| 5.Phytovolatilization: | Some plants can transform contaminants into volatile compounds to absorb and transport via transpil. volatile compounds from the soil to the above ground biomass where they can then be released into the atmosphere (eg: Cotton wood). |
| 6.Phytodesalination: | Phyto desalination uses halophytes (plants adapted to saline soil) to extract salt from the soil and to improve its fertility (eg: Spartina alterniflora). |
| 7.Phytoscreening: | As plants are able to translocate and accumulate particular types of contaminants, plants can be used as biosensors. Biosensors: They are devices that are used to detect the presence or concentration of contaminants in the environment. |

## Sources of contamination:

Heavy metal pollution has emerged due to anthropogenic activity which is the primary Source of pollution. These are inorganic pollutants which are being discovered in our waters, soils and into atmosphere due to rapid growth of metal and agricultural industries, improper waste disposal, fertilizers, and pesticides. These metals affects both animals, plants and environment biological functions and growth, they accumulate in one or more different organs Carving many serious carcinogenic diseases.




## Impact on human

The Times of India Reported on December 8, 2020, Heavy metal Content in water Caused mysterious disease in Andhra Pradesh, Eluru district. Lead and nickel content in drinking water and milk was primarily established as the root cause of the mysterious disease, which so far claimed over 600 people reported multiple neurological problems. The disease saw people suddenly falling unconscious after suffering from fits, nausea, 3-5 minutes memory loss for a few minutes, anxiety, vomiting, headache and back pain. (https://timesofindia.indiatimes.com)

The analyst has given a report that hundreds of cultivation land, animals, plants, water, and atmosphere were being highly polluted. Research from the national institute of nutrition, published a paper identifying triazophos an organophosphate pesticide that works by damaging an enzyme in the body called acetylcholinesterase. This enzyme is critical for the controlling reverse signals in the body. The damage to this enzyme kills pests and caused unwanted side effects on humans.

**Inimical effects on environment**

The ecosystem is being ruined to the fact that the heavy metals are entering the food chain. Heavy metals also affect the biodegradability of organic pollutants, making them less degradable and thus causing double the effect of polluting the environment.
(https://www.sciencedirect.com)

**Fringe Benefits**

Phytoremediation is proposed as a cost-effective plant-based approach of environmental remediation that takes advantage of the ability of plants to concentrate elements and compounds from the environment and to detoxify various compounds.

1. The cost of the phytoremediation is lower than that of traditional processes both in-situ and ex-situ.
2. The possibility of the recovery and re-use of valuable metals (by companies specializing in "Phyto-mining")
3. The use of plants also reduces erosion and metal leaching in the soil.
4. It preserves topsoil, maintaining the fertility of the soil, increase soil health, yield, and plant phytochemicals.

***Conclusion***

With reference to Phytoremediation both government and individual have to take initiative, government should enforce industries and abandoned mines to plant Phytoremediation plants. As International Journal of Molecular Sciences has published, heavy metals affect not only industrial sites but also cultivated land, spreading risks for human health.

(https://land8.com/5-best-plants-for-phytoremediation/)

***a) White Willow (Salix species)***

These plants have a more interesting use for phytoremediation:

***b) Populus deltoides (cottonwood)***

The advantageous effect of poplar trees on soil and underwater has also been widely studied. Their secret lies in the naturally well-designed root system which take up large quantities of water and that helps in phytoremediation

***c) Helianthus annus (Sunflower)***

Experiments like Influence of the sunflower rhizosphere on the biodegradation of PAHs (Polycyclic aromatic hydrocarbons) in soil reveals that sunflowers reduce different PAHs level from soil.

***d) Sorghastrum nutans (Indian grass)***

Indian grass is one of the nine members of the graminae family identified by Phyto Pet (Bioremediation of Aquatic and Terrestrial Ecosystems), as capable to remediate petroleum hydrocarbons.

**Refernces**

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http://The Times of India December 8, 2020.eluru mysterious disease
https://land8.com/5-best-plants-for-phytoremediati

## 8. AGRICUTURE

# Spiny Gourd
# An Underutilized Vegetable with High Nutrition

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Momordica dioica is a perennial vegetable crop. It is dioecious in nature which means that it has separate male and female individual organisms, cucurbitaceous climbing creeper (also known as kakrol, spiny gourd or teasle gourd). It is native to Asia with extensive spread in India, Srilanka, Bangladesh, China, Nepal, Myanmar and Pakistan. In Indian *Momordica*, there are six well known species of which four are dioecious and two are monoecious.

Momordica dioica genus is originated from Indo-Malayan region, now it is found to grow in India, Bangladesh, Srilanka, Myanmar, China, Japan, South East Asia, Polynesia, Tropical Africa, and South America. It is considered as an underutilized summer vegetable compared to vegetables in cucurbitaceous family. It is propagated by underground tubers. It has small leaves, small yellow flowers, it has small, dark green, round or oval fruits. The fruit length is 5 to 7 meters. Various plant parts are consumed in a variety of ways, viz., immature green fruits are cooked as vegetable, young leaves and flowers are also eaten. It is used as a vegetable in all regions of India and some parts in South Asia. It has commercial importance and is exported and used locally.

Momordica dioica has high demand in market but still remain underutilized and underexploited (Bharathi et al. 2007; Ali et al. 1991) mainly due to its vegetative mode of propagation and dioecious nature. Conventional commercial propagation of spine gourd largely depends on tuberous roots (Nabi et al. 2002), followed by stem cuttings, and seeds. Commercial multiplication using the tuberous roots and stem cuttings are critically limited due to inadequate availability of tuberous roots and late availability of stem cuttings in fruiting season.

Tuberous roots have low multiplication rate (Mondal et al. 2006) and occupies the valuable cultivable land until next planting season (Ram et al. 2001; Nabi et al. 2002). Stem cuttings containing 2–3 nodes from dark green vines of 2–3 months old plants are planted, but only 36 % of the plants sprout and survive (Ram et al. 2001). Difficulties in propagation by seeds are dormancy and unpredictable sex ratio in seedling progenies (Mondal et al. 2006; Ali et al. 1991). Male plants dominate natural populations and sex determination is possible only when the plants start flowering. Since fruits are the main edible portion of this species, which are harvested on female plants, it is desirable to have commercial fields with a large proportion of female plants. Accommodating 5–10 % male plants to act as pollinators in the field is imperative for good fruit set (Rasul et al. 2007).

Kantola can grow all type of soils, except the saline soil. It is also tolerant to low sun shine hours and high rainfall. For every 10*10 feet distance, prepare a pit of 1*1 width and length should be taken. Each pit is filled with top soil and farm yard manure. After that, sow the male and female tuber in alternative pit. After sowing, irrigate the field once in a week. Stake the plants 15 days after planting with 1 - 1.5 m tall stakes. Flowering starts 35 days after sowing. The plant starts to give yield 55 days after sowing. We can

get 50 to 60 kg yield per week.

In comparison to other cucurbitaceous vegetables, *Momordica dioica* fruits have the highest levels of carotene (162 mg/100 g of edible portion). They also include significant levels of proteins, calcium, phosphorus, iron, and other minerals. Furthermore, this species is valued for its various therapeutic and rejuvenating qualities.

Momordica dioica as the average nutritional value per 100 g edible fruit was found to contain 84.1 g moisture, 7.7 g carbohydrate, 3.1 g protein, 3.1 g fat, 3.0 g fiber and 1.1 g minerals. It also contained small amounts of carotene and vitamins like ascorbic acid, thiamine, riboflavin and niacin. It also contains protein in the leaves and dry weight of aerial plant parts remained higher in male as compared to female defruited and monoecious plants.

Luo et al. showed that the $CHCl_3$ extract of roots and five isolated constituents had anticancer activity during pharmacological testing on cancer cell. Shrinivas et al. studied methanolic extract and aqueous extract of fruit and found that methanolic extract had more promising antimicrobial activity. Shreedhar et al. reported the antifertility activity of ethanolic and aqueous extract of *Momordica dioica* root. The extracts showed moderate estrogenic activity and caused significant increase in uterine weight.

The higher incidence of diabetes, cancer, obesity, high blood pressure and neurodegenerative diseases around the world is becoming alarming for everyone. Enormous research is being conducted to find the causes and remedies of these. As a result, the search for a better alternative than synthetic drugs becomes the demand for time or need of the hour. As one of the world's most abundant sources of medicinal plants, South Asia offers a vast amount of medicinal plants, including Momordica dioica, which has several important folks uses.

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## 9. EXTENSION EDUCATION

# Self-Help Groups (SHGs) for Human Welfare

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**What is Self-help Groups (SHGs) –** Self-help Groups (SHGs) are informal associations of people who come together to find ways to improve their living conditions. They are generally self-governed and peer-controlled.

People of similar economic and social backgrounds associate generally with the help of any NGO or government agency and try to resolve their issues, and improve their living conditions.

### Objectives of Self-Help Groups:

- To inculcate the process of savings and banking habits among the members.
- To empower members financially, economically and socially.
- To enable obtaining of loan for productive purposes.
- To ensure economic prosperity through loan/credit disbursement.
- To gain from the collective wisdom involved in the organisation and management of own finances and distributing the various benefits among themselves.
- To enhance the confidence along with capabilities of women.
- To develop collective saving decisions among women.

- To encourage savings habit among women and make easy the accumulation of their own capital.
- To inspire women taking up various social responsibilities mainly related to women's all round development.
- It also acts as the forum for members to render space and support to one another.

## Types of self-help groups

Self-help groups come in different forms and address diverse life experiences and conditions.

***Examples are:***

- Recovery. These groups focus on gaining control of behaviors that may negatively affect your daily life or health, such as substance abuse disorder. Common examples are Alcoholics Anonymous (AA), Narcotics Anonymous (NA), or Twelve Step groups.
- Common challenging situations. Groups based around a shared life challenge, such as divorce or grief, with the goal of reducing stress and anxiety by sharing coping strategies and advice.
- Personal growth. The goal for members of these groups is improving your life through encouragement of growth and shared advice.
- Online groups. Support communities that exist online — either with a designated time to meet and a topic to discuss, or as a virtual forum that runs continuously — led by peers or a mental health professional.
- Groups for family members. These groups provide support and education for loved ones and relatives of people experiencing difficult health or life circumstances, such as Al-Alon.

## Characteristics of self-help groups:

Some common characteristics of self-help groups that are :

- Voluntary nature – they are run by and for group members, have regular meetings, and are open to new members.
- Generally being formed in response to a particular issue, e.g. no access to education for children with disabilities, limited income-generating opportunities.
- Clear goals, which originate from the needs of group members and are known and shared by all members.
- Informal structure and basic rules, regulations and guidelines to show members how to work effectively together;
- Participatory nature – involving getting help, sharing knowledge and experience, giving help, and learning to help oneself.
- Shared responsibility among group members – each member has a clear role and contributes his/her share of resources to the group.
- Democratic decision-making.
- Governance by members, using an external facilitator only if necessary in the formation of the group .
- Evolution over time to address a broader range of issues.
- Possibility of joining together to form a federation of groups across a wider area.

## Functions of self-help groups

- Initiate and maintain savings within the group: All members must regularly save at least a small amount. These savings allow them to get future credits for their group.
- Lending loans to the members: The savings made by the SHG must be used to provide loans to members of the group. Everything related to the loan must be decided within the group.
- Solving common problems: SHGs mostly consist of individuals who face similar problems. The grouping should essentially help the individual overcome these problems through discussions and interactions within the group and overcoming the problems and finding a common and united solution to the problems.

- Bank Loans: SHGs must work on getting a collective guarantee system so that they can avail of loans from official sources.
- It looks to build the functional capacity of the poor and the marginalized in the field of employment and income generating activities.
- It resolves conflicts through collective leadership and mutual discussion.
- It provides collateral free loan with terms decided by the group at the market driven rates.
- Such groups work as a collective guarantee system for members who propose to borrow from organized sources. The poor collect their savings and save it in banks. In return they receive easy access to loans with a small rate of interest to start their micro unit enterprise.

## Help in the formation of SHGs?

- Any local individual who has needed education or skills may help initiate the SHGs.
- This individual is involved in bringing together all those who are facing similar problems and advocating the benefits of the SHGs.
- This person is often called the "animator" or a "facilitator".
- He or She is usually well-known within the community.
- A woman animator can play a significant role in woman empowerment in rural India.
- However, the animator cannot bring the people together into the SHGs by himself/herself.
- They are assisted by the following agencies:
    - NGOs
    - Developmental departments of the state governments
    - Any of the locally available banks

## Why does India need SHGs?

- **The need to solve problems at the ground level:** India is a country that has a diverse culture, traditions, historical backgrounds, etc. Therefore, it is difficult for the government to solve the socio-economic problems by itself. Thus, bringing together the people who face similar problems may be a game-changer for the Indian economy.
- **Financial Inclusion:** According to the NSSO data, 51.4% of the farmer households are not able to have access to formal credit. This has led to many negative implications such as poverty, farmer suicides Many in India are not able to obtain loans due to the absence of collateral. SHGs can help solve this problem.

## Advantages of SHGs:

- Members can take loans from the groups savings themselves on a decided rate of interest. The rate of interest is much lower than the interest that is charged by the informal sources.
- After two years of regular savings, the SHG can also take a loan from the bank. The loan is given in the name of the group and creates tremendous opportunities for the self-employment of the members.
- Due to SHG, the poor members are able to avail of loans even in the absence of collateral.
- Many women as members of SHGs have become economically independent. This has led to women's empowerment at the rural levels.
- Not only do they help women become financially self-reliant, the regular meetings of the group provide a platform to discuss and act on a variety of social issues such as health, nutrition, domestic violence, etc.

Consequently, Self-Help Groups have emerged as the most effective mechanism for delivery of microfinance services to the poor.

**Disadvantages of SHGs**

- Too much dependence on government and NGOs: Many SHGs are dependent on the promoter agencies for their survival. In case these agencies withdraw their support, the SHGs are vulnerable to downfall.
- Lacks qualified facilitator: The facilitators do not have professional training with regard to organising SHGs.
- Lacks up-gradation of skills: Most SHGs are not making use of new technological innovations and skills. This is because there is limited awareness with regards to new technologies and they do not have the necessary skills to make use of the same. Furthermore, there is a lack of effective mechanisms that promote skill development in rural areas.
- SHGs are run by non-professionals: There is no professionalism within the SHGs. This does not promote the expansion and improvement of the SHGs. This does not allow for the increase of wages of the members and improvement in their living conditions. This also leads to errors in accounting and mismanagement of the funds.
- Lacks security: SHGs are mostly not registered. They are run based on the trust between the members. The savings made by the SHG members may not be safe, which brings in mistrust between the members.

## 10. AGRICULTURAL SCIENCES

# Applications of ARIMA in Agricultural Science Research

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**Introduction**

A time series is a set of observations obtained by measuring a single variable regularly over a period of time. One of the most important reasons for doing time series analysis is to try to forecast future values of the series. A model of the series that explained the past values may also predict whether and how much the next few values will increase or decrease. The ability to make such predictions successfully is obviously important to any business or scientific field. ARIMA, is a statistical analysis model that uses time series data to either better understand the data set or to predict future trends. ARIMA models rely heavily on autocorrelation patterns in the data. ARIMA models are regression models that use lagged values of the dependent variable and/or random disturbance term as explanatory variables.

**ARIMA in simple**

AR: Autoregression. A model that uses the dependent relationship between an observation and some number of lagged observations.

**I**: Integrated: The use of differencing of raw observations (i.e. subtracting an observation from an observation at the previous time step) in order to make the time series stationary.

**MA**: Moving Average. A model that uses the dependency between an observation and residual errors from a moving average model applied to lagged observations.

A standard notation is used of ARIMA (p,d,q) where the parameters are substituted with integer values to quickly indicate the specific ARIMA model being used.

The parameters of the ARIMA model are defined as follows:

**p**: The number of lag observations included in the model, also called the lag order.

**d**: The number of times that the raw observations are differenced, also called the degree of differencing.

***q*:** The size of the moving average window, also called the order of moving average.

The original model uses an iterative three-stage modeling approach:

1. **Model identification and model selection:** making sure that the variables are stationary, identifying seasonality in the dependent series (seasonally differencing it if necessary), and using plots of the autocorrelation (ACF) and partial autocorrelation (PACF) functions of the dependent time series to decide which (if any) autoregressive or moving average component should be used in the model.
2. **Parameter estimation** using computation algorithms to arrive at coefficients that best fit the selected ARIMA model. The most common methods use maximum likelihood estimation or non-linear least-squares estimation.
3. **Statistical model checking** by testing whether the estimated model conforms to the specifications of a stationary univariate process. In particular, the residuals should be independent of each other and constant in mean and variance over time. (Plotting the mean and variance of residuals over time and performing a Ljung–Box test or plotting autocorrelation and partial autocorrelation of the residuals are helpful to identify misspecification.) If the estimation is inadequate, we have to return to step one and attempt to build a better model.

## Application of ARIMA model in Agricultural Sector

ARIMA models have wide application in agricultural sector, especially in the fields of social sciences such as economics, business management and administration, statistics and extension education. They are mostly used for forecasting of prices, export and import of commodities, stock exchange, weather parameters estimation, yield forecasting, pest and disease incidence forecasting.

## Some salient features of ARIMA models

1. They are Mathematical models.
2. They are widely used in Economics, Planning, Hydrology, Dendrochronology and many other fields.
3. Predictions based on these models are more reliable in comparison with other methods.

## Examples

- Area, production and productivity of different crops for a specific region can be forecasted
- Pest incidence/outbreak can be forecasted for the region under study
- Forecasting the prices of various commodities for traders and investors
- Forecasting export of different agro-products in order to plan strategies regarding export

## Conclusion

**ARIMA** analysis is time series model, which is widely used in forecasting analysis to know the predicted values provide complementary approaches to the problem. They are also referred to as Box-Jenkins models, due to the systematic methodology of identifying, fitting, checking, and utilizing ARIMA models, which was popularized by George Box and Gwilym Jenkins in 1976. These models are mainly based on autocorrelations in the data. ARIMA models have wide application in agricultural sector in general and in economics, management (Business and Administration) and statistics in particular.

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## 11. PLANT BREEDING

# Counting on Crossovers: Controlled Recombination for Crop Improvement

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### Introduction

Plant breeders rely on natural recombination of genetic information during COs to generate novel and favorable haplotypes. A minimum of one CO for each chromosome pair, termed the obligate CO, is required for proper segregation, and three COs are rarely exceeded per meiosis (Taagen *et al*., 2020).

Manipulation of pro- and anti-CO factors, the use of site-directed nucleases and epigenetic modifiers, are novel and increasingly applicable approaches for manipulating the recombination or CO frequency and distribution. These approaches collectively referred as 'controlled recombination'. Controlled recombination has potential to reduce the cost and time of high-resolution mapping to identify genes of interest. Likewise, it may facilitate reintroduction of genetic variance at sites of selective sweeps and introgression of diverse alleles from wild crop relatives for varietal development (Rey, *et al*., 2018). So, the mechanisms underlying recombination and CO patterns in plants are the concept to understand in context to manipulate crossover frequency and distribution and utilize it for the crop improvement.

### Case Studies

**Hayut et al. (2017)** planned targeted recombination between homologous chromosomes upon somatic induction of DNA double-strand breaks (DSBs) *via* CRISPR-Cas9. DSB induction between two alleles carrying different mutations in the Phytoene Synthase (*PSY1*) gene results in yellow fruits with wild type red sectors forming *via* HR-mediated DSB repair. In another assay, they demonstrated evidence of a somatically induced DSB in a cross between a *psy1* edible tomato mutant and wild type *Solanum pimpinellifolium*, targeting only the *S. pimpinellifolium* allele. This enables characterization of germinally transmitted targeted somatic HR events, demonstrating that somatically induced DSBs can be exploited for precise breeding of crops.

**Ru and Bernardo (2018)** used predicted gain from nontargeted recombination as the baseline, calculated relative gains from creating a doubled haploid with up to one targeted recombination [$RG_{(x \leq 1)}$] and two targeted recombinations [$RG_{(x \leq 2)}$] per chromosome or linkage group. Targeted recombination significantly ($P = 0.05$) increased the predicted genetic gain compared to nontargeted recombination for all traits and all populations, except for plant height in barley. The mean $RG_{(x \leq 1)}$ was 211%, whereas the mean $RG_{(x \leq 2)}$ was 243%. The predicted gain varied among traits and populations. So, results suggested that targeted recombination could double the genetic gains in both self-pollinated crops.

**De Maagd et al. (2017)** used CRISPR/Cas9-mutagenesis in an interspecific tomato hybrid to knockout *RecQ4*. A biallelic *recq4* mutant was obtained in the $F_1$ hybrid of Solanum lycopersicum and S. pimpinellifolium. Compared with the wild-type $F_1$ hybrid, the $F_1$ *recq4* mutant was shown to have a significant increase in crossovers: a 1.53-fold increase when directly observing ring bivalents in male meiocytes microscopically and a 1.8-fold extension of the genetic map when measured by analysing SNP markers in the progeny ($F_2$) plants. This demonstrated increasing crossover frequency in interspecific hybrids by manipulating genes in crossover intermediate resolution pathways by directed

mutagenesis.

**Wang et al. (2018)** used Virus-Induced gene Silencing (VIGS) to downregulate the expression of recombination-suppressing genes *XRCC2* and *FANCM* and of epigenetic maintenance genes *MET1* and *DDM1* during meiosis in $F_1$ hybrids of a cross between two tetraploid wheat lines. Recombination was measured in $F_2$ seedlings derived from $F_1$-infected plants and non-infected control and found significant up and down-regulation of CO rates along subtelomeric regions as a result of silencing either *MET1*, *DDM1* or *XRCC2* during meiosis. In addition, also found upto 93% increase in COs in *XRCC2*-VIGS treatment in the pericentric regions of some chromosomes. Overall, consequences showed that CO distribution was affected by VIGS treatments rather than the total number of COs which did not change.

## Conclusion

Strategies for 'controlled recombination' have potential to reduce the time and expense associated with traditional breeding, reveal currently inaccessible genetic diversity, and increase control over the inheritance of preferred haplotypes and thereby a reliable source for crop improvement.

In heterozygote plants containing one *psy1* allele immune and one sensitive to CRISPR, repair of the broken allele using the unbroken allele sequence template is a common outcome. A somatically induced DSB in a cross between a *psy1* edible tomato mutant and wild type *Solanum pimpinellifolium*, targeting only the *S. pimpinellifolium* allele. This enables characterization of germinally transmitted targeted somatic HR events, demonstrating that somatically induced DSBs can be exploited for precise breeding of crops.

The predicted gain varied for most traits and populations, having targeted recombination on all the chromosomes and led to the same or higher predicted gain than non-targeted recombination.So, on the basis of findings, it can be suggested that targeted recombination could double the genetic gains in both self- pollinated crops.

The $F_1$ *recq4* mutant was shown to have a significant increase in crossovers: a 1.53-fold increase when directly observing ring bivalents in meiocytes microscopically and a 1.8-fold extension of the genetic map when measured by analysing SNP markers in the progeny ($F_2$) plants suggesting, increasing crossover frequency in interspecific hybrids by manipulating genes in crossover intermediate resolution pathways by directed mutagenesis.

The VIGS method to silence meiotic anti CO genes and DNA methylation genes during meiosis, found a redistribution of recombination events in euchromatic and heterochromatic regions. Hence, this method can be used as a simple fast and non-GMO tool to modify the recombination landscape and enhance variation in certain regions for more efficient plant breeding.

## Future Thrust

- Stimulation of recombination by perturbation of pro- and anti-CO genes and epigenetic modifiers, and by targeting DSBs and epigenetic changes using genome editing tools, is a novel and promising set of approaches that should be explored for crop improvement
- The potential to dramatically decrease the time and cost required to identify causal variants, break undesired linkages of traits, and select preferred haplotypes is a compelling motivation to pursue further work in this area
- Future research should focus both on improving our basic understanding of recombination in plants and on translating the knowledge from model species to economically important crops. It will be particularly important to determine how controlled recombination can most efficiently increase genetic gain during the plant breeding cycle
- By accelerating fundamental understanding and practical advances in plant breeding, continued development and adoption of controlled recombination will lay a strong foundation for improving food security and human health

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## 12. HORTICULTURE

# Sensors for the Measurement of Soil Properties

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Sensors are a sophisticated agricultural device that are developed to assist farmers in determining various soil qualities and to help them get results faster and better. These sensors can be used to create field maps of specific soil qualities and also for real-time control of variable rate application equipment using a Global Positioning System (GPS). Apart from generating maps, these sensors are also utilized to measure several important soil parameters. Different types of sensors are created in recent days and its benefits in analysing soil characteristics are vividly explained in the following passages.

### Types of Sensors

- Electromagnetic sensors
- Electrochemical sensors
- Mechanical sensors
- Optical sensors
- Radiometric sensors
- Pneumatic sensors
- Acoustic sensors

#### *Electromagnetic sensors*

A variety of soil parameters, including soil texture, cation exchange capacity (CEC), drainage conditions, organic matter content, salinity, and subsurface features are measured by electromagnetic sensors. The sensors detect the ability of soil particles to conduct or acquire electrical charge using electric circuits. With respect to measure soil EC, there are two ways that electromagnetic sensors assess it, they are contact and non-contact.

The electrodes used in the contact approach penetrated in to the soil. The sensor is mounted on a machine that is pulled by a tractor or other vehicle that has a GPS receiver. It is an extensively utilized in soil measurement technique due to its capacity to deliver an accurate mapping of the entire field. The sole drawback is that it cannot be used for too large or too small land holdings

The non-contact method uses electromagnetic induction (EM) which does not make physical contact with the soil. The sensor is usually installed on the opposite side of a vehicle or a tractor and equipped with a GPS receiver. Measured soil EC has no direct effect on crop growth or yield. However, based on a measured soil data, a farmer can easily determine specific soil properties which may affect the crop yield

#### *Electrochemical Sensors*

The most important soil properties for precision management *viz*., pH and soil nutrient levels, are measured by electrochemical sensors. It is one of the best alternative to traditional chemical soil analysis, which is more expensive and time-consuming. These sensors assess the voltage between the sensing and reference parts of the system in relation to the concentration of particular ions ($H^+$, $K^+$, $NO^{3-}$), using an ion-selective electrode (ISE) or an ion-selective field effect transistor (ISFET). A soil sample is taken

by the soil sampling device, which then contacts an electrode with the sample. The electrode is cleaned before the subsequent measurement is made following a stable reading.

***Mechanical sensors***

In order to calculate soil mechanical resistance as it relates to the varying level of compaction, mechanical sensors are used. These sensors record the force detected by strain gauges or load cells using a device that penetrates or cuts through the soil. A sensor that is moving through the soil detects resistance forces brought on by the cutting, breaking, and displacing of the soil. The ratio of the force needed to penetrate the soil medium to the frontal area of the tool engaged with the soil is known as soil mechanical resistance, and it is expressed in units of pressure.

***Optical Sensors***

Optical sensors assess the soil's reflectance, absorption, and transmittance properties. They measure the soil organic matter, moisture, mineral content, clay content, soil colour, organic carbon, pH, and cation exchange capacity using light reflection. The soil's capacity to reflect light in various electromagnetic spectrum regions is measured by sensors. Wave reflection modifications might reveal modifications in soil density or limit soil layers. Four separate wavelengths are combined by optical sensors to assess certain soil properties: ultraviolet (100-400 nm), visible (400-700 nm), near-infrared (700-2500 nm), and mid-infrared (2500-25000 nm). Inorganic minerals (iron oxide) in the soil can be identified by combining visible and ultraviolet spectra.

***Radiometric sensors***

Radiometric sensors use the gamma-ray spectrometer to measure the distribution of the intensity of gamma (γ) radiation versus the energy of each photon. There are two types of radiometric sensors namely active and passive. Active γ-ray sensors use a radioactive source to emit photons of energy that can then be detected using a γ-ray, whereas passive sensors measure the energy of photons emitted from naturally occurring radioactive isotopes of the element from which they originate. Measured data is compared to the isotopes of potassium, uranium, and thorium in the soil, where the intensity of γ-ray is related to the elemental content in the soil

***Acoustic sensors***

Acoustic sensors are used to measure soil texture (sand, silt, clay), soil bulk density (compaction), and soil depth variability (depth of topsoil, depth to hardpan). They work by measuring the change in noise level due to the interaction of a tool with soil particles.

***Pneumatic Sensors***

Pneumatic sensors are the air flow sensors which measures soil-air permeability. It is the pressure required to force a given volume of air into the soil, at a certain depth. The measured data is compared to soil properties such as soil structure and compaction. This pneumatic sensor is a good alternative to mechanical sensors.

**Conclusion**

Soil productivity is limited by many different factors such as soil type, texture, organic matter content, and moisture. Therefore, there is a need to measure soil characteristics more accurately in order to make successful, data-driven decisions. Inadequate soil samplings and high cost are the main reasons to make a revolutionary change in farming, by using sensors. A sensor detects events or changes in soil characteristics and provides a corresponding output, indicated through an electrical or optical signal. Sensors can both improve the quality and reduce the cost of laboratory soil analysis, as well as improve crop management and overall crop production.

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## 13. AGRICULTURE

# Importance of Zero Budget Natural Farming (ZNBF)

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Zero Budget Natural Farming (ZNBF) means raising crops without using any fertilizers and pesticides or any other external materials. The word Zero Budget refers to the zero cost of production of all crops. It is not a new thing. We need to replicate this innovative model". Zero Budget Natural Farming (ZBNF) with no external inputs of any sort, including finance, has been advocated for decades by Padma Shri awardee Subhash Palekar. Zero-budget natural farming (ZBNF), popularised by Maharashtrian agriculturist and Padma Shri recipient Subhash Palekar, refers to the process of raising crops without using chemical fertilisers and pesticides or any other external materials. In short, ZBNF, is a farming method that believes in growing crops in tune with nature. The concept was promoted by agriculturist & Padma Shri awardee Subhash Palekar, in the mid-1990s as an alternative to the Green Revolution's methods driven by chemical fertilizers and pesticides and intensive irrigation. Government has been promoting organic farming under the dedicated scheme of Paramparagat Krishi Vikas Yojana (PKVY) which encourages all kinds of chemical-free farming systems including Zero Budget Natural Farming. During his address to the farmers at the National Conclave on Natural Farming on 16 December, 2021 Prime Minister Shri Narendra Modi remarked that "we need not only to re-learn this ancient knowledge of agriculture but also to sharpen it for modern times. In this direction, we have to do research afresh, mould ancient knowledge into the modern scientific frame". The Prime Minister said that those who will benefit the most from natural farming, constitute about 80% of the farmers of the country. He urged every state, every state government, to come forward to make natural farming a Jan Andolan. In this AmritMahotsav, efforts should be made to associate at least one village of every panchayat with natural farming, he insisted.

An area of 4.09 lakh ha area has been covered under natural farming and a total fund of Rs. 4980.99 lakh has been released to 8 States namely Andhra Pradesh, Chhattisgarh, Kerala, Himachal Pradesh, Jharkhand, Odisha, Madhya Pradesh and Tamil Nadu while an area of 5.68 lakh ha have also been approved for 3 States namely Andhra Pradesh, Rajasthan & Uttar Pradesh (This information was given in a written reply by the Union Minister of Agriculture and Farmers Welfare Shri Narendra Singh Tomar in Lok Sabha on March 29, 2022 ).

## Objectives

Mainly ZBNF is work on the objective of reduces farming expenses and promotes the use of natural fertilizers and local seeds. It uses biological pesticides. To crop protection, farmers can use natural compounds like, cow dung, urine, human excreta, plants, natural fertilizers, and earthworms. It protects the soil from degradation and decreases the farmer's investment.

## Principles of Zero Budget Natural Farming

- No external inputs.
- Soil to be covered with crops 365 days (Living Root)
- Minimal disturbance of Soil.
- Biostimulantsas necessary catalysts.
- Use indigenous seed.
- Mixed cropping.
- Integration of trees into the farm.
- Water and moisture conservation.

## Four Pillars of Zero Budget Natural Farming

### *Jeevamruth*

Jeevamrutha is a natural liquid fertilizer. It is made by mixing water, dung (in the form of manure) and urine from cows with some mud from the same area as. Jeevamrutha is prepared by mixing 10 kg local cow dung with 10 litres cow urine, add 2 kg local jaggery, 2 kg pulse flour and handful of garden soil and the volume made upto 200 litres. Keep the drum in shade covering with wet gunny bag and stir the mixture clockwise thrice a day and incubate.

### *Bijamrita*

Bijamrita is a technique of seed treatment from locally available ingredients including local desi cow urine and cow dung. Use cow urine 250 ml for one liter of water. Use Cow

dung 250 grams for one liter of water. Use Lime 2.5 g per liter of water. Use soil-like dikes or clay bundles, which do not have any stone.

***Acchadana***

Acchadana/Mulching: Mulching is the process of covering the top soil with crop wastes/organic waste or with cover crops

***Whapsa***

Whapasa is a condition where water molecules and air molecules are present in the soil. It helps to reduce the extra irrigation requirement.

These are the basic and essential pillars of zero budget farming.

## Advantages

- ZBNF processes require 50–60 per cent less water and less electricity (than non-ZBNF) for all the selected crops.
- ZBNF reduces methane emissions significantly through multiple aeration. It also has the potential to avoid residue burning by practicing mulching.
- The cost of cultivation is lower in ZBNF.
- Improve Yield.
- Increased Farmers' income.
- Minimize cost of production and increase farmer's income.
- Ensure better health.
- Employment Generation.
- Eliminate the application of chemical inputs.
- Environment Conservation.
- Reduce Water Consumption.

## Disadvantages

Disadvantages of Zero Budget Natural Farming. This farming method used in some parts of India. The type of farming being debated, and there is not much scientific research under evaluation. It is highly sustainable farming. This farming technique used in negligible areas.

## Institutions that Supports ZBNF:-

Below are the organizations that supported zero budget natural farming in India.

- Isha sadhguru foundation
- The art of living foundation
- Karnataka Rajya Raitha Sangha
- Sony India private limited

## Government Schemes and Plans for ZBNF

- India's Legislature is advancing natural farming in the nation from 2015-16 through the traditional agricultural development plan's committed schemes and the National Agricultural Development Plan.
- In 2018, Andhra Pradesh started a plan to become the first state in India to practice 100% natural farming by 2024. It aims to carry out chemical farming on 80 lakh hectares of land by converting 60 lakh farmers of the state into ZBNF methods.
- In this context, the Government of Andhra Pradesh (GoAP) implemented a Zero Budget Natural Farming (ZBNF) Program in 2015-16 to enhance farmers' welfare and conserve the environment, ZBNF is a farming practice advocating the natural growth of crops without adding fertilizers and pesticides or any other foreign elements. Zero budget refers to the zero net cost of production of all crops.

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## 14. PLANT BREEDING AND GENETICS

# Crop Nutrient Enrichment through CRISPR-based Genome Editing: A Promising Strategy to Global Food Production

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### Introduction

Over one billion people worldwide are suffering from chronic hunger, while agricultural production is falling, exacerbated by biodiversity loss and the mounting problems of climate change. With the world population predicted to exceed 9 billion by 2050, modern agriculture will confront enormous challenges, demanding higher yields and increased crop quality while using fewer inputs. While conventional breeding is currently the most widely used method of plant improvement, it is time consuming and often takes many years to progress from the earliest stages of sampling phenotypes and genotypes to the first crosses into industrial varieties. The technique is now being used to bio fortifies cereal crops including rice, wheat, barley, and maize, as well as vegetable crops like potato and tomato. Crop genome editing using CRISPR-Cas has been used to impart/produce qualitative improvements in aroma, shelf life, and sweetness, as well as quantitative improvements in starch, protein, gamma-amino butyric acid (GABA), oleic acid, anthocyanin, phytic acid, gluten, and steroidal glycoalkaloid contents.

To feed the world's growing population, the food industry has set a time constraint of 2050 for creating and expanding the food supply chain. For this reason, progress in crops, livestock, and microbes is essential. Since 2005, researchers have attempted but failed to take the necessary steps to reach this milestone. With the arrival of CRISPRs and CRISPR proteins, the food production sector is now in a position to make some of the most exciting breakthroughs since the Green Revolution.

### CRISPR/Cas9 Vectors for Gene Editing in Plants

Cas9 and sgRNA expression within the targeted cell is sufficient to modify plant genomes. The promoters. AtU6 (Arabidopsis); TaU6 (wheat); OsU6 or OsU3 (rice)] of plant specific RNA polymerase III are used to express Cas9 and gRNA in plant systems. In plant systems, there are many commercially produced vectors for expressing variants of Cas9 or Cas9 and gRNAs. Add gene is a national, non-profit plasmid database that can currently make available in binary vectors2 more than 30 empty gRNA backbones.

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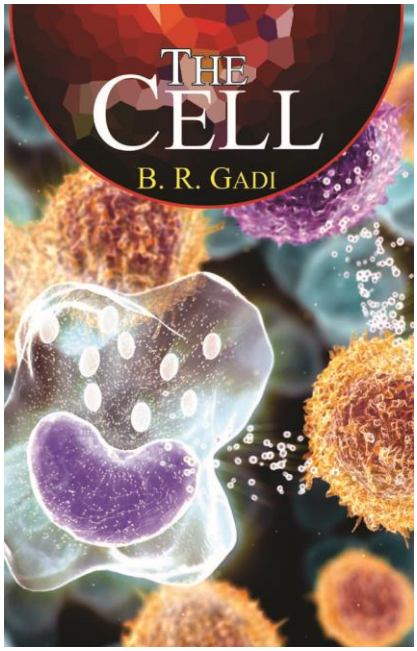


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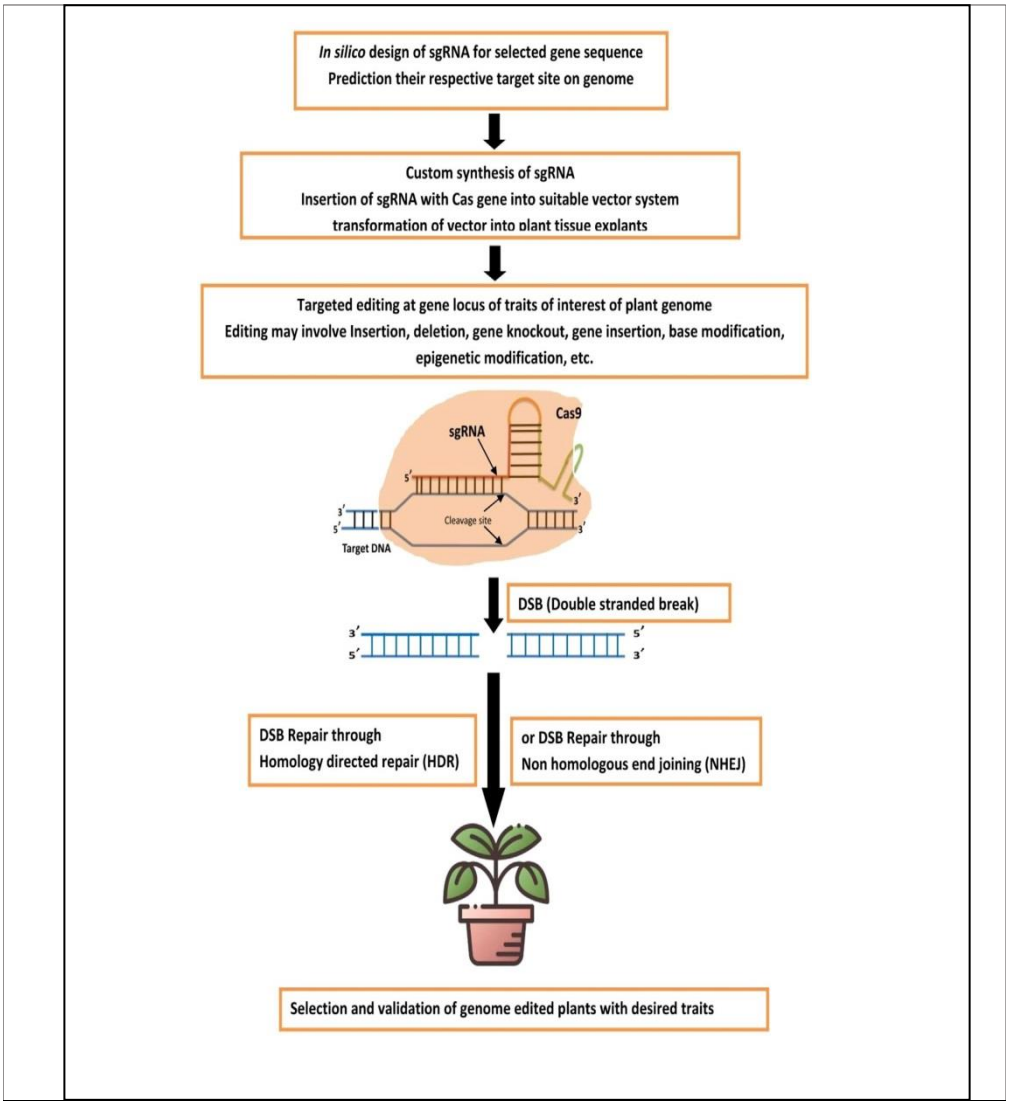
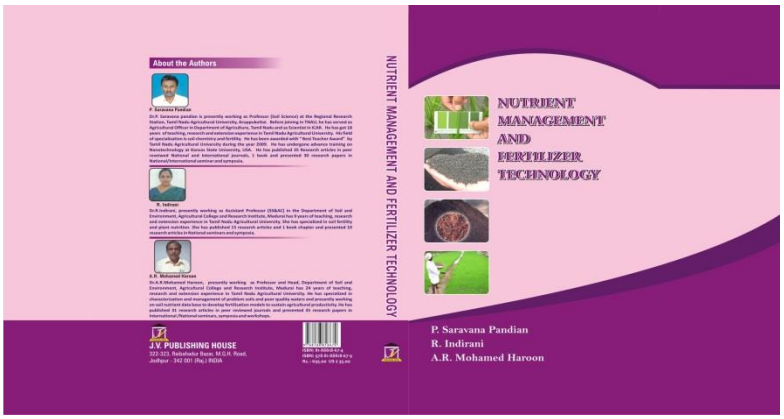

*In silico* design of sgRNA for selected gene sequence
Prediction their respective target site on genome
Custom synthesis of sgRNA
Insertion of sgRNA with Cas gene into suitable vector system
transformation of vector into plant tissue explants
Targeted editing at gene locus of traits of interest of plant genome
Editing may involve Insertion, deletion, gene knockout, gene insertion, base modification, epigenetic modification, etc.
sgRNA
Cas9
Cleavage site
Target DNA
DSB (Double stranded break)
DSB Repair through
Homology directed repair (HDR)
or DSB Repair through
Non homologous end joining (NHEJ)
Selection and validation of genome edited plants with desired traits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## CRISPR for Crop Improvement

To present, the CRISPR/Cas9 gene editing technology has been used in approximately 20 plant species for a variety of purposes, including yield increase and biotic and abiotic stress control. Many of the publications that have been published are considered proof-of-concept studies because they characterise the implementation of the CRISPR / Cas9 system by knocking out specific reported genes that play a substantial role in processes that endure abiotic or biotic pressure. Pathogenic microorganisms impose tremendous hurdles in the development of disease-resistant crops, accounting for more than 42% of potential yield loss and contributing to 15% of global food production reductions. CRISPR/Cas9 genome editing has been used to improve crop disease resistance as well as tolerance to significant abiotic conditions such as drought and salinity.

## In Monocots: Wheat

Wheat is a cereal grain that is grown as a staple food crop all over the world. It has also been demonstrated that the CRISPR TaMLO knockdown confers resistance to Blumeria graminis f. sp. (Btg) Tritici-caused powdery mildew disease. Four of the 72 T0 knockout MLO wheat homoeolog (TaMLO-A) transgenic lines examined for restriction enzyme digestion utilising T7 endonuclease I (T7E1) were found to be modified for the restriction enzyme site. Effective building delivery strategies may reduce or enhance the number of transgenic lines acquired. SSN and gRNA introduction techniques based on T-DNA are commonly employed. Nonetheless, amplicons based on DNA-virus tend to result in numerous increases in gene targeting efficacy. The use of geminiviral wheat-based DNA replicates for transitory and clear expression of CRISPR / Cas9 cassettes resulted in a 12-fold increase in endogenous ubiquitin gene expression in hexaploid wheat.

## In Dicot: Soybean

Soybean (Glycine max), one of the most important seed oil crops with a high protein content. Furthermore, the seed includes a number of physiologically active chemicals that are beneficial to humans. CRISPR/Cas9-mediated soybean genome editing was carried out utilising a single transgen (bar) sgRNA and six sgRNAs targeting distinct loci of two endogenous soybean genes (GmFEI2 and GmSHR), as well as testing the efficacy of sgRNAs in a hairy root system. Selective mutagenesis of two genomic loci on soybean chromosome 4 (DD20 and DD43) resulted in modest deletions and insertions. Complementation and CRISPR/Cas9-mediated gene knockout experiments were used to demonstrate the role of Rj4, a dominant nodulation restriction gene in soybean that inhibits nodulation by numerous strains of Bradyrhizobium elkanii. CRISPR has been utilised to destroy the pathogenic virulence gene (Avr4/6) in Phytophthora sojae. The CRISPR / Cas9-induced homologous gene substitution of Avr4/6 with a marker gene (NPT II) underlined the role of the virulence gene in pathogen detection by plants carrying the soybean R gene loci, Rps4 and Rps6.

## Future Perspectives for the Improvement of Agriculture

While genome editing has numerous advantages over traditional plant breeding, it still faces several hurdles in its application to horticulture crops. Molecular and genetic studies in horticulture crops are difficult, making it difficult to identify genes responsible for desired features. To uncover genes linked with desired features, it will be necessary to sequence the genomes of intriguing horticultural crops. Using degenerate primers tuned for retained protein patterns with suspected roles associated to desirable features, the target sequence might be cloned for crops without a reference genome. The MLO, which has been extensively documented in barley, is an excellent example; the MLO's phylogenetic conservatism has aided in the development of powdery mildew-resistant plants in wheat, tomato, and strawberry. Scientists must grasp the methodology utilised to deliver editing reagents as well as the procedure used to restore the modified mutants once a gene has been identified for editing. More than 25 horticultural plant species have been successfully altered to far, typically using editing reagents given via agrobacteria or virus systems, and the modified plants are regenerated in vitro via tissue culture. In plant transformation, it refers to in vivo explant

infection in which the targeted tissues are apical or auxiliary. It is an alternative answer to Agrobacterium transformation based on in vitro tissue culture.

## Conclusion

The scientists are able to precisely and rapidly insert the desired characteristics of new breeding techniques than traditional breeding. Genome editing based on CRISPR / Cas9 is a key advance. Future studies will focus on the use of genome editing techniques to improve agricultural output, nutritional value, disease resistance, and other features. Over the last five years, several plant systems have been widely employed to undertake functional research, battle biotic and abiotic challenges, and improve other critical agricultural qualities. While various improvements to this technology will result in greater target quality, the majority of the work is still preliminary. However, CRISPR/Cas9-based genome editing will gain popularity and become a major tool for proper plant editing, assisting in the achievement of the zero hunger objective and ensuring food security for the world's rising population.

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# 15. AGRICULTURE

# Paruthi Paal – Triple Nutrient Healthy Drink from Cotton Seed

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## Introduction

Cotton is primarily grown for its fibre, which is regarded to be its main economic component. After the removal of fibre after ginning, the seed cotton was left with the most important by-product cottonseed. Unsaturated fatty acids are present in cottonseed oil (20–22%), which is regarded as a healthy oil. If used as a food supplement, cottonseed can play a significant role in helping to solve these issues in an affordable way.

## Paruthi Paal

(Paal signifies milk and Paruthi means cottonseed.) Paruthi Paal, a traditional delicacy of the Indian state of "Tamil Nadu," is known as a "triple-nutrient" food because of its abundance in protein, vital fatty acids, and carbohydrates. It can also be referred to as a "energy drink." To make cottonseed milk safe for ingestion, the deadly phenolic chemical known as gossypol that is contained in cottonseeds must be eliminated. Use of glandless seed, which carries no gossypol danger, is therefore preferable.

## Protocol for preparation Paruthi Paal

### *Ingredients*

Ingredients include cottonseeds (Paruthi) (one tumbler (glass)), rice/kudu millet (one-fourth tumbler (glass)), jaggery (one tumbler (glass)), cardamom powder (onefourth tsp), coconut milk (one tumbler (glass)), grated coconut (one-half tsp)/coconut milk and dry ginger powder (one-fourth tsp)

***Preparation***

Pick out any cotton or mud that has adhered to the cottonseeds and soak them in water overnight before washing them under running water. Repeat the cleaning process 3–4 times under running water. Add a little water to the cottonseeds and process in the blender for a minute to extract the milk from them. Utilizing a sieve or muslin cloth, remove the milk from it. Then, add another cup of water, blend it once more, and separate the milk from the cottonseed mash. Make jaggary syrup by extracting milk from coconut milk in a similar manner. Crushing the jaggery and adding it to a pan with water (to dissolve the jaggery) and heating it over a medium flame until it reaches the consistency of syrup is one way to make syrup. Filter it, then set it apart. The filtered cottonseed milk should be placed in a pot and heated, stirring occasionally, until it begins to boil. Once it begins to boil, keep it on a low flame for 5 minutes while stirring. Make a paste with almonds or combine rice flour and kodu millet flour in a cup with a cup of water, stirring well to prevent lumps from forming. Now add this to the cottonseed milk that is now heating while continuing to whisk to prevent lumps from forming. The cardamom pods should be crushed and set aside. Cardamom powder, cardamom pods, and ginger powder can be added; stir continuously until the mixture thickens. Pour the jaggery syrup in and cook for 5 minutes on medium heat, stirring occasionally, until it thickens. Pour the coconut milk into the pan while maintaining a low flame, stirring continuously until the raw scent disappears. In the morning, remove from the fire and serve hot. This can also be made into a herbal beverage that is beneficial for digestion, colds, and coughs by adding a few herbal spices.

## Beneficial effects of Paruthi Paal

***Heals stomach ulcer***

Stomach ulcers are caused by a variety of reasons, including eating habits, which alter the environment of the stomach. The bacteria Helicobacter pylori are the most frequent cause of stomach ulcers. Consuming Paruthi Paal has established itself as an age-old remedy for stomach ulcers. It might be caused by Helicobacter pylori activity being suppressed.

***Prevents polycystic ovary syndrome***

Other major health issues like diabetes, cardiovascular issues, depression, and an increased chance of endometrial cancer can also be brought on by polycystic ovarian syndrome (PCOS). managing diabetes by eating foods with minimal calories or a low glycemic index, such as fruits, seeds, nuts, and legumes. Cottonseed is regarded as having a low glycaemic index and is helpful in reducing PCOS. Second, cottonseed has demonstrated promising results in the prevention of PCOS and is also a very rich source of magnesium.

***Regulates menstrual cycle***

The management of menstrual cycle can be also be regulated by consuming low carbohydrate diet as discussed in PCOS section.

***Remedy for cold and cough***

In Tamil Nadu, Paruthi Paal, a combination made from cottonseed milk, ginger, cardamom, and almonds, is favoured as a remedy for colds and coughs.

***Ease in labour pains***

The concoction of cottonseed and root of cotton stimulates uterine contraction and leads in preventing the labour pains.

***Antioxidant benefits***

It is well known that the lipids in cottonseed are a good source of antioxidants, which are crucial for preserving human health. They also aid in the removal of reactive oxygen species produced by the body and have anti-aging properties.

***Cholesterol benefits***

Consuming cottonseed has been shown to boost levels of HDL, commonly known as the good cholesterol, in the body and assist in lowering LDL, or the bad cholesterol, levels in the body. This is because the oleic acid content of cottonseed oils is high, which over time tends to increase HDL activity.

***Helps prevent cancers***

One of the best vegetable oils that is safe and aids in protecting the body from many diseases, including cancer, is cottonseed oil. This is because cottonseed oil aids in the body's absorption of vitamin E, which in turn is believed to prevent several types of cancer.

***Maintains blood pressure***

It has been observed that the presence of mono- and polysaturated fats like oleic acid and linoleic acid in cottonseed has a positive impact on lowering the risk of blood pressure in humans and regulating the same. Additionally, sustaining heart health depends heavily on it.

***Improves neurological health and memory***

Another crucial source of vitamin E, an antioxidant, is cottonseed. Thus, Paruthi Paal contributes positively to the nervous system's operation, thereby enhancing memory abilities.

The positive impacts that are mentioned require scientific support as evidence. These positive benefits are based on both traditional knowledge held by Tamil Nadu locals and information found online.

**Conclusion**

The key ingredient of Paruthi Paal is cottonseed milk, which is a great source of fibre, healthy fat, and protein. The study also created a method for making cottonseed milk. In order to combat malnutrition, the created ready-to-serve product "Paruthi Paal" can also be used as a protein supplement. In fact, cottonseed milk is a revolutionary product that can be made and sold in India. In addition to serving as a health supplement, Paruthi Paal also acts as an antioxidant, protects against heart-related issues, reduces stomach ulcers, and has many other positive effects. It is important to utilise glandless cottonseeds for making Paruthi Paal since the high amount of gossypol found in glanded varieties of cotton can be hazardous.

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## 16. MAIN SUBJECT - AGRICULTURE

# *m*-Agriculture in Indian Context

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*m*-Agriculture is about bringing mobile information access to rural communities and small holders. In many countries these farmers make up a large percentage of population, and provide most of the food for the country. So improving the efficiency and farming methods for these farmers can have a very big impact on the country's production. Over the last few years, the rapid growth of mobile telephony enabled a variety of m-agricultural services as a means to overcome the existing information asymmetry. It also helps, at least partially to bridge the gap between the availability and delivery of agricultural inputs and infrastructure.

*m*-Agriculture is defined as the delivery of agriculture related information and services via mobile communication technology, in

particular mobile phones, smart phones, tablet devices such as the iPad. Increasing use of mobile phones and mobile phone-based services enhances the availability of content-specific information, and also helps to improve awareness, education, better adoption of technology, better health and operational efficiency and better climate-linked risk management in agriculture. These in turn catalyze agricultural development and economic growth. Mobile can do wonders to reach the farmers with the necessary information related to choice of crop, seed/variety, options for better crops and varieties, season and date of sowing, pest management, disaster management, harvesting, cultivation practices best suited for the area , input usage, availability of inputs, market demand, transportation, etc.

After the inception of Indian telecom Policy (1998), this sector has exposed an exponential growth. Mobile cellular subscriptions are growing rapidly in the country since the last two decades. The growth of tele density was very low (1.92%) during 1948-1998. It recorded abrupt growth from 1999 to 2012 (78.66%). In 2011 alone, 142 million mobile cellular subscriptions were added in India, twice as many as in the whole Africa, and more than in the gulf countries, Common Wealth of Independent States (CIS) and Europe Union together (ITU, 2012). Faster expansion of mobile networks in the rural areas (nearly comprised of 35.17 % of rural population) of India presents and unparalleled opportunity to give rural farmers access to information that could transform their livelihood and eventually help them to get rid of poverty.

## Initiatives of *m*-Agriculture

The major uses of mobile phones in agriculture are as given below:

**Agricultural Production:** Farmers at the time of sowing need information on selection of remunerative crops, high yielding varieties, planting techniques, judicious use of plant nutrients, seed treatment, soil treatment, etc., and at harvesting about weather. For better production, accurate and timely information is essential for making right decision. The Reuters Market Light (RML) and IFFCO Kisan Sanchar Limited (IKSL) are providing the services on crop advisory and weather forecasting in association with State Agricultural Universities (SAUs) and Krishi Vigyan Kendras (KVKs) to offer class advisory tips in the timeliest manner.

**Agricultural Climatic Risk Mitigation:** Now-a-days, Indian agriculture is suffering from uncertainty of weather and climate. Indian Meteorological Department (IMD) and RML are working together to disseminate weather and crop/livestock advisory, including climate resilient technical modules developed by Agromet Field Units (AMFUs) located at SAUs, Indian Institute of Technologies (IITs), Indian Council of Agriculture Research (ICAR) etc., in thirteen states of India. The information is basically crop and region specific weather data and delivered within actionable time to the farmers on their mobile phones in the form of short message service (SMS). Another initiative by State Department of Agriculture, Government of Maharashtra is sending SMS to the farmers through the website (http://www.mahaagri.gov.in) on weather forecasting and agriculture. In Tamil Nadu,

**Agricultural marketing:** In Gujarat, Halvad Agriculture Produce Market Committee (APMC) has initiated mobile based market price disseminated service. Farmers connected with the network receive latest price of their produce on their mobile phone would influence their selling decisions. Market information improves farmers` ability to negotiate better pricing for their farm produce from the local traders. Today, IFFCO, REUTERS and other organizations are also providing the information related to market.

**Agricultural extension education:** voice Krishi Vigyan Kendra (vKVK) is an ICAR initiative through Krishi Vigyan Kendras to communicate with their large set of registered farmers via three kinds of medium i.e., voice, SMS and email. This platform supports services like announcing alerts, informing farmers regarding field days, exhibition, krishi melas, broadcasting advisories, weather forecasting, farmers asking question to the experts and experts from concerned KVK`s replying back to them. m-Agriculture will cover large number of farmers in delivering latest information useful for them.

**Agricultural supply chain:** Agricultural production involves input components (such as seeds, fertilizes, and pesticides) and the credit and other financial arrangements that make it possible for supply to flow. IFFCO is a recent example which is using mobile technology in its supply chain. Through IKSL, it is providing services to farmers on use and availability to fertilizers, which enhance their supply system and farmers become capable to get the product at negotiated rates

**Agricultural research:** Due to versatility and advances application, mobile phones had become a powerful tool for research community. There are number of ICT tools that could be combined with mobile phones in order to create a revolution in agricultural research. Research and related activities can easily be communicated with the use of mobile phones. Scientist can be getting connected to the scientific community as well as has access to information related to research. Moreover, scientists can easily get the feedback from the farmers and research will become participatory.

## Key benefits of *m*-Agriculture

These *m*-Agriculture initiatives are helping the Indian farming community for sustainable growth in this globalization era. Some of the key benefits are:

- As the mobile phone penetration is more in rural areas, it can be effective approach of mass communication.
- It provides timely and crop specific information to the farmers anywhere.
- Voice SMS service can overcome the constraint of literacy of the farmers.
- Regular mobile based market price information of agricultural communities facilitates farmers in marketing decision to get higher profit from farming.
- Mobile phone use can reduce information cost as well as transport cost of the farmers.
- The weather based information can help farmers in the decision of crop choice, pest and disease control, harvesting of crop, marketing, etc.,
- SMS through mobile also help extension functionaries in creating awareness among the farmers about activities like field days, exhibition, krishi melas, etc.

## Challenges for *m*-Agriculture

Insufficiencies in physical infrastructure, problems and poor access to agriculture-related information have been the major constraints on the growth of agricultural productivity in India. Though mobile phones have lot of benefits but like all technologies it has some challenges like:

- Scattered nature of agriculture based ICT initiatives.
- High costs, especially for new generation sets for poor farmers.
- Limited network coverage and low bandwidth in some rural areas.
- Limited competency of rural people to use the technology, particularly for more complicated applications for images, global positioning system (GPS) data, etc.
- Low awareness of the technology use for agricultural and educational purposes.
- Technology limitations such as character limit for SMS (impact on complex information sharing) and the lack of available non-Roman scripts.
- Challenge of translating the content into local language.
- Issues of quality, reliability and timeliness of information.
- Expert needs training to write down effective script for short massages.

## Conclusion

Information is the key ingredient for sustainable agricultural development. The initiatives of mobile based agro advisory services have opened up new frontiers for agricultural development in India. It can transform the Indian agriculture by reducing the information asymmetry that exists between farmers and between regions. Still there is need to join hands by public and private sector to develop an integrated and sustainable model.

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## 17. SUBJECT: AGRICULTURE

# Block Chain Technology in Agriculture

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### Introduction

Utilizing data and information is crucial if the agriculture sector is to become more sustainable and productive. Thanks to information and communication technology, the efficacy and efficiency of collecting, storing, analysing, and utilising data in agriculture has substantially grown (ICT). It enables farmers and other agricultural professionals to easily obtain the most recent information and take better decisions in their day-to-day activities. For instance, the development of the Global Positioning System (GPS) makes it easier to plan fields, guide machinery, and manage crops. Mobile phones also reduce the cost of information, making it easier for farmers to access markets and financial help.

ICT and Blockchain Information and communication technology cannot completely eliminate bias in data collection and consumption. Users of ICT are constantly compelled to use information in a way that furthers their own objectives. In a multi-criteria choice, for instance, the organisation a stakeholder represents has a considerable influence on their preference, and NGOs may focus too much on the issues to be addressed due to their interest. An effective method to prevent this bias is to spread control over data management to a very large number of people, which makes data tampering difficult or even impossible.

A blockchain is a public ledger where users can record information on the production, exchange, and consumption of commodities and services. Collectively, all parties engaged manage the ledger, typically through a peer-to-peer network. The blockchain cannot be updated with a new record until the network has approved it. Consensus decision-making protocol, which requires the approval of the vast majority of the parties, should be followed for every update to the recorded data. Furthermore, if one record is modified, all records that follow it will also be changed. As a result, it is virtually difficult to change anything that has been saved in a blockchain. Blockchain is "an open, distributed ledger that may effectively record transactions between two parties in a verifiable way," according to one definition.

### Potential Benefits of Blockchain Technology for Agriculture

Now, peer-to-peer transactions can be carried out transparently and without a bank or middlemen in the agriculture sector (for bitcoins, for example). Due to the technology's removal of the need for a central authority, cryptography and peer-to-peer architecture are now trusted instead of a body. Thus, it helps to restore consumer and producer trust, which can reduce the price of transactions in the agri-food sector.

Blockchain technology offers a reliable way to monitor transactions between unknown parties. Therefore, fraud and mistakes can be discovered right away. The ability to report problems in real time is another benefit of incorporating smart contracts. This helps to address the issue of things being difficult to trace due to the complicated agri-food system's broad supply chain. Therefore, the technology provides solutions to issues about food quality and safety that customers, the government, etc. may be concerned about. Thanks to blockchain technology, transparency is made possible between all stakeholders, which also makes it simpler to obtain correct data. From conception through disposal, every step of a product's value chain may be documented using blockchain.

### Applications

Four classes of applications in agricultural and food sectors: agricultural insurance, smart farming, food supply chain, and transactions of agricultural products.

### Agricultural Insurance

Extreme weather puts agricultural

productivity at risk and puts the world's food security in danger. The productivity of both crops and livestock is affected, and climate change is expected to exacerbate current weather extremes in the future. Programs for agricultural insurance are a well-known method of lowering weather-related risks. Farmers pay an insurance premium before the crop cycle begins, and whenever a loss occurs on their property, the insurance company pays out. Due to the insurer's assumption of the entire insured risk in this manner, farmers are able to manage their financial exposure to weather extremes, i.e., financial losses resulting from weather extremes.

Agricultural insurances vary in terms of how losses are determined and, as a result, how reimbursements are initiated. Indemnity-based insurances are those that compensate farmers according to a damage estimate made by a professional on the farm. While indemnity-based insurances can accurately pay losses, they are vulnerable to issues brought on by asymmetric knowledge concerns. More precisely, the distribution of information between farmers and insurers regarding the riskiness of agricultural production and production practises is uneven. Farmers are anticipated to be more knowledgeable about the two factors that encourage moral hazard and adverse selection. According to adverse selection, farmers who are exposed to greater risk are more likely to get insurance than those who are less exposed.

## Smart Agriculture

The agri-food systems' foundation is made up of the essential facts and knowledge about the natural resources that underlie all forms of farming. Numerous actors and stakeholders produce and handle data and information in accordance with their needs and skills. Smart agriculture is characterised by the use of ICT, the internet of things (IoT), and a variety of modern data collection and analysis techniques, including unmanned aerial vehicles (UAV), sensors, and machine learning. In order to build smart agriculture, a comprehensive security system that enables data use and management must be developed. Traditional methods manage data centrally and are vulnerable to cyberattacks, faulty data, data distortion, and misuse. For example, environmental monitoring data is generally managed by centralized government entities that have their own interest. They can manipulate the decision-making related to data.

The data and information that various actors and stakeholders produce during the entire value-added process of generating an agricultural product, from seed to sale, are stored using blockchain technology. It ensures that any data that has been captured is unalterable and that the information is transparent to all parties involved, including actors and stakeholders. Blockchain technology, in contrast to earlier systems, which rely on the "security of obscurity," creates security through decentralisation (Ibm Institute for Business Value, 2015). When data is disseminated to stakeholders' PCs rather than being held on servers that are under administrators' control, data loss and tampering are less likely to happen.

A blockchain is a database with timestamped groups of activities and transactions associated with a product. Data distribution to servers on the Internet is less prone to loss and distortion than data storage on servers that are centrally controlled by administrators. For the creation of data-driven mobile applications that improve farming, the database is tremendously useful. The blockchain also solves the problem of developing a thorough, secure IoT infrastructure and integrating various ICT e-agriculture technologies. Numerous IoT and blockchain-based smart farming models are being suggested and put into practise. The owner centrally manages a private local blockchain using IoT sensors in greenhouses. Farming groups are also utilising blockchain to improve their farming techniques. Each association conducts business as a "public juridical entity," publishing to the blockchain their own data and information regarding irrigation management that the general public can see. The public becomes more involved in irrigation management and works harder to optimise the use of water resources as a result of the transparency. The longitudinal database built utilising blockchain technology can be utilised in the future to help with decisions about irrigation canal development and

maintenance, for example. Smart agriculture with blockchain does not lower, if not raise, the technological barrier for farmers to participate. Importantly, it is better motivated to collect trustworthy data from large farmers than from smallholders for uploading to the blockchain. Large farmers are more likely to be involved in block chain based smart agriculture and benefit from it. This thus can create or increase the discrepancy between large farmers and smallholders.

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