# Indian Farmer

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## Innovative Technologies in Agriculture


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# INDIAN FARMER

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# Nitrogen Fixing Trees: Nature's Solution to Curing Nitrogen Deficiency

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Nitrogen (N) deficiency is a big challenge to world agriculture. N is one of the most important nutrients for the survival and growth of plants. Nearly 78% of earth's atmosphere consists of this gas essential to supporting life. However, plant life is unable to take vital nutrients from its gaseous form. Instead, plants must derive nitrogen from their soil.

The introduction of chemical fertilizers to compensate for nitrogen deficiency has created a host of environmental challenges. The continuing practice of using chemical fertilizers has resulted in extensive ecological damage. Groundwater contamination, eutrophication, acid rain and ozone depletion are the consequences of the extensive use of harmful chemicals in agricultural practices. Nature offers healthy alternatives to artificial treatments that pollute the environment. Collaborate with nature as a partner is paying off beyond the balance sheet. Natural solutions are proving successful in resolving environmental issues, allowing communities to rely less on toxic remedies. When it comes to nitrogen deficiency, microorganisms and root nodule trees are two essential partners.

## Biological Nitrogen Fixation

Biological Nitrogen Fixation is a natural process where some bacteria and trees with nodules in their root systems are able to convert the gas into a form that is utilizable for other plant life. What makes them extraordinary is their unique ability to deal with the sturdy gas molecule and unpack its compounds essential to supporting plant life. Nitrates, nitrogen dioxide and ammonia become transformed into available components.

Diazotrophs are one example of the type of bacteria and archaea capable of transforming the atmospheric gas into more utilizable forms (mainly ammonia). Others such as *Azotobacter* and *Clostridium* are non-symbiotic, and fix nitrogen without association to other plants. Rhizobium, for instance, collaborates with legumes, while Frankia work with non-legumes.

## Nitrogen fixing Trees

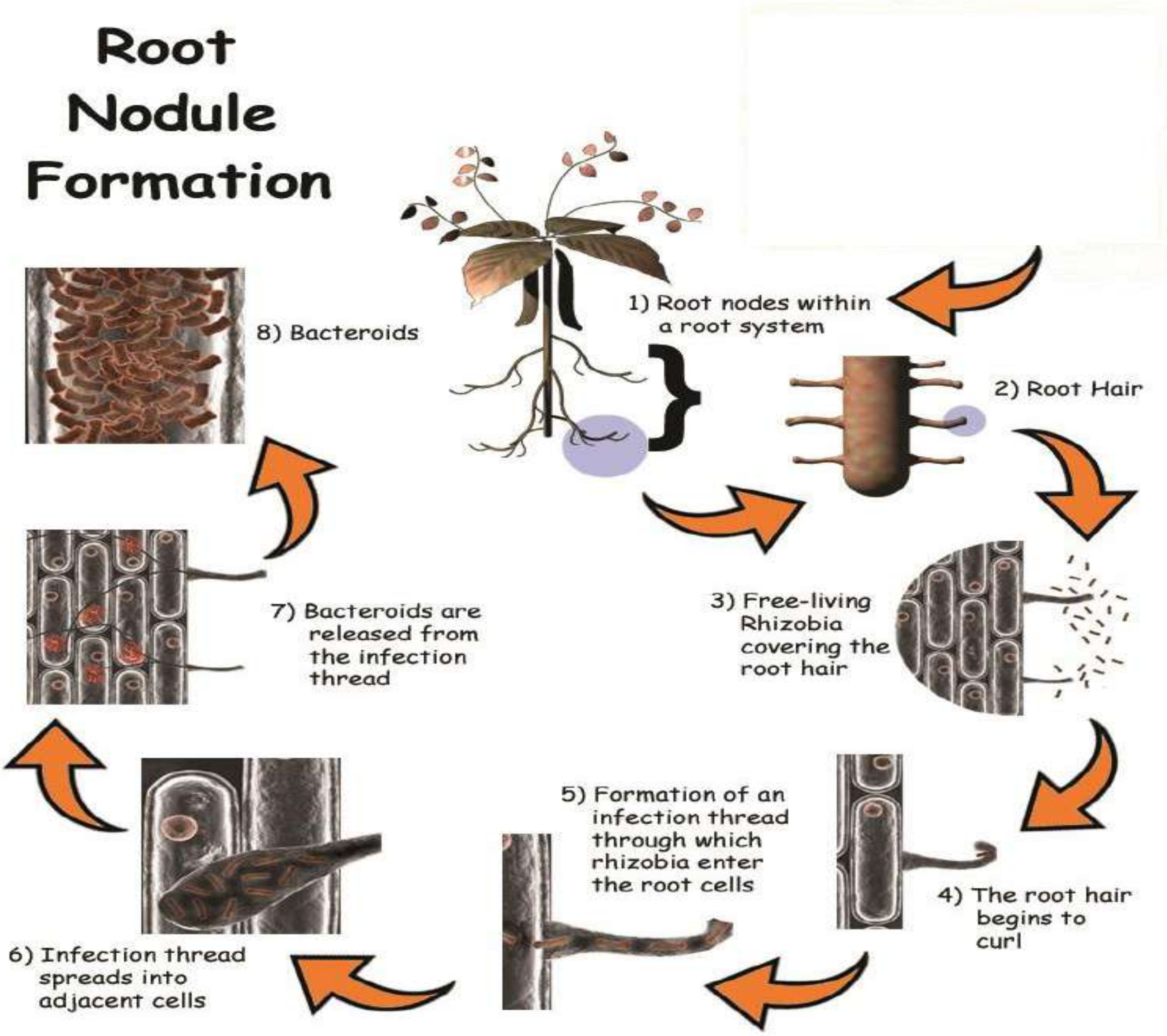
Trees with the capacity to convert the atmospheric gas into utilizable compounds, such as ammonia, are nitrogen fixing trees. A limited number of plants in nature have this extraordinary ability to use atmospheric nitrogen for their own purpose and to add it to the soil. Leguminous plants such as alfalfa, sesbania, clover (perennials), beans, peanuts, and soybeans (annuals) are greater fixers. Gliricidia (*Gliricidia sepium*), Subabul (*Leucaena leucocephala*), Pongamia (*Pongamia pinnata*), Neem (*Azadirachta indica*), Acacia, Alder, Autumn Olive, and others are examples of trees that add nitrogen in soil with the help of bacteria. These nitrogen fixing trees pull the element out of the atmosphere and build a storehouse of the gas through their nodule root formation. For example, the co-cultivation of leguminous nitrogen fixing trees with other plants has been found to be beneficial in African countries. In developing tropical nations, leguminous trees that are nodulated including *Dalbergia sissoo*, *Acacia nilotica*, *Pongiamia glabra* and others are planted to restore denuded land. Along with improving the fertility of marginal soil, NFTs also moderate the harsh conditions of unvegetated areas, playing a fundamental role as the benevolent pioneer species.

## Nodules: the Warehouses of Nitrogen

Bacteria live within the nodules of nitrogen fixing trees, making the nodes their single most important feature. Nitrogen fixation and ammonia production are the work of these microorganisms that labor intensively inside these nodes of varying size. Even though nodules may be formed on stems or leaves, but most common are found on root systems. The morphology of nodules varies widely depend upon the characteristics of the host plant. For example, clover forms club-shaped nodules; soybeans produce nodules that are spherical in shape; and pigeon pea and alfalfa develop branched nodules. Nodules also vary in their size and number. Most are small, usually less than 0.5 cm in diameter; others are as large as a baseball. Plants with more nodules tend to have smaller nodes and are less efficient in fixation. Successful nodules are larger in size and show greater efficacy in fixing higher amounts of nitrogen. New nodules are generally grey or white inside. They are unable to nitrogen fixation. Mature and larger nodules are indentified by their pink or reddish internal color due to the presence of leghemoglobin, an oxygen and nitrogen carrier. They are the most effectual fixers.

## Nodulation in Legumes by Rhizobium

Nodulation is the formation of nodules. It is important because this part of the nitrogen fixation process differs between legumes and non-legumes, creating some significant distinctions.



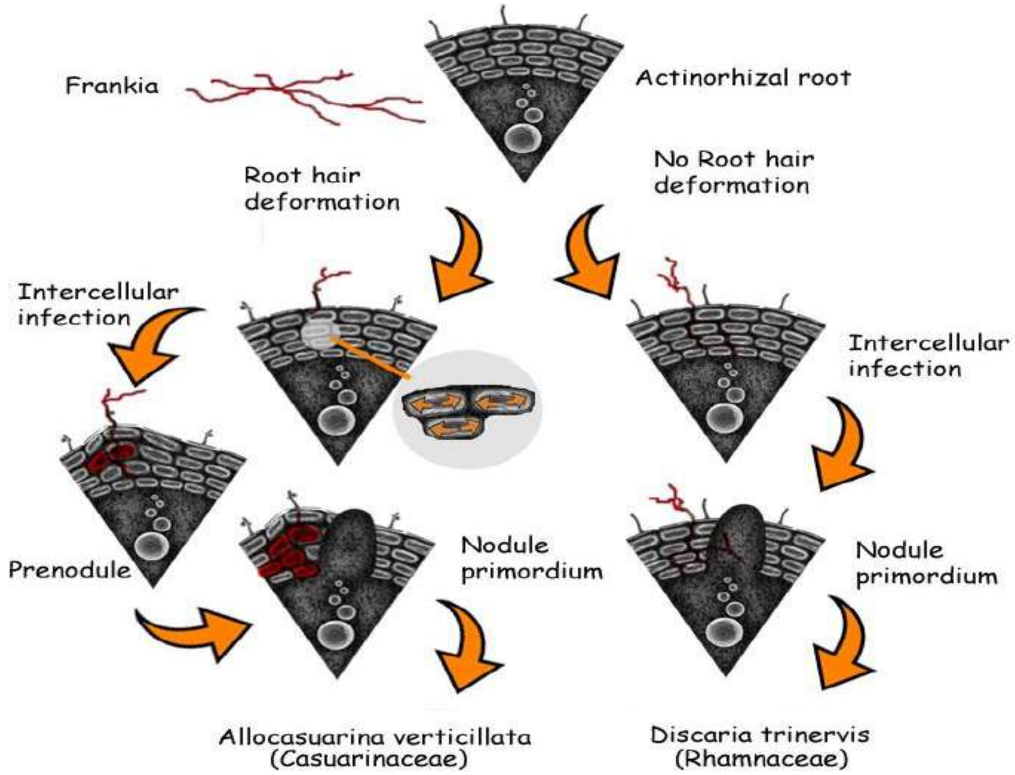

## The stages of nodulation in legumes are:

1. Legumes release flavonoids whenever they experience nitrogen deficiency. This sends a signal to the rhizobia about their interest in a symbiotic association.
2. Rhizobia classically live in soil. When exposed to flavonoids, they release a nodulation factor that encourages the plant to produce deformed root hairs.
3. To pierce the root cells through the deformed root hairs, rhizobia then form an "infection thread."
4. Rhizobia penetrate the curled root hairs, multiplying within the infection threads.
5. The infection thread reaches the cortical region and divides into multiple branches.
6. Under rhizobial infection, the cortical region shows meristematic growth and young nodules are produced. Tiny nodules are visible to the naked eye within a week of infection.
7. Finally, mature nodules develop, filled with both advanced and young bacteroids (the misshapen form of the rhizobium bacteria).

## Nodulation in Non-Legumes by Frankia

Actinorhizal plants (trees and shrubs) form a symbiotic association with Frankia, the nitrogen fixing actino bacteria, to make root nodules. Depending upon the host plant, Frankia beneficially infects actinorhizal plants in two different ways: (1) by intracellular infection, or (2) by intercellular infection.

- An intracellular infection starts when Frankia employ an unknown signal to stimulate the root hairs to curl.
- Frankia makes its way through the root hairs and infects the cells. When cell divisions occur inside of the cortex, small external protuberances called the prenodules start to form.
- After the nodule lobe premordium forms, Frankia Hyphae continue towards the young nodule lobe to create mature nodules.
- Intercellular infection is a nodule formation process that occurs without any root hair deformation or the development of prenodules.




## How nitrogen fixing trees add Nitrogen to the Soil

As nitrogen accumulates in the roots of nitrogen fixing trees, new nodules develop allowing for increased storage capacity. Furthermore, the nitrogen fixing trees collect the nutrient from the air and store it in the nitrogen-friendly warehouses, expanding the size of the nodes. A large variety of nitrogen fixing legumes can accumulate an estimated 100-300 kg of nitrogen per hectare per year. Some higher yielding legumes are capable of contributing up to 500 kg N $ha^{-1}$ $year^{-1}$. The process is not without trade-offs for the nitrogen fixing trees. In this symbiotic interaction, the trees provide carbohydrates (malate and succinate) to the rhizobia, obtaining the ammonia needed to form amino acids. The nodules hold the preponderance of the nitrogen, enabling host plants to grow. On the other hand, excess gas accumulates in plant tissues eventually causing the trees to die. Still, this process benefits the surrounding soil and neighboring plants. The decomposed trees provide valuable nitrogen enrichment to the soil that later becomes available to future plant growth. Also, protect the integrity of overall environmental health.

## Additional Nitrogen fixing tree Contributions to Soil

- Nitrogen fixing trees are consistent food suppliers, producing a important number of food grains and vegetables.
- Nitrogen fixing trees play a fundamental role as a forge species in harsh, arid and infertile regions. Through their ability to moderate environmental severity and restore fertility, they create land that is cultivable and productive.
- Their constant addition of organic matter to the soil reduces the demand for fertilizers.
- With their extensive root system, they improve the soil structure and prevent erosion.
- Both growing and atrophying roots create many channels that enhance healthy soil aeration.
- Nitrogen fixing trees provide fodders, fuel wood, wind protection, living fences and timber.
- Some nitrogen fixing trees offer microclimates for crops that require shade.
- Nitrogen fixing trees can also serve as a trellis for vine crops.

## How to Introduce Nitrogen fixing trees into a System

Alley cropping, clump plantings, contour hedgerows, shelter belts and single distribution plantings are some practices commonly used to integrate nitrogen fixing trees into a system. The variety should be selected with extreme care to avoid unwanted invasion by nitrogen fixing trees.

## Planting of Nitrogen fixing trees

The following prerequisites must be satisfied before and during the planting of Nitrogen fixing trees:

- Nitrogen fixing trees offer a wide variation of characteristics. A number of nitrogen fixing trees species are small, while many are large with a rapid growth rate. Some produce edible shoots and pods and are well suited for home gardens. Others are very useful for providing fuel wood or poles. Accordingly, it is supreme to survey both a region's particular environmental characteristics as well as its population's needs before deciding which species to plant.
- Cutting the seed coat using thermal stress, abrasion, or chemicals to stimulate germination is known as scarification. Hard seed coats of many nitrogen fixing trees

hamper the germination of the seeds. To avoid this problem, scarification using hot water is extensively used. Seeds are placed into water with a temperature of 70-90°C for one to three minutes and rinsed afterwards.

- Sowing the seeds of nitrogen fixing trees requires inoculation. Just a little amount of pure water is applied to the seeds allowing inoculums to be dusted afterwards. Note: Once seeds are inoculated, they become sensitive to high temperature and sunlight, requiring prompt sowing.
- Stump cuttings, bare root seedlings or branch cuttings can be used to grow nitrogen fixing trees, but must be kept uninjured and moist until planting. Stump cuttings require scarification with a sharp tool to promote rooting.
- Prepare a small hole in the soil that is approximately the same diameter as the plant material. Seedlings should be positioned so that their root/shoot collar is at ground level.
- Soil amendments and the application of mulch at planting facilitate the growth of healthy young plant by ensuring they receive the required amount of moisture and nutrients. These practices also protect seedlings from weed competition.

**Proceed with Care**

Nitrogen fixing trees are not always the best solution. The introduction of a single non-native nitrogen fixing tree species can bring the total collapse of an invasion-resistant ecosystem, paving the way for other invaders. Because they are sturdy of growing even in the most unfavorable conditions, they have the possible to become an invasive species, negatively impacting primary crops. As well, an excess number of nitrogen fixing trees could over nitrify the soil and pollute surface and ground water. To avoid this unnecessary invasion, only those species that are known for their compatibility with local conditions should be considered.

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All images are from Zaytuna Farm, taken by Ingrid Pullen.
*permaculturenews.org.*

# Innovative technologies to boost up productivity in Agriculture

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Agriculture is the mainstay of India which provides employment to nearly 52 per cent of the population. However, Agriculture contributes only 16 per cent to India's Gross Domestic Product. Increasing agricultural growth is the top priority of our government and will continue to remain, as around 70 per cent of the population lives in rural India. Agriculture plays an important role in economic development, such as provision of food to the nation, enlarging exports, transfer of manpower to non-agricultural sectors, contribution to capital formation, and securing markets for industrialization. India is the world's largest producer of milk, pulses and spices and has the largest area under wheat, rice and cotton. The effectiveness of Indian agriculture is the effectiveness of the Indian economy. In the geographical aspect India has the highest advantage of farm area under cultivation, but the yield is neither encouraging nor remunerative to the cultivators. In China net cropped area is only ten per cent while the world average is 10.7 per cent.

There is a limit to cultivable land, which is currently 11 per cent of the 13.2 billion ha of the total land area of the planet, the rest being taken up by forests, settlements and grass lands etc. So the solution lies in increasing productivity of agriculture. In spite of the Green Revolution, our agricultural productivity continues to be low at 1.7 tonnes/ha as against the world's average of 2.6 tonnes/ha. In India, Green Revolution in agriculture has made significant contribution on aggregate supply of food grains, ensuring food security to the growing population. However, the momentum gained during the period of Green Revolution has slowly declined. Now, the agricultural growth faces a serious challenge in terms of sustainability. Today, the main problem in agriculture pertains to sustainability of resources, use and indiscriminate use of chemical fertilizers and pesticides. These problems have led to increasing awareness and a felt need for moving away from the input intensive agriculture perused during the Green revolution phase, to sustainable farming in different parts of the world. Better agriculture practices are needed to bring sustainability in Indian Agriculture.

Agriculture has to match the pace of the population growth to counter hunger and poverty in the world particularly in the developing countries. Cereals are the dominant part of our food security and world cereal output in 2012 was 2.309 billion tonnes. It is estimated that the world population will be 9.1 billion persons by 2050, up from the current population of 7 billion. More importantly, income growth will increase the quantity and change the composition of agricultural commodity demand. Demand for energy will also compete with the food security as parts of our agricultural commodities are going for the production of bio-fuels which will also continue to grow. Thus, significant increases in production of all major crops, livestock and fisheries will be required. According to the estimates of the Food and Agricultural Organization (FAO), agricultural production would need to grow globally by 70 per cent by 2050 and more specifically by almost 100 per cent in developing countries, to feed the growing population alone. This excludes additional demand for crops as feedstock and the demand for bio-fuel sector.

Today, agriculture is in serious constraint due to the challenge of hunger, malnutrition, poverty and climate change. Some recent estimates suggest that total factor productivity (TFP), the most comprehensive measure of productivity reflecting the efficiency to turn all inputs into outputs, grew at an average rate of around 2 per cent per year since 2000 across major world regions. The most popular indicator of land productivity is crop yield. This is a worrying factor as the average global rates declining. Since the 1980s, growth in wheat and rice yields fell from 2.5-3 to around 1 per cent. Maize yields showed growth of slightly less than 2 per cent over the last decade. This is the major concern due to the lack of technology transfer. The gap between farmers' yields and technical potential yields reflects the largely suboptimal use of inputs and insufficient adoption of most productive technology. According to FAD, this yield gap was approximately 11 per cent in East Asia and with unequal access to resources and inputs could raise total agricultural output in developing countries by 2.5-4 per cent which can lead to a reduction of 12-17 per cent in the number of undernourished globally.

## INDIAN SCENARIO

Sustainable agriculture growth is important to check the hunger and poverty in the vulnerable population of the country as for 1 per cent growth in agriculture sector there would be a 2-3 per cent reduction in poverty. India's population is expected to reach 1.5 billion by 2025, making food security most important social issue and food production will have to be increased considerably, to meet needs of growing population. The farm sector achieved 3.6 per cent growth during the $11^{th}$ Five Year Plan (2007-12) which was much higher than growth of 2.5 and 2.4 per cent during 9th and 10th plans. Food grains production in India has shown remarkable improvement in recent years. The production of food grains in 2011-12 was at a record high of 259.32 million tonnes. While focusing on increasing productivity in agriculture, innovative technologies should be infused to lower production costs, conserve biodiversity, more efficient use of external inputs for more sustainable agriculture and environment increase stability of production to lessen suffering during droughts due to abiotic and biotic stresses. Indian agriculture has all capabilities in the form of technology and management to accelerate the growth.

The Planning Commission has targeted an annual growth rate of 4 per cent for the agriculture sector in the Twelfth Five-year Plan. This is evident from the statistics as the production of food grains has increased by 4 times, horticultural crops by 6 times, fish by 9 times (marine 5 times and inland 17 times), milk 6 times and eggs 27 times since 1950-51. Green Revolution is our biggest success which resulted in an increase in food production from 800 million tonnes to more than 2.2 billion tonnes between 1961 and 2000. Indian Council of Agricultural Research (ICAR) with 99 Institutes, 78 AICRPs/AINPs, 08 Zonal Project Directorate, 68 Agricultural Universities and 637 *Krishi Vigyan Kendras* (KVKs) spread across the country constitutes one of the largest national agricultural research systems in the world. But now, there is need for another green revolution by tapping the unexplored potential of vast tract of the country with the augmentation of irrigation and technology.

Our agriculture is still technology deficit as far as world agriculture is concerned. Yields per hectare of foodgrains, fruits and vegetables in our country are far below global averages. Our rice yields are one-third of China's, and about half of Vietnam's and Indonesia's. Even India's most productive states lag global averages. For example, Punjab's yield of rice in 2010 was 3.8 tonnes per hectare against the global average of 4.3 tonnes. The average yield for apples in India (J&K) is about 11 tonnes per acre compared to the US, New Zealand, Israel or China, where yields range 30-70 tonnes per acre. The available data show that the productivity of *kharif* sorghum can be increased 3 to 4 times, *rabi* sorghum 1.4 to 2.3 times and bajra 1.8 to 2.3 times from their current level of productivity. Similarly, the productivity of pulses and oilseeds can be increased 2.3 to 2.5 times, through attention to seeds, soil health, pest management, crop life saving irrigation and post-harvest technology. Supplemental irrigation based on rain water harvesting will help to increase yields further. A second area needing immediate attention and action relates to improving the productivity of wheat, rice, pulses and oilseeds in the Indo-Gangetic plains and eastern India, particularly in Bihar, Jharkhand, Chhattisgarh, Odisha, eastern Uttar Pradesh, West Bengal and Assam. According to a report of Chambers of Indian Industries (CII) and Mc Kinsey, the country's agricultural output by 2030 could reach Rs 29.28 lakh crore level and food exports could jump to over Rs 7 lakh crore. Consequently, processing could grow from Rs. 1.1 lakh crore to Rs 5.65 lakh crore by 2030 while India's food exports could grow from Rs 1.4 lakh crore to Rs. 7.72 lakh crore by 2030. The new Food and Agriculture Integrated Development Action (FAIDA) report focuses on mango, banana, potato, soybean and poultry which represent categories that are likely to drive the next wave of growth.

## NEED FOR CLIMATE CHANGE RESILIENT TECHNOLOGY

Climate change is the biggest threat to sustainable agriculture in the world. Global agriculture will need to adapt to climate change. The number of people on Earth is expected to increase from the current 6.7 billion to 9 billion by 2050. To accommodate the increased demand for food, world agricultural production needs to rise by 50% by 2030 (Royal Society, 2009). Compounding the challenges facing agricultural production are the predicted effects of climate change (Lobell *et.al.*2008). There is growing evidence that climate change has had negative effects on agriculture and particularly in developing countries. Agriculture (including deforestation) accounts for about one-third of greenhouse gas emissions; for this reason, it contributes significantly to climate change mitigation. Agriculture is the largest water user worldwide, representing about 70 per cent of total withdrawal. Agriculture is also a major source of water pollution from nutrients, pesticides, soils and other contaminants, leading to significant social, economic and environmental costs. It also damages the wider environment through the emission of greenhouse gasses. In some intensive farming systems, up to 50 per cent of available inorganic and organic nutrient inputs are not always utilized by crops or pastures, leading to significant pollution from nutrient run-off. The scenario is just opposite in the case of large parts of the developing world, where crop farming leads to a net extraction of nutrients from the soil.

While crops can be adapted to changing environments, the need to reduce emissions will increasingly challenge conventional, resource- intensive agricultural systems. Productivity growth needs to increase to keep up with demand growth, but also to supply shocks, whether due to climate change or due to resource limits more generally. Agriculture planning in future has to take into consideration the total scenarios of land, water and energy keeping in view the demand of food and other agricultural commodities. Indian Council of Agricultural Research has taken various initiatives to mitigate the impact of climate change such as National Initiative on Climate Resilient Agriculture (NICRA) and development of abiotic stress tolerant crops. During 2011-12, more than 15000 germplasm of wheat and 2000 germplasm lines of other crops like rice, maize, pulses were screened for drought, heat and submergence tolerance which are the major climatic stresses and more than 50 promising lines were identified in different crops which will be used for breeding purposes during next year. Drought and flood coping technologies were demonstrated on farmers' fields for adoption in large number of villages for up-scaling. For agriculture to respond to future challenges, innovation will not only need to improve the efficiency with which inputs are turned into outputs, but also conserve scarce natural resources and reduce waste.

## BETTER MANAGEMENT OF WATER RESOURCES

Availability of water is most critical for increasing the productivity in agriculture. In India, around 78 per cent water goes to the agriculture sector, while the remaining part shared out between drinking, industry and other usage. Therefore, it is required that water storage facilities to be increased in the country to 450 million cubic meter by 2050. Dry land agriculture should be the main focus area as more than 60 per cent of the cultivated area in the country is without irrigation. The Centre had earmarked 60 per cent of allocation to agriculture in dry land farming in the 12th Five Year Plan to provide major thrust to enhance agriculture production.

**Fig.1**: Resource Management Technology

## NEED TO INFUSE INNOVATIVE TECHNOLOGIES

Technology transfer in agriculture should focus on key interventions at different stages of the crop from sowing of the seed, crop protection, harvesting, post-harvest management and marketing. There is need to infuse innovation systems in agriculture that allow more sustainable use of resources, such as no-till farming,

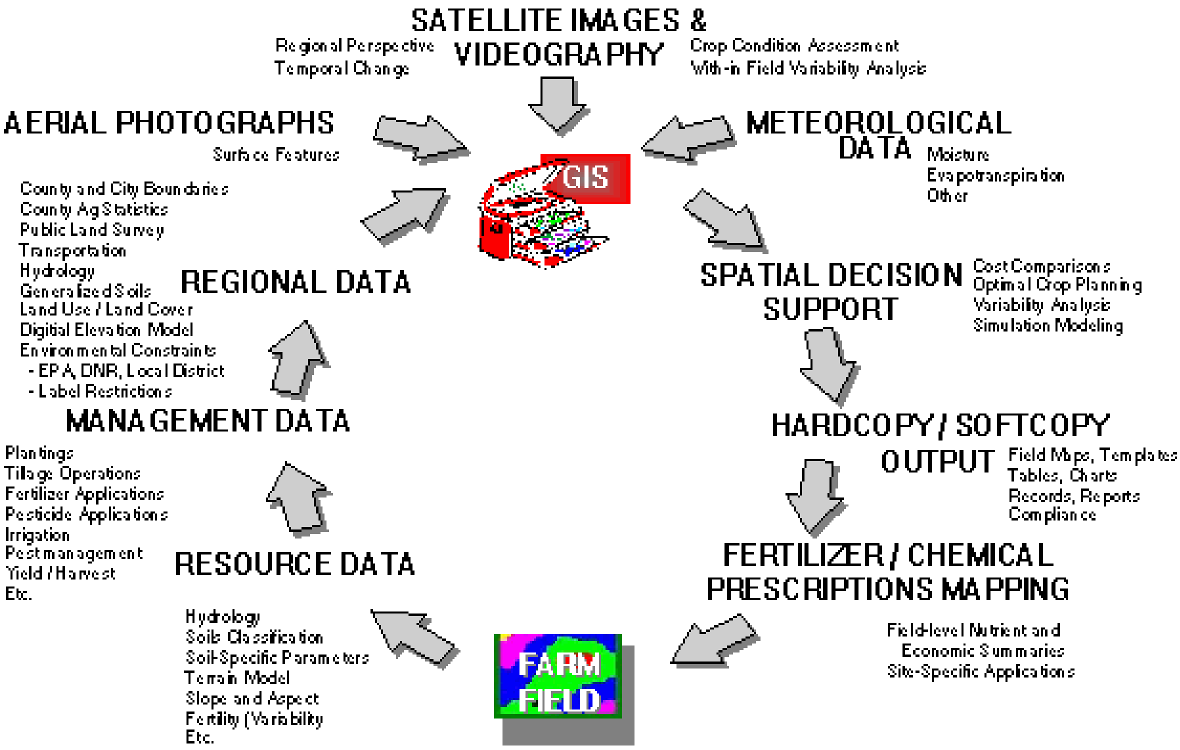


**Fig. 2:** GIS Networking

insect- resistant crops, more efficient irrigation, water management systems, sensors for nutrient status in crops, remote sensing, Global Positioning Systems (GPS) and Geographic Information Systems (GIS) to improve and monitor land use and SMS messaging for enhancing advisory services to farmers (Dabermann *et al.*, 2004). ICAR has taken number of steps for technology dissemination and human resource up gradation. Presently, more than 300 KVKs are providing Kisan Mobile Advisories to farmers on their registered mobile phones. In the year 2011-12, about 1.10 lakh short text messages (SMSs) were delivered to 13.40 lakh farmers for timely actions. Student ready scheme is one such thrust area for 12th Five Year Plan. Village Knowledge Centres, and online databases in local language should be established. Fast technology dissemination will certainly reduce the knowledge deficit with the farmers and will help in accelerating the stagnant growth of agriculture, realizing higher potential of our land and hard work of our farmers. Under this, students of around 11 branches of agriculture will be given training in skills, knowledge, attitude,

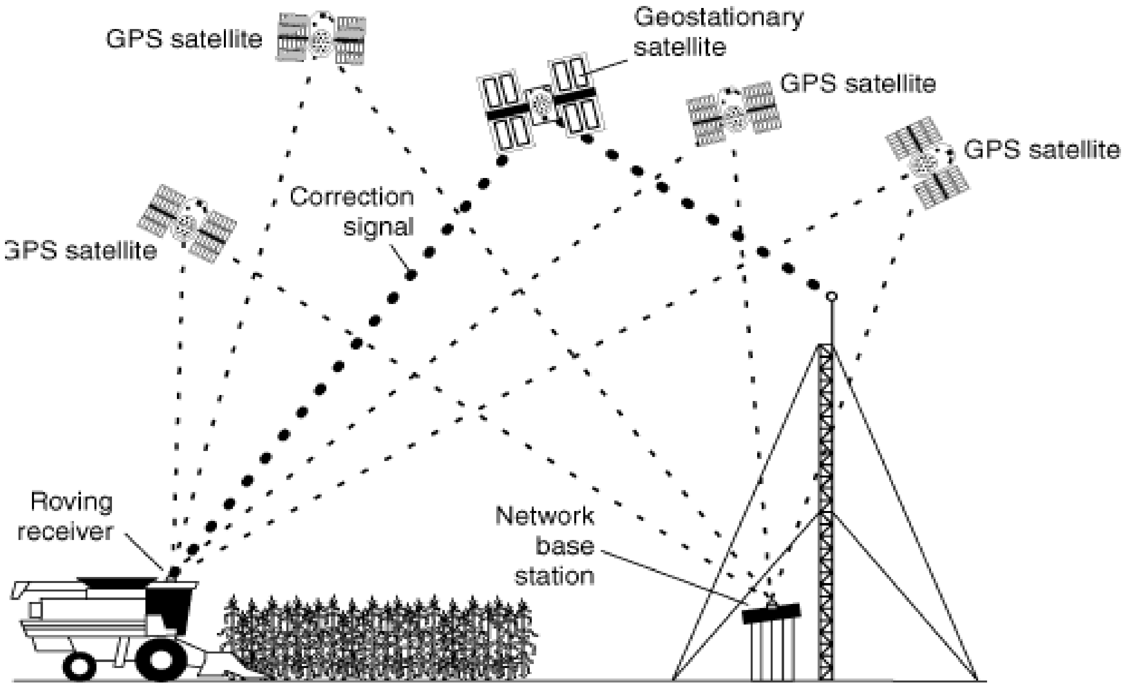


**Fig. 3**: GPS-Networking

innovation and confidence. The thrust of this scheme is to give hands on experience on working in rural areas and ICAR has come up with more than 300 experiential learning models for agri-graduates. Our traditional knowledge is also one of our important time tested technologic asset. Agricultural universities across India will now be able to take on board progressive farmers as teaching faculty in their respective institutions. It is known that a traditional Indian farmer has nearly 40-50 skill sets with him and that is why they can be equally good teachers on par with teaching faculty in agricultural varsities.

## POTENTIAL OF PLANT BIOTECHNOLOGY

Biotechnology is one of the important area which with the help of various technologies like Genetically Modified crops can lead our agriculture to a higher trajectory of growth. GM food crops along with other GM non-food crops were grown

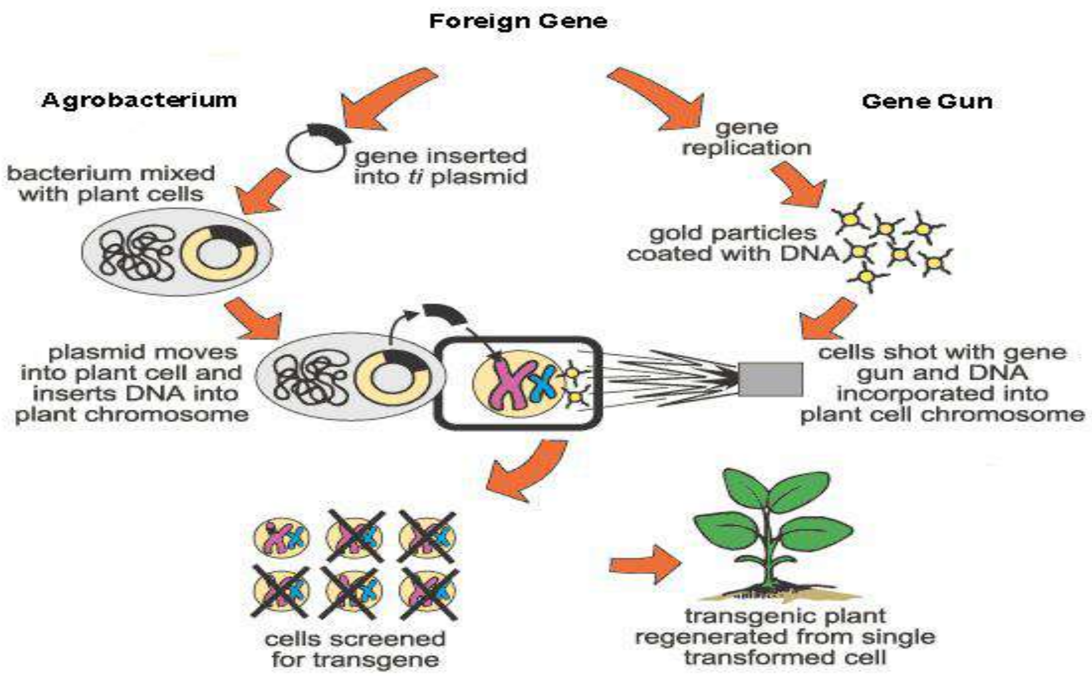


**Fig-4:** Development of Bt. Cotton

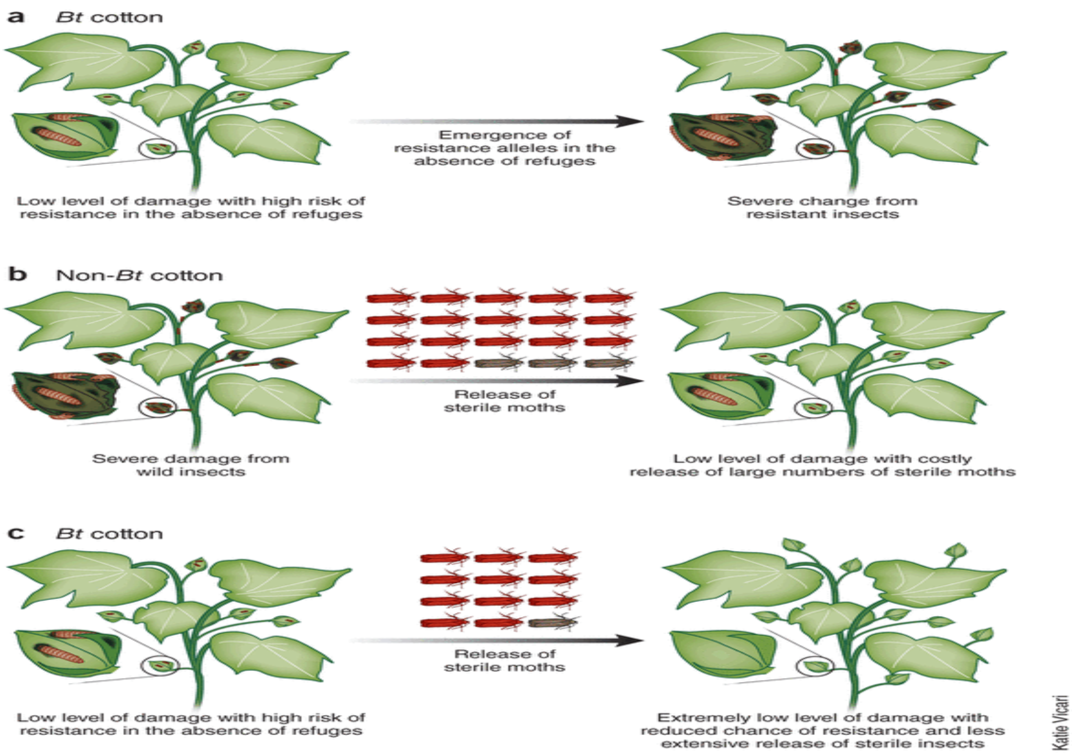


**Fig-5:** Bt. Cotton and Non-Bt. Cotton by farmers in 160 million hectares, in 2011 in more than 25 countries wherein the share of the developing countries is 46 per cent. India grows transgenic Bt. Cotton in 8.4 million hectares.

The government has approved 17 GM crops of 8 traits which are of virus- and bacteria-resistant as in 2012. The country has also developed golden rice which is rich in β-carotene. This is a great solution for India as nearly 5,000 children go blind every year because of β-carotene deficiency. According to the information from the National Research Centre on Plant Biotechnology, two golden rice varieties with vitamin-A - Swarna and Jaya would be tested in open fields in 2013 and the Bt pigeonpea and chickpea would be released for field trials in 3-4 years.

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# Role of refugia crop in maintaining Bt Cotton resistance

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Cotton (*Gossypium hirsutum*) is an industrially important crop. India annually produces 5.97 Million Metric tonnes of cotton. Bollworm is reported to be a major pest on this crop, which accounts for more than 70% of crop yield losses annually. To save the crop from attack of this destructive pest, farmers are using huge amount of insecticides, which subsequently increases the cost of production and also pollutes natural resources like soil and water. Transgenic *Bt* was introduced in India to reduce crop damage by bollworm infestation in 2002. *Bt* cotton is developed by incorporation of insecticidal genes from *Bacillus thuringiensis* like Cry1A, Cry1C etc., which provides resistance against bollworm (*Helicoverpa armigera)*. As cultivation of Bt cotton requires less amount of insecticide application, it reduces cost of production and it increases productivity.

Within few years after introduction of Bt cotton, bollworm acquired resistance against toxic Cry proteins. In the presence of selection pressure, only resistant bollworm can feed on transgenic cotton. Such resistant insects can multiply in Bt cotton field and a huge population of resistant bollworm population can build up. Eventually after few years of cultivation, effectiveness of *Bt* cotton against bollworm is reduced due to evolution of natural resistance acquired by bollworm insect against toxic Cry protein. In the recent past it has been observed that *Bt* cotton is getting affected by bollworm. This is typical case of breakdown of *Bt* resistance and has many reasons such as development of *Bt*-protein resistance insect population, outbreak of similar kind of non-targeted pest and proper cultivation practices not followed by the farmers.

Increasing attack of pink bollworm is considered as outbreaks of minor pest as major pest and there are no genes and characteristics present in the *Bt* cotton to kill the pink bollworm. It is therefore necessary to adopt proper cultivation practices for management of insect resistance present in the crop plant. The planting of 20% refugia crop (non-*Bt* cotton) around the *Bt* cotton is an important practice for maintenance of *Bt*-cotton resistance against bollworm. The refuge designs that can be followed in *Bt* cotton is depicted in Fig. 1. The private seeds companies and agencies, provide a small packet of non-*Bt* cotton seeds along with *Bt* cotton seeds and instruct farmers to sow at least 5 rows of non-*Bt* cotton in each border of *Bt* cotton field. Bollworms that attack transgenic *Bt* cotton get killed due to presence of insecticidal protein present in it. If any insect gets acquired resistance against these insecticidal proteins will able to survive on *Bt* cotton. The self-mated progenies of this resistant insect lead to development of resistant insect population in further generations. Outbreak of such resistant insect population is responsible for breakdown of resistance present in the *Bt* cotton variety. If there are susceptible insects in the fields, resistant bollworm can randomly mate with the susceptible bollworm. As resistance is recessive trait progeny developed from the mating of susceptible bollworm and resistant bollworm becomes susceptible to Bt cotton. The probability of the susceptible insects mating with the resistant insects from *Bt* plants would be high due to presence of large population of susceptible insects from the non-*Bt* refuge. Hence having a refuge in close proximity helps in maintaining the effectiveness of Bt protein. The Genetic Engineering Appraisal Committee (GEAC), Govt. of India has recommended to grow 20% refuge of non-*Bt* (5 border rows) cotton along with *Bt* cotton. Non Bt refugia may be subjected to insecticide spray whenever required. Recently pigeonpea has also been approved as refugia to be cultivated as border rows around *Bt* cotton.

In India most of the cotton farmers do not follow refugia cropping practice. Farmers also lack of awareness regarding refugia crop. Most of farmers consider planting of 5 rows of non-*Bt* cotton around the *Bt* cotton is the wastage of their 20% cultivated land. Non-*Bt* cotton (refugia) is more prone for attack of bollworm. Hence, farmers always think that it is threat and can spread bollworm from refugia to *Bt* cotton. Apart from this, the farmers who have adopted the refugia cropping practice did many rounds of insecticide spraying to control the attack of bollworm on refugia crop thereby increasing the insecticide load.

## CONCLUSION

Planting of refugia/non-*Bt* cotton in about 20 % of cotton cultivated land is necessary to maintain the *Bt* resistance and for avoiding the outbreaks of resistance in bollworms. Spraying of insecticides on refugia crop should be avoided, as the purpose of planting refugia crop is to maintain susceptible bollworm population. If the farmers are not willing to grow non-*Bt* cotton, they can be encouraged to grow pigeonpea as alternate refugia crop with in *Bt*-cotton.

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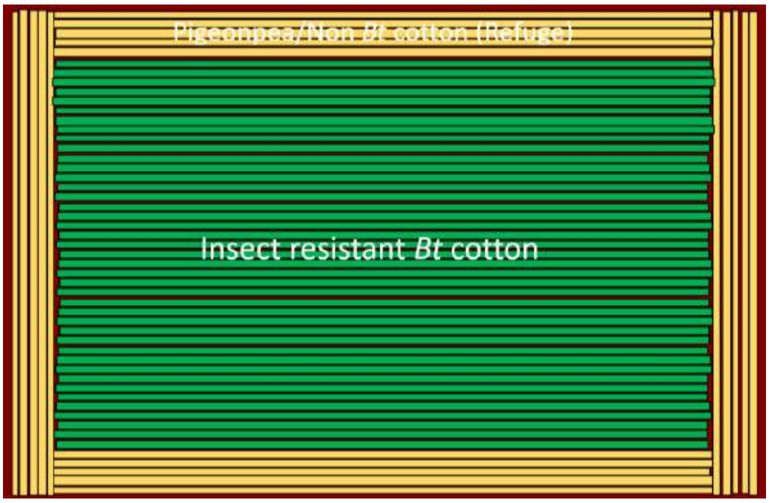


**Fig. 1** Refugia design for *Bt* cotton

# Scientific Management of Pests and Diseases in Radish Cultivation

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## 1. INTRODUCTION:

*Raphanus sativus L.,* 2n = 2x = 18, the cultivated radish, is thought to have originated in cultivation and is not listed as an indisputable wild plant in any flora. It exists as a number of botanical varieties, the one of greatest commercial importance being *Raphanus sativus var. radicula.* Radish is best adapted to a mild to cool climate. The Asiatic cultivars with greater temperature adaptation it can resist heat more than the European cultivars. The roots best flavour, texture and size at cool temperature range of 10°-15°C. Long day and high temperature favour early bolting even prior to proper development of roots. Normally the plants bolt when days are 8-10 hr long. At lower temperature, pungency is reduced and crop can easily withstand frost. Low temperature is a critical factor causing flowering, which is accelerated by long photo period. Radishes can be grown on nearly all types of soils, but best results are obtained on light, friable, loam soil that contains ample humus. Since it is a short duration crop, it can be grown on types of soil that are not considered satisfactory for other root crops. For early crop, sandy or sandy loam soils are preferred; however, for summer crop a cool, moist soil gives best result. Usually, heavy soils produce rough, misshapen roots with a number of small fibrous laterals and such soils should be avoided. Well drained sandy loam rich inorganic matters with pH 5.5 – 6.8 are best suitable. The Tropical or Asiatic Varieties are Pusa Desi, Pusa Reshmi, Pusa Chetki, Arka Nishant, Chinese Pink, Co- 1, Japanese White, Punjab Safed and Jaunpuri Giant or Newari whereas Temperate or European types are Pusa Himani, Rapid Red White Tipped, White Icicle, French breakfast, Scarlet Lon, and Scarlet Globe.

## 2. INSECT PESTS

### 2.1. Mustard saw fly (*Athalia lugens proxima*)

Grubs alone are destructive. They make hole preferably in young leaves and skeletonise them sometimes eating away even the epidermis of the shoot. The seedlings become dry and fail to bear seeds in older plants. Larvae are dark-green with black dorsal stripes and wrinkled body. The activity of mustard saw fly id found from July to March.

#### 2.1.1. Management

Summer ploughing to destroy the pupa of mustard saw fly. Collection and destruction of grubs of saw fly in morning and evening and use of bitter gourd seed oil emulsion as on anti-feedent. Installing pheromone trap to monitor and control diamond back moth adult. Application of Phosphamidon dust 0.02 per cent or 0.075 per cent Endosulfon or Dichlorvous. Following natural enemies efficiently control the pests: Lady bird beetles (*Coccinella septempuncttata*) and *Syrphus serarius* are parasitoid for mustard aphid and *Perilissus cingulator* parasites the grubs of mustard saw fly and *Cotesia plutellae* is an important parasitoid for diamond back moth

### 2.2. Cabbage Borer (Hellula undalis Fabr.)

The larva in its first two instars mines the leaf along the sides of the vein and tenders it a papery white structure with excreta filled in it. Thereafter, it nibbles the leaf and later feeds within the head of the cabbage. In severe attack, the plants become weak and produce deformed heads.

#### 2.2.1. Management

Spraying the crop with Malathion (0.1%) or dusting 4% Carbaryl gives excellent control of the larvae. Use clean planting materials: transplant only healthy, vigorous insect-free seedlings.*Bacillus thuringiensis var. aizawai* and *Bt var. kurstakiare* very effective in controlling infestations of the cabbage webworm*. Bt var. kurstakiis* widely used at a weekly interval and a rate of 0.5/ha.

### 2.3. Painted bug (Bagrada cruciferarum)

Both nymphs and adults do the damage by sucking plant sap, often in clusters. The attacked plants look like sickly, dry up or get stunted.

#### 2.3.1. Management

Clean cultivation by removing weeds harbouring this pest is imperative for avoiding infestation of these bugs. In case of heavy infestation, spray with 0.05% Dichlorvos or 0.05%, Endosulfan or 0.05%. At least 7 - 10 days waiting period should be there between treatment and harvest.

## 3. DISEASES

### 3.1. Fungal

#### A. Alternaria Blight (Alternaria raphani)

The pathogen affects leaves, stem, pods and seeds. Symptoms of the disease first appear on the leaves of seed stem in the form of small, yellowish, slightly raised lesions. Lesions appear later on the stems and seed pods. Infection spreads rapidly during rainy weather, and the entire pod may be so infected that the styler end becomes black and shrivelled. The fungus penetrates in pod tissues, ultimately infecting the seeds. The infected seed fails to germinate.

**A.1. Management**

Though hot water treatment of the seed kills the fungus, use of diseases- free seeds is recommended. Regular spraying with Difolatan (0.3%) or Dithane M 45 (0.2%) or Ridomil (0.1%) controls the disease effectively

**B. White rust (Albugo candida)**

White rust is one of the most destructive foliar diseases of radish. White rust, sometimes called white blister, is easily recognized by the chalk-white, cheesy, raised spore masses (sori) which occur mostly on the underleaf surfaces severe outbreaks commonly occur in the spring and fall months during prolonged periods of cool dewy nights and slightly warmer days. It affects the leaves, petioles, stems, and roots. Normal root development is retarded, causing the primary root to be woody and form numerous lateral roots. Secondary, rot-producing bacteria and fungi may enter through white rust infections and cause additional losses. Affected leaves may wither and drop prematurely weakening the plants

**B.1. Management**

Clean cultivation, using the resistant varieties help to prevent the disease. Regular spraying with Dithane Z 78 (0.2%) effectively controls the disease

**C. Club root (Plasmodiophora brassicae)**

Clubroot disease is caused by an obligate pathogen and is one of the most serious diseases of cruciferous crops. The pathogen infects the roots of plants, causing abnormal growth and, eventually, a massive gall called a club. The abnormal growth prevents the root from absorbing water and nutrients, resulting in slow growth of the host plant. Consequently, the disease reduces the quality and commercial value of the products. Because the pathogen survives as resting spores for long periods in the soil, it is hard to control the disease using cultural practices or agrochemicals.

**C.1. Management**

Crop rotation and clean tillage help reduce the risk of disease by reducing the amount of primary inoculums. Crop rotation with non-host species. Hydrated lime incorporated into the soil to raise the pH to 7.2 reduces club root.Growing club root resistant varieties

**D. Root rot of Radish (Erwinia rhapontici)**

It is a bacterial disease, which spreads through implements and irrigation water. Symptoms appear as rotting of pith tissues resulting in cavity formation and wilting of plants. The disease spreads when the roots are transplanted for seed production.

**D.1. Management**

Dipping of the seeds in a solution of Agrimycin-100 (100 ppm) at the time of sowing is effective in check the disease.

**3.2. Viral diseases**

**3.2.1. Mosaic I**

The disease is transmitted by aphids. Mosaic mottling of young leaves often associated with inter-veinal chlorotic areas which gradually increases in size. Finally coalesce to form irregular chlorotic patches.

**3.2.2. Mosaic II**

It is also transmitted by aphids. The affected plants are conspicuous by stunting, reduced leaf lamina and root size. Diseased leaves show interveinal chlorosis, vein banding and dark green patches on light green leaves.

**3.2.3. Phyllody (Phytoplasma)**

The disease is transmitted by jassid *Orosius albicinctus*.The diseased plants assume a dull-grey to light violet colouration and thus can easily be distinguished from a distance. The symptoms of the disease appear at the time of flowering where all the floral parts become green thick knob-headed leaves. The ovules are transformed into leafy structure. The disease is caused by Phytoplasma and the disease incidence may vary from 5-20%.

**3.2.4. Management**

The disease spread can be minimized by uprooting and burning of infected plants as soon as detected in the field and using safer insecticides to control the insect vector which spread the disease. Soil application of Thimet 10-G (1.5 kg a.i./ha) is also recommended. The application of Thimet should be followed by irrigation.Spraying of Monocrotophos (0.05%) or Malathion (0.1%) at 10-15 days interval contains aphid population effectively. To prevent recurrence of the pest granular insecticides like Phorate @1.0 kg a.i./ha should be applied to soil.

## CONCLUSION

The various scientific management of pest and disease can be successfully utilised in radish production for quality roots.

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# Phytoremediation of Contaminated Soils and Water

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Contamination of soil and water by heavy metals owing to agricultural and industrial activities assumes serious concern, which eventually proves harmful to all living forms. Heavy metals are defined as elements with metallic properties and atomic number greater than 20. The most common heavy metal contaminants are Cd, Cr, Cu, Hg, Pb and Zn. Heavy metals do not undergo chemical or microbial degradation and persist in the soil for longer period and need to be physically removed or transformed into non-toxic compounds. They constitute a very heterogenous group of elements extensively varied in their chemical properties and biological functions. Various methods are by now being used to clean up the environment from these types of contaminants, but most of them incur high costs. Chemical and thermal methods are both technically difficult and expensive, contribute to deterioration of the valuable constituents of soils. Heavy metal contaminated soils are conventionally remediated either through onsite management or excavation and consequent disposal to a landfill site shifting the contaminants to another place along with perils associated with transportation of contaminated soil and movement of contaminants from landfills into an adjacent location. An alternate way to excavation and disposal to landfill is soil washing, but it is very costly and results in production of heavy metal rich residue.

Emerging apprehensions concerning environmental pollution have paved the way for the development of suitable technologies to evaluate the existence and movement of metals in soil, water and wastewater. Currently phytoremediation has become an operative and reasonable panacea utilized to extract or remove inactive metals and metal pollutants from contaminated soils. The utilization of plants to clean up contamination from soils, sediments and water is referred as phytoremediation. Phytoremediation is economically viable and ecofriendly. The generic term "phytoremediation" is derived from *phyto* (Greek) meaning *plant* and *remedium* (latin) meaning *to correct*. Metal accumulating plant species can accumulate heavy metals like Cd, Zn, Co, Mn, Ni and Pb upto 100 or 1000 times when compared to non-accumulator plants. Microorganisms bacteria and fungi living in the rhizosphere closely in association with plants might contribute to metal ions mobilization, enhancing the bioavailable fraction. The mechanisms involved in heavy metal uptake by plants through phytoremediation is elucidated below:

A. **Phytoextraction**: It is the uptake or absorption and translocation of contaminants by plant roots into the above ground portions of the plants (shoots) that can be harvested and burned gaining energy and recycling the metals from the ash.

B. **Phytostabilization**: It is the use of certain plant species to immobilize the contaminants in the soil and groundwater through absorption and accumulation in plant tissues, adsorption onto roots or precipitation within the root zone preventing their migration in soil as well as their movement by erosion and deflation.

C. **Rhizofiltration**: It is the adsorption or precipitation onto plant roots or absorption of contaminants in the solution surrounding the root zone. Rhizofiltration is similar to phytoextraction but the plants are used primarily to address contaminated groundwater rather than soil.

D. **Phytovolatilization**: It is the uptake and transpiration of a contaminant by a plant, with release of a contaminant or a modified form of the contaminant to the atmosphere from plant.

**Selected plant species used for phytoremediation**

| Plant Species | Heavy metal |
|---|---|
| *Ricinus communis* | Cd |
| *Populus deltoides* | Hg |
| *Astragalus bisulcatus* | Se |
| *Populus canescens* | Zn |
| *Salix viminalis, Salix fragilis* | Cd, Cu, Pb, Zn |
| *Jatropha curcas* | Cd, Cu, Ni, Pb |
| *Populus deltoides, Populus nigra, Populus trichocarpa* | Cd, Cu, Pb, Zn |

## ADVANTAGES OF PHYTOREMEDIATION

- In comparison to physical and chemical techniques, phytoremediation is widely acceptable, aesthetically fair and causes low levels of disruption
- It incurs less cost, effective in contaminant reduction and pertinent for wide range of contaminants
- It is environment friendly method and referred as *green technology*

## DISADVANTAGES OF PHYTOREMEDIATION

- The principal limitation associated with this technology is root contact, the contaminants need to be in contact with the root zone of the plants to accomplish remediation

- Contaminated plant biomass consumption by animals may find its path into food chain hence the harvested plant biomass from phytoextraction may be disposed with utmost care.
- The rate of growth of plants utilized for phytoremediation is largely governed by climatic conditions
- It is mainly restricted to sites with low contaminant concentrations

## CONCLUSION

Phytoremediation can be regarded as a viable strategy to remediate heavy metal contaminated soils and water. Selection of suitable plant species plays a prominent role in attaining remarkable results by application of this technology. Coupled with advantages, phytoremediation also has few limitations which calls for long-term and extensive research to attain decontamination and management of heavy metal polluted sites.

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# Role of quality seed in feeding of mounting population

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Indian Agriculture contributes nearly 18 per cent of the GDP and the total production level has reached up to 277 million tons with the concentrated efforts of agricultural scientists, planners and farmers. Indian human population has crossed the 1.2 billion mark and is projected to reach 1.3 billion by the year 2030. There will be a need of nearly 350 million tons of food grain, excluding the requirements for seed and export which is a great task before the agricultural scientists to achieve. In order to achieve the projected demands, the average yield of food grains will need to be increased by about 1 ton per hectare between now and the year 2030.

This gap can be bridged either by increasing the land under cultivation and/or increasing the yield per ha. The first option is not feasible due to increased demand for land under road, houses and factories. Moreover, the arable earth surface is deteriorating and decreasing as a result of soil erosion, salinization and acidification. It is possible to increase gross sown area to some extent, through increasing the cropping intensity. Second option may be achieved and is possible by:

- Ensuring availability and efficient use of water, fertilizer and plant protection measures,
- Timely planting of quality seeds and ensuring desired plant population and
- Development and release of more productive varieties.

When we talk about quality seed, it includes two components *viz.* seed of improved variety and seed quality parameters.

## Improved varieties

In fact, in the year 1960, when the process of modernization of Indian agriculture was initiated, the vision was to increase production in irrigated and more fertile lands so that the serious food shortage that was prevalent could be wiped out. The challenge had been successfully met and will continue to be met, thanks to the good work done by agricultural scientists in many parts of the country. More than 2500 high yielding varieties and hybrids have been released for commercial cultivation in different crops, out of which about 700 varieties are in active sheet production chain. However these high yielding varieties could not spread up to desired level due to many reasons.

To increase the adoption and spread of high yielding varieties by more farmers, extension activities and availability of seed should be strengthened and quality seed should reach the farmers.

## Seed quality parameters

To define quality seed, four parameters *viz.,* physical purity, germinability and vigour, health and genetic purity (true to type) are important. The physical purity means that farmers should sow only pure seed without any kind of mixture of other crops seed, weed seed and inert matter. The plant population at desired level could be maintained, if farmer will sow quality seed at the recommended quantity per acre. Seed health is related again to the population of healthy and productive plants in the field as unhealthy seeds either will not germinate or die before flowering or will give poor vigour of plant. In fact each variety has been developed for specific agro-climatic zone and specific agricultural practices. Hence mixture of two different varieties recommended for different agro-climatic zone will not give full potential in a given environment. Moreover, quality of produce may also reduce, which in turn will not fetch proper market price.

## Yield productivity

Now the question arises how the quality seed and seed technologists can achieve the targeted food grain production in 2030 and beyond? In fact productivity (yield $ha^{-1}$) of a variety is the resultant of yield per plant and plant population per ha. The yield per plant is further representative of genetic potential of the variety/genotype and vigour of the plant. Maintenance of plant vigour and population per unit area is the need of the hour.

## Seed: A basic input for higher productivity

Improved seed is a catalyst for making other inputs cost-effective *viz.* fertilizer, irrigation, insecticide and weedicide. Seed demands had increased as farmers realized its catalytic effect in harvesting the full potential of modern high yielding varieties. In early stage, the NSC (National Seeds Corporation) alone played the role in disseminating scientific seed production technology and supply of quality seed to the Indian farmers. Subsequently, almost every state developed its own seed corporations and seed certification agencies. Forty-one breeder seed production units (crops) were also established. The country also launched “new open door policy” (New policy on seed development, 1988). However, all these efforts could not make any dent in seeds apply particularly of food grain crops. Large area under food grain crops is still sown with seeds saved by farmers. Experimental evidences are there that cereal crops give 10 to 20 per cent less yield per ha when farmers use their own saved seed. With simple calculation, one could say that about 20 to 30 million tons food grain production may be added in our total production through the use of quality seed of improved varieties and hybrids.

In spite of the fact that India was first in world to develop hybrid in a number of crops, yet the area coverage under hybrids is quite low. Hybrids’ proportion of total seed produced is not very satisfactory. Ideal condition to boost the production is to increase the area under quality seed up to 100 per cent if possible and under hybrid in the crop where hybrid is available. In non hybrid crops, replacement rate of quality seed should be ideally 33per cent in self-pollinated and 50 per cent in cross-pollinated crops. Based on research, it was found that the seed quality deteriorate within 2 to 3 years, when farmers used their own saved seed continuously.

As per the Indian Seeds Act, seed production passes through three generations system *i.e.* breeder seed, foundation seed and certified seed, and sometimes, either foundation or certified seed class happens to be twice. Therefore, the seed, which reaches the farmers, passes through four multiplication cycles. Deterioration of varieties occur during stages of repeated multiplication cycles as a result of mixture, unwanted out-crossing, segregation resulting from unwanted pollination and rarely mutation and genetic drift and they create problems in variety performance under specific zone or sub-zone or specific location. In fact, in spite of application of suggested operational farming system, farmers cannot exploit the full potential of specific variety selected for his area unless its own is true-to-the type. The true-to-the type seeds have the specific genetic constitution to respond to Physical inputs. Therefore, there is a need to strengthen the seed production programme.

## Seed programme: A new Outlook

A seed programme can be defined as an "outline of measures to be implemented and activities to be carried out to secure the timely production and supply of seed of a prescribed quality in required quantity". Seed production and testing techniques for each crop should be developed and popularized as soon as they are released. In India, seed production program is in the hands of organized and unorganized sector (farmers). In fact, most of these farmers are resource poor and do not have expert hand in their command. They need technical and financial support to produce the quality seed and also store them properly up to next sowing season. It would be more practical and financially viable to identify a group of farmers having better resources like land and water, in each district and provide them seed and technical support.

Some may support participatory approach in seed production. If we look critically, seed production is not the only problem; the real problem is to make available the quality seed in required quantity at right time to the resource poor farmers. If we can do this, the seed production programme will reach up to small farmers and seed produced by them will spread from farmer to farmer, preferably through better barter system. In earlier days, barter system was popular in our country particularly for seed at the time of planting. Small and marginal farmers are not financially capable to purchase the seed. Therefore, barter system will be helpful in spreading of quality seed. In barter system, farmers usually get seed for sowing from another farmer who has produced quality seed in exchange of 1.25 or 1.50 times grain after the harvest of his crop which has been produced by that seed.

## Seed: A carrier of new varieties to the farmers

A breeder releases the new variety after confirming its suitability by repeated multi-location tests. New varieties can achieve its potential in adopted area under recommendation operational farming system. Neither good quality seed of poor varieties nor poor quality seed of superior varieties serve farmers well. Success of a new variety depends on supply of quality seed in time. Faulty seed production and supply program fails to justify the novelty of a new variety among the farmers and that variety will die before it spreads. It happens sometimes due to lack of availability of quality seed of newly released variety and very often, poor quality seed and spurious seed give wrong message to the farmers. Therefore, a seed production program must be designed and strengthened in such a way that sufficient quantity of quality seed reaches the farmers at right time. The availability of sufficient quantity of quality seed in the market will check the marketing of spurious seed. A seed technologist can access seed quality more precisely. Moreover, quality seed creates the demand for other inputs like fertilizers, pesticides and water.

## Quality seed in less favorable production area

Quality seeds, particularly seed lot of high vigour, give comparatively better results under unfavorable conditions such as low moisture, rainfed cultivation and high soil salinity or alkalinity. There are varieties resistant/tolerant against the abiotic factors, but can work only if seed of good vigour is possible to be distributed to the farmers. Hard crust formation due to immediate rains after sowing creates the problem in emerging out of the seedlings. Vigorous seeds may give better emergence in such conditions. Aged seeds with poor vigour may fail to give the profitable returns to the farmers. Adoption of new technology like seed hardening, pelleting and priming developed by seed technologists could help the farmers in such situations in maintaining the plant population stand at optimum level and farmers may have better harvest.

In recent past, as commercial introduction of transgenic crops are welcomed particularly in highly insect infested areas, role of seed technologists have become more important. In fact release of transgenic crops is not the end of story; more scientific methods of commercial multiplication of planting material with high genetic purity and vigour are important for them. Test of the trans-gene(s) in the crop is also essential. Otherwise, crop may fail to give targeted results at farmer's field. It has been observed in some cases that the trans-gene(s) has either become silent or has lost in subsequent cycle of multiplication. Farmers will grow, unknowingly, transgenic crop with mixture of non transgenic plants (trans-gene become lost or became silent). In such situation, chances are there that pathogen may infect more vigorously on non-transgenic plants. There are evidences to support that heavy multiplication of pathogen on susceptible plant forced the attack on resistant plant (in the absence of susceptible host plant in near vicinity). If a plant is of the high resistance, pathogen will be forced to develop new biotype. It is a natural law of struggle for survival. To avoid this disastrous situation, transgenic crops should be grow with high genetic purity, which should be maintained during seed multiplication

## Seed: A tool to serve in disaster

Before 1917, U.K. was dependent on other countries for food materials and they were getting it cheaper than their own growing. But after First World War, it became difficult to receive regular supply of food material from other countries and it was felt necessary to produce own crop and the importance of seed was realized. The British government passed an emergency Seeds Order- 1917. Further to monitor the seed quality, National Institute of Agricultural Botany (NAIB) was established in 1919. The lessons learnt from U.K. underline the need to improve seed quality production work and develop national seed reserve stocks. Dependence on MNCs and other countries will not serve the purpose on a long-term basis. Need may arise due to unpredictable calamities like war, drought, flood etc., and seed crops may fail. The MNCs actively engaged in seed business may suddenly stop their activities on pretext of any government policy decision or any decision regarding seed quality law enforcement. One can argue that under such situation, the Government of India can take up the multiplication of the seed under the compulsory licenses granted under "The protection of plant varieties and farmers- Act 2001". But at the same time, registration under this act is not compulsory and most of the MNCs with fear of loss of identity of parental material of hybrids will not get registration under this Act. Some say that seed may be used as war weapon. Before the situation of this kind of colonization arises, the country's seed programme should be strengthened and prepared for, if needed, immediate and rapid rehabilitation for agricultural under disaster situations. The establishment of national seed reserves stocks should receive higher priority. Generally, seed production is based on sexual cycle and seed multiplication a particular multiplication ratio to reach up to the desired quantity takes 3-4 crop seasons. Moreover, seed of an improved variety developed by pedigree method in a self pollinated crop is not possible to regenerate, if lost, with the same quality characteristics. Seed storage researchers have developed techniques to store the seeds for short, medium and long duration without losing quality. Further, researchers have suggested seed storage under natural cold climate conditions available in the country, without much energy utilization.

Seed Technologists are component in providing the technical assistance to Law Enforcement Agencies in eradicating or reducing at lowest levels the malpractices in seed trade. Along with cereals and pulses, if production and supply of quality vegetable seeds can also be made available, it will ensure the nutritional security and decrease, up to some extent, the demand of food grains. Both national and multinational seed companies have done a good job in improving the vegetable scenario. However, we need more progress in this direction too.

# Management strategies for control store grain pest

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**Abstract**

Stored grain infestation is a very serious problem as various life stages of insects cause economic damage and deteriorates the quality of food grains and food products. There are number of stored grain insect pests that infest food grains in farmer stores and public ware houses and massively surge due to un-controlled environmental conditions and poor ware housing technology used. However, for suppression of multiplying insect population highly specific and more appropriate modern methods are to be used. Few important methods such as microwave and ionizing irradiation, pheromone baited traps, IGRs and use of entomopathogens are proved highly effective against stored grain insects. Over these methods, repellents and oviposition inhibitors isolated from various plant species are considered as much safer in comparision to synthetic pesticides. These natural pesticides have no side effect and are biodegradable in natural environment.

**Key words:** *IGRs, Entomopathogens, Oviposition inhibitors.*

## INTRODUCTION

The origin of insect pests of stored grain is not well known. Undoubtedly, they lived in the fields, some of them breeding in supplies of seed that escaped the attention of birds and animals, and others feeding on the dried or decaying remains of plant or animal life, while still others bored into the roots, tubers and stems of plants. The custom of storing seeds, roots, herbs and dried meats for food adopted by man in early times provided an easy living for insects that were accidentally brought in with these stores. Ideal conditions for breeding provided by such stores made it unnecessary for these insects to fly long distances in their search for food. Whether or not it is the result of leading such an easy living and the lack of need for flight, it is true that a number of pests of stored grain have completely lost the power to fly. The granary weevil (*Sitophilus granarius* L.) has in fact lost all but the vestiges of its wings, although the closely related rice weevil (*Sitophilus oryzae* L.) is still a powerful flier. Evidence indicates that many of the animals that trouble stores of grain today were prevalent in ancient times.

Damage of stored food grains is very serious, problem in South-East Asia and throughout the globe. Due to lack of proper ware housing facilities, stored grain insects largely damage food grains in stores as well as during shipping and transportation. For better protection appropriate methods for disinfecting the food grains are required. Farmers, through a long history of battle against stored product pests, have learnt to exploit natural resources, or to implement accessible methods, that would leads to a degree of population suppression of pests.

## ASSESSMENT OF LOSSES:

Losses can occur at several stages of the postharvest chain, including threshing, storage, transport, milling, wholesale and retail distribution. There has been a tendency to overestimate storage losses mostly based on guesswork rather than on sound empirical testing. Losses to the extent of 30% or more are not uncommon (Greeley, 1987). According to one estimate, postharvest losses during storage may be as high as 25–30% (Champ, 1985). By contrast, the results of more detailed field studies suggest that, under traditional storage systems in tropical countries, losses are typically around 5% over a storage season (Tyler and Boxall, 1984), depending on the crop, the ambient conditions, the period of storage and other factors. Somewhat

higher levels have been encountered in the wetter parts of West Africa and Central America. Even losses around the 5% level should not be considered insignificant, as the physical losses are usually ac companied by qualitative losses affecting the mass of the grain in store. Furthermore, the losses are mainly experienced during the lean season before the new harvest is ripe, thereby having an adverse effect on the food security of farming families at a particularly critical period. To overcome this problem, farmers in Honduras have adopted metal bins for storage.

Worldwide losses in stored products, caused by insects, have been estimated to be between five and ten percent. Heavier losses occurring in the tropics may reach 30%, and the net value of losses in storage in the United States has been placed at over $200 million annually. While several procedures to manage pests are used at storage facilities before storage, those that minimize pest invasion into storage structures include:

- Cleaning bins, harvest and loading equipment prior to harvest and after bin emptying,
- Applying "empty-bin" insecticides to the inside of the structures, Sealing structures, Cleaning up grain spills on the grounds, Removing weeds close to structures.
- Since higher moisture can encourage mold and insect development, additional management techniques also include:
- Storing sufficiently dry wheat (less than 13%),
- Aerating the stored grain with fans to cool the wheat thus slowing insect development,
- Close monitoring of grain temperature and insect populations.

## INTEGRATED MANAGEMENT OF STORED PRODUCE PESTS

The control methods of stored produce pests can be categorized into preventive and curative measures.

### Preventive measures

• Brush the cracks, crevices and corners to remove all debris in the godown.

• Clean and maintain the threshing floor/yard free from insect infection and away from the vicinity of villages.

- Clean the machines like harvester and thresher before their use.
- Made the trucks, trolleys or bullock carts free from infestation.
- Clean the godowns/ storage structures before storing the newly harvested crop to eliminate various bio stages of pest hiding.
- Provide a metal sheet upto a height of 25 cm at the bottom of the wood in doors to arrest the entry of rats.
- Fix up wire meshes to windows, ventilators, gutters, drains etc., to prevent entry of rats, birds and squirrels.
- Remove and destroy dirt, rubbish, sweepings and webbings etc from the stores.
- Close all the rat burrows found in godown with a mixture of broken glass pieces and mud plastered with mud/ cement.
- Plaster the cracks, crevices, holes found on walls, and floors with mud or cement and white wash the stores before storing of grains.
- Provide dunnage leaving gangway or alleyway of 0.75 to 1 m all around to maintain good storage condition.
- Store the food grains in rat and moisture proof storage structures.
- Disinfest the storage structures receptacles by spraying malathion 50 EC @ 3 lit 100 m before their use.

## CURATIVE MEASURES

**Ecological methods:**

- Manipulate the ecological factors like temperature, moisture content and oxygen through design and construction of storage structures/ godown and storage to create ecological conditions unfavourable for attack by insects.
- Temperature above 42°C and below 15°C retards reproduction and development of insect while prolonged temperature above 45°C and below 10°C may kill the insects.
- Dry the produce to have moisture content below 10% to prevent the buildup of pests.
- Kill the pests bio stages harbored in the storage bags, bins etc., by drying in the sun light.
- Store the grains at around 10 % moisture content to escape from the insects attack.
- Manipulate and reduce oxygen level by 1% to increase the CO2 level automatically, which will be lethal to all the stages of insects.

**Physical methods:**

- Provide a super heating system by infrared heaters in the floor mills and food processing plants to obtain effective control of pests since mostly the stored produce insects die at 55 –600C in 10 – 20 minutes.
- Modify the storage atmosphere to generate low oxygen (2.4% and to develop high carbon di oxide (9.0 – 9.5) by adding CO2 to control the insects.
- **Seed purpose:** Mix 1 kg of activated kaolin (or) lindane 1.3 D (or) malathion 5 D for every 100 kg of seed and store/pack in gunny or polythene lined bags.
- **Grain purpose:** Mix 1 kg activated kaolin for every 100 kg of grain and store. To protect the pulse grains, mix activated kaolin at the above dosage or any one of the edible oils at 1 kg for every 100 kg of grain or mix 1 kg of neem seed kernel for every 100 kg of cereal / pulse and store. Do not mix synthetic insecticides with grains meant for consumption.

**Cultural methods:**

- Split and store pulses to escape from the attack by pulse beetle since it prefers to attack whole pulses and not split ones.
- Store the food grains in air tight sealed structures to prevent the infestation by insects.
- For better disinfestation, godowns should be superheated with burninig charcoal at the rate of 8 kg per cubic feet space so as to riase the tempreture of the room to about150 °F. During temperature treatment the doors should be tightly closed for 48 h after which godowns should be allowed to cool and cleaned before storage.

## MECHANICAL METHODS:

- Sieve and remove all broken grains to eliminate the condition which favour storage pests.
- Stitch all torn out bags before filling the grains.

## BIOLOGICAL CONTROL:

- One possible solution to overcome the resistance problem is the use of biological control measures such as parasites and predators and disease organisms or pathogens such as various subtypes of the bacterium, Bacillus thuringiensis amoebae and sporozoans such as Triboliocystis garnbami, Mattesia trogoderma and other species, Nosema spp., Halics spp., which are most frequently encountered in dense populations of insects and can cause high mortality (Semple, 1985).
- Different biological agents are used for suppression of population of stored grain insects. Most commonly hymenoptera parasitoids are used to reduce infestation.
- Few predators such as hemimpteran bug, *Xylocoris flavipes* (Reuter) and several other anthocorid bugs of the sub-family Lyctocorinae are more frequently apply to control insect pests in store houses.
- One demerit that *X. flavipes* although found effective against many unprotected insects which are incapable of penetrating hard materials like seeds but is found ineffective against weevils that infest grain and pulse. It is especially used to suppress bruchids population in stored legumes.
- Two common parasitoids that in stored products are *Bracon hebetor* Say (Braconidae) and *Venturia canescens* (Gravenhorst, Ichneumonidae) and used to suppress *E. cautella* populations. *Laeluis pedatus* (Say) (Bethylidae) is another parasitoid which successfully controls dermestid larvae.

## CHEMICAL METHODS:

- Treat the alleyways and gangways with malathion 50 EC 10 ml/L or DDVP 76 WSC 7 ml/ L (1 L of spray fluid/270 m3).
- Spray malathion 50 EC 10 ml/ L with @ 3 L of spray fluid / 100 $m^2$ over the bags.
- Do not spray the insecticides directly on food grains.
- Use knock down chemicals like lindane smoke generator or fumigant strips pyrethrum spray to kill the flying insects and insects on surfaces, cracks and crevices.
- Use seed protectants like pyrethrum dust, carbaryl dust to mix with grains meant for seed purposes only.

- Decide the need for shed fumigation based on the intensity of infestation.
- Check the black polythene sheets or rubberized aluminium covers for holes and get them ready for fumigation.
- Use EDB ampoules (available in different sizes 3 ml, 6 ml, 10 ml, 15 ml and 30 ml) at 3 ml/quintal for wheat and pulses and 5 ml/ quintal for rice and paddy (Do not recommend EDB for fumigation of flour oil seeds and moist grains)
- Use EDCT (available in tin containers of 500 ml, 1 liter and 5 litres) at 30 – 40 litres/ 100 cubic meter in large scale storage and 55 ml/quintal in small scale storage.

## FUMIGATION:

Use fumigants like ethylene dibromide (EDB), ethylene dichloride carbon tetra chloride (EDCT), aluminium phosphide (ALP) to control stored produce pests effectively. Apply aluminum phosphide (available in 0.6 g and 3 gram tablets) @ 3 tablets (3 gram each) per tone of food grains lot with help of an applicator. Choose the fumigant and work out the requirement based on the following guidelines.
• 3 tablets of aluminum phosphide 3 g each per ton of grain.
• 21 tablets of aluminium phosphide 3 g each for 28 cubic meters
• Period of fumigation is 5 days.
**Liquid fumigants:** Formulations of liquids usually contain a mixture of two or more compounds. Liquids commonly used in farm fumigant mixtures are combinations of carbon tetrachloride with carbon disulfide, or ethylene dichloride. Do not use carbon disulfide alone because it is extremely explosive and flammable.

## CONCLUSION

Today, there is a common intention of worldwide to limit the pest problems at all steps of the pre- and postharvest food chain by expanding IPM applications. If managers fully considered the "value-added" aspect of IPM implementation instead of the simpler conventional/chemical pest control tactics, we believe that physical control measures would be more predominantly used. Implementation of IPM strategies reduces economic costs associated with pesticide applications.

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# Sub-Acute ruminal Acidosis (SARA) in Dairy Animals

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**Abstract**

*Sub-acute ruminal acidosis (SARA) is also known as chronic or sub-clinical acidosis. It is a common digestive disorder and an increasing health problem in most dairy animals. SARA is an indirect condition in most high-producing dairy animals, leading to huge production and economic losses to farmers. Feeding of large amounts of concentrates and inadequate amounts of fiber to increase milk production in early lactation results in a fiber-deficient ration likely to results in subacute ruminal acidosis. Dairy herds experiencing SARA will have a decreased efficiency of milk production, impaired animal health, reduced dry matter intake, diarrhea, faeces with grains and gas bubbles. Dairy cows are especially at risk in the transition period, because the ruminal mucosa needs several weeks to adjust to high-grain diet, and in peak lactation, when high levels of easily fermentable carbohydrates are fed to avoid excessive negative energy balance. The present article aims to make aware the farmers about the occurrence, clinical signs and treatment involved with sub-acute ruminal acidosis so that they can seek feeding advice and effective treatment support.*

## INTRODUCTION

### Sub-Acute Ruminal Acidosis (SARA)

SARA is a ruminal fermentation disorder which is marked by higher acidity levels for proloned period i.e. ruminal ph is low, below 5.5-5.6., Ruminal pH should lie between 6.0 and 6.4 for optimum fermentation and fibre digestion This drop in ruminal pH is a result of the breakdown of dietary carbohydrates (starch), particularly from cereal grains such as corn, wheat and barley. Grains are rich in carbohydrates which are readily fermentable and are also rapidly broken down by ruminal bacteria, leading to the production of volatile fatty acids (VFA) and lactic acid. VFA are readily absorbed by ruminal papillae under normal feeding conditions,.

➢ **Etiology:**

1. SARA results from excessive VFA (Volatile fatty acids) production that exceeds the ability of the ruminal papillae to absorb them. Volatile fatty acids accumulate in the rumen resulted in low ruminal pH.
2. A sudden dietary change does not allow ruminal bacteria and ruminal papillae adequate time to adjust, thereby leading to the rapid production and accumulation of VFA.
3. Feed scarcity/starvation causes cattle to overeat when feed is reintroduced, this creates a double effect in lowering ruminal pH.
4. The ruminal microflora are less stable and less able to maintain normal ruminal pH during periods of sudden dietary change.
5. Improperly balanced or mixed rations i.e. effective fibre content falls below recommended levels.

➢ **Clinical signs:**

1. Abdominal distension.
2. Reduced feed intake to reduce the further acid load in their rumen.
3. Reduced rumination.
4. Decreased milk production
5. Reduced fat percentage in milk, poor body condition score (BCS) despite adequate feed intake.
6. Profuse and prolonged diarrhoea.
7. Faeces containing gas bubbles and undigested yellowish grain kernels.
8. Severe and progressive dehydration
9. The laminitis is characterized by ridges in the dorsal hoof wall, sole ulceration, white line lesions, sole hemorrhages and overgrowth of hooves.

➢ **Diagnosis:**

1. **Measuring ruminal fluid pH:** A practical method to obtain ruminal fluid samples under field conditions is rumenocentesis.
2. The animals tested having a ruminal **pH <5.5**(less than) is considered to be at high risk of subacute ruminal acidosis.
3. Ration evaluation, evaluation of management practices, on a herd basis could be helpful diagnostic tools.

➢ **Preventive measures to be followed:**

1. The intake of readily fermentable carbohydrates should be limited and also allow the animal for high-grain diets so that the rumen can be adapted.
2. To reduces the risk of subacute ruminal Adding of long-fiber particles (Alfalfa) in the diet acidosis by encouraging.
3. It is recommended that concentrate levels in the feed should be increased gradually.
4. Adequate dietary fibre levels with a minimum neutral detergent fibre (NDF) 27% - 30% of ration, dry matter (DM) with 70%-80% of the NDF from forage should be supplied.

5. Dietary buffers (Ex. Sodium Bicarbonate) are commonly added to dairy rations to help manage SARA.
6. Supplementing the diet with direct-fed microbials i.e. Yeasts, lactobacilli etc.
7. Ionophore (Ex. Monensin sodium) supplementation may also reduce the risk by selectively inhibiting ruminal lactate producers.

➢ **Treatment:**

1. Correct the ruminal and systemic acidosis and prevent further production of lactic acid.
2. Restore fluid and electrolyte losses and maintain circulating blood volumes.

## CONCLUSION

Sub-acute ruminal acidosis is a huge loss bearing disease that is common in the high producing dairy animals. It can be prevented by ensuring adequate functional fibre available to the rumen, attempting to reduce the challenge to ruminal flora by reducing the quantity of rapidly fermentable carbohydrate and providing periods of adaptation to these more concentrated diets.

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# e-Choupal: An initiative by ITC to help farmers

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E-Choupal is an innovative market-led business model designed to enhance the competitiveness of Indian agriculture. E-Choupal leverages the power of Information and Digital Technology and the internet to empower small and marginal farmers with a host of services related to know how, best practices, timely and relevant weather information, transparent discovery of prices and much more. E-Choupals not only connect farmers with markets but also allow for a virtual integration of the supply chain and create significant efficiencies in the traditional system. A business concept embedded with social goals, e-Choupal was designed to empower farmers and triggers a virtuous cycle of higher productivity, higher incomes, enlarged capacity for farmer risk management, and thereby larger investments to enable higher quality and productivity. The e-Choupal model has been specifically designed to tackle the challenges posed by the unique features of Indian agriculture, characterized by fragmented farms, weak infrastructure and the involvement of numerous intermediaries, among others. The program installs computers with Internet access in rural areas of India to offer farmers up-to-date marketing and agricultural information. These interventions have helped transform village communities into vibrant economic organisations, by enhancing incomes and co-creating markets. ITC's e-Choupals serve 40,000 villages and 4 million farmers, making it the world's largest rural digital infrastructure created by a private enterprise. ITC's Agri Business Division, one of India's largest exporters of agricultural commodities, has conceived e-Choupal as a more efficient supply chain aimed at delivering value to its customers around the world on a sustainable basis.

**The Value Chain of 'e-Choupal':**

'e-Choupal' also unshackles the potential of Indian farmer who has been trapped in a vicious cycle of low risk taking ability, low investment, low productivity, weak market orientation, low value addition, low margin, low risk taking ability. This made him and Indian agribusiness sector globally uncompetitive, despite rich & abundant natural resources. Such a market-led business model can enhance the competitiveness of Indian agriculture and trigger a virtuous cycle of higher productivity, higher incomes, and enlarged capacity for farmer risk management, larger investments and higher quality and productivity. Further, a growth in rural incomes will also unleash the latent demand for industrial goods so necessary for the continued growth of the Indian economy. This will create another virtuous cycle propelling the economy into a higher growth trajectory.

## THE MODEL IN ACTION

Appreciating the imperative of intermediaries in the Indian context, 'e-Choupal' leverages Information Technology to virtually cluster all the value chain participants, delivering the same benefits as vertical integration does in mature agricultural economies like the USA. 'e-Choupal' makes use of the physical transmission capabilities of current intermediaries - aggregation, logistics, counter-party risk and bridge financing -while disinter mediating them from the chain of information flow and market signals. With a judicious blend of click & mortar capabilities, village internet kiosks managed by farmers - called sanchalaks - themselves, enable the agricultural community access ready information in their local language on the weather & market prices, disseminate knowledge on scientific farm practices & risk management, facilitate the sale of farm inputs (now with embedded knowledge) and purchase farm produce from the farmers' doorsteps (decision making is now information-based).

## ADVANTAGES OF E–CHOUPAL:

- Real-time information and customized knowledge provided by 'e-Choupal' enhance the ability of farmers to take decisions and align their farm output with market demand and secure quality & productivity.
- The aggregation of the demand for farm inputs from individual farmers gives them access to high quality inputs from established and reputed manufacturers at fair prices.
- As a direct marketing channel, virtually linked to the 'mandi' system for price discovery, 'e-Choupal' eliminates wasteful intermediation and multiple handling. Thereby it significantly reduces transaction costs.
- 'e-Choupal' ensures world-class quality in delivering all these goods & services through several product / service specific partnerships with the leaders in the respective fields, in addition to ITC's own expertise.
- While the farmers benefit through enhanced farm productivity and higher farm gate prices, ITC benefits from the lower net cost of procurement (despite offering better prices to the farmer) having eliminated costs in the supply chain that do not add value.

## THE STATUS OF EXECUTION OF E-CHOUPAL:

Launched in June 2000, 'e-Choupal', has already become the largest initiative among all Internet-based interventions in rural India. 'e-Choupal' services today reach out to over 4 million farmers growing a range of crops - soybean, coffee, wheat, rice, pulses, and shrimp - in over 35000 villages through 6100 kiosks across 10 states (Madhya Pradesh, Haryana, Uttarakhand, Uttar Pradesh, Rajasthan, Karnataka, Kerala, Maharashtra, Andhra Pradesh and Tamil Nadu).

**The problems encountered while setting up and managing these 'e-Choupals:**

- Infrastructural inadequacies, including power supply, telecom connectivity and bandwidth
- The challenge of imparting skills to the first time internet users in remote and inaccessible areas of rural India.

**Solutions to these problems:**

- Power back-up through batteries charged by Solar panels,
- upgrading BSNL exchanges with RNS kits, installation of VSAT equipment,
- Mobile Choupals, local caching of static content on website to stream in the dynamic content more efficiently, 24x7 helpdesk etc.

## PARTICIPATION OF FARMERS:

As India's 'kissan' Company, ITC has taken care to involve farmers in the designing and management of the entire 'e-Choupal' initiative. The active participation of farmers in this rural initiative has created a sense of ownership in the project among the farmers. They see the 'e-Choupal' as the new age cooperative for all practical purposes. This enthusiastic response from farmers has encouraged ITC to plan for the extension of the 'e-Choupal' initiative to altogether 15 states across India over the next few years. On the anvil are plans to channelize other services related to micro-credit, health and education through the same 'e-Choupal' infrastructure.

## 'CHOUPAL PRADARSHAN KHET'

Another path-breaking initiative - the **'Choupal Pradarshan Khet'**, brings the benefits of agricultural best practices to small and marginal farmers. Backed by intensive research and knowledge, this initiative provides Agri-extension services which are qualitatively superior and involves pro-active handholding of farmers to ensure productivity gains. The services are customised to meet local conditions, ensure timely availability of farm inputs including credit, and provide a cluster of farmer schools for capturing indigenous knowledge. This initiative, which has covered over 64,000 hectares, has a multiplier impact and reaches out to around 70,000 farmers.

## CONCLUSION

ICT initiative e–choupal has been playing a very important role in dissemination of technology to rural people or farmers. But the main problem in dissemination technology through e–choupal is illiteracy of the farmers to gain and understand the information which they get through e–choupal. So the government should mainly focus to literate the farmers.

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# Farmer Producers Organizations: An initiative to eliminate middleman

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In India, Small and marginal farmers have been vulnerable to price as well production risk. There is a need for aggregation of farmers to benefit from economies of scale. It also helps farmers to sharing services such as input knowledge, production supervision, storage, transportation, etc, and to absorb price risks to which primary produce is always subjected. The failure of co-operatives in country with some exceptions leads to emergence of new form of aggregation of farmers' group i.e. Farmer Producer Organization. Department of Agriculture and Cooperation under Ministry of Agriculture, Govt. of India has identified 'Farmer Producer Organizations 'registered under the special provisions of the Companies Act, 1956 as the most appropriate Institutional form around which the mobilization of farmers is to be made for building their capacity to collectively leverage their production and marketing strength. Farmer Producer Organization (FPO) is an entity formed by primary producers, viz. farmers, milk producers, fishermen, weavers, rural artisans, craftsmen. An FPO can be a Producer Company, a Cooperative Society or any other legal form which provides for sharing of profits/benefits among the members. The main aim of an FPO is to ensure better income for the producers through an organization of their own. Small producers do not have the large marketable surplus individually (both inputs and produce) to get the benefit of economies of scale. Besides, in agricultural marketing, there is a long chain of intermediaries who very often work non-transparently leading to the situation where the producer receives only a small part of the value that the ultimate consumer pays.

**What is a "Farmers Producer Organisation" (FPO)?**

Farmers Producer Organisation is Collectivization of producers, especially small and marginal farmers, into producer organisations has emerged as one of the most effective pathways to address the many challenges of agriculture but most importantly, improved access to investments, technology and inputs and markets. An FPO can be a Producer Company, a Cooperative Society or any other legal form which provides for sharing of profits/benefits among the members. It is one type of Producer Organisation where the members are farmers. Small Farmers' Agribusiness Consortium (SFAC) is providing support for promotion of FPOs. PO is a generic name for an organization of producers of any produce, e.g., agricultural, non-farm products, artisan products, etc.

**Essential features of a Producer Organisations**

a. It is a registered body and a legal entity.
b. It is formed by a group of producers for either farm or non-farm activities.
c. It deals with business activities related to the primary produce/product.
d. Producers are shareholders in the organization.
e. It works for the benefit of the member producers.
f. A part of the profit is shared amongst the producers.
g. Rest of the surplus is added to its owned funds for business expansion.

**Important activities of a Producer Organisations**

The primary producers have skill and expertise in producing. However, they generally need support for marketing of what they produce. The PO will basically bridge this gap. The PO will take over the responsibility of any one or more activities in the value chain of the produce right from procurement of raw material to delivery of the final product at the ultimate consumers' doorstep. In brief, the PO could undertake the following activities:

a. Procurement of inputs
b. Disseminating market information
c. Dissemination of technology and innovations
d. Facilitating finance for inputs
e. Aggregation and storage of produce
f. Primary processing like drying, cleaning and grading
g. Brand building, Packaging, Labeling and Standardization
h. Quality control
i. Marketing to institutional buyers
j. Participation in commodity exchanges
k. Export

## Different legal forms of Producer Organisation:

a) Cooperative Societies Act/ Autonomous or Mutually Aided Cooperative Societies Act of the respective State
b) Multi-State Cooperative Society Act, 2002
c) Producer Company under Section 581(C) of Indian Companies Act, 1956, as amended in 2013
d) Section 25 Company of Indian Companies Act, 1956, as amended as Section 8 in 2013
e) Societies registered under Society Registration Act, 1860
f) Public Trusts registered under Indian Trusts Act, 1882

## Support for promotion of FPOs

The formation and development of FPOs will be actively encouraged and supported by the central and state governments and their agencies, using financial resources from various centrally sponsored and State-funded schemes in the agriculture sector agencies. This goal will be achieved by creating a coalition of partners by the concerned promoter body, involving civil society institutions, research organisations, consultants, private sector players and any other entity which can contribute to the development of strong and viable producer owned FPOs.

## Principles for sustaining farmer producer organisation development

1. Voluntary and Open Membership FPOs are voluntary organisations, open to all persons able to use their services and willing to accept the responsibilities of membership, without gender, social, racial, political or religious discrimination. Democratic Farmer Member Control

2. FPOs are democratic organisations controlled by their farmer-members who actively participate in setting their policies and making decisions. Men and women serving as elected representatives are accountable to the collective body of members. In primary FPOs farmer-members have equal voting rights (one member, one vote) and FPOs at other levels are also organised in a democratic manner.
3. Farmer-Member Economic Participation Farmer-members contribute equitably to, and democratically control, the capital of their FPO. At least part of that capital is usually the common property
4. Autonomy and Independence FPOs are autonomous, self-help organisations controlled by their farmer-members. If they enter into agreements with other organisations, including governments, or raise capital from external sources, they do so on terms that ensure democratic control by their farmer- members and maintain their FPO's autonomy.
5. Education, Training and Information FPOs operatives provide education and training for their farmer-members, elected representatives, managers, and employees so that they can contribute effectively to the development of their FPOs. They inform the general public – particularly young people and opinion leaders – about the nature and benefits of FPOs.
6. Co-operation among FPOs FPOs serve their members most effectively and strengthen the FPO movement by working together through local, national, regional and international structures.
7. Concern for the Community FPOs work for the sustainable development of their communities through policies approved by their members.

## PROBLEMS AND ISSUES:

1. Lack of marketing skills
2. Lack of cooperation
3. Weak economic status
4. Access to local market
5. Poor management
6. Lack of leadership and understanding
7. Lack of communication and participation among the members
8. Absence of common brands
9. Poor management of Storage facilities
10. Middlemen makes excessive profits
11. Groups and cooperatives formed only for the sake of getting government and donor's support.
12. Old traditional business activities

## CONCLUSION

Farmer Producer Organisations are facing the above Problems. So the government should focus on solving these Problems so that with the help of the FPOs, farmers may get the full benefit by selling their Products.

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# Organic vis-a-vis Inorganic: an Ultra level Choice Crisis of 21st Century Farmers

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**Abstract**
*Farming is always one of the most glamorous and prime sector on this earth and it has been an age old system. But the present century farming itself is creating a certain dilemma which is supposed to be highly urgent by its self nature. Inorganic system is active in its way through last few decades but organic is being highly emphasized by the experts presently. That's the particular point from which this dilemma begins and the common farmers are in greatest confusion regarding the exact proportion of these two ways to be implemented in practice. So, it is the high time for the extension professionals to guide the peasants in the authenticated direction for the sustainability of the future food basket without compromising the environment.*
**Key Words:** Organic, Inorganic, Farming, Visibility

Agriculture is one of the most attractive sectors in today's world, not only for the current enhancing food demand, but also for the crucial varieties of means of production which is rather offering a more wonderful and extraordinary shape to "Peasantry". If the critical analysis is kept confined within the context of Asia, majorly Indian subcontinent, it can easily be claimed that since the inception of the High-Yielding varieties of the principle cereals i.e. rice and wheat during 1966-67, the production as well as the productivity increased in a tremendous fashion. This is because all those crop varieties were greatly fertilizer responsive, simply more responsive to various synthetic molecules altogether.

But with the passage of time, there was a radical transformation in the productivity data, moreover, in the present days greatly. The statistical record is showing some awkward results which are non-empirical as well and that is rather depicting one kind of irresponsiveness of those cultivars towards the synthetics. But a huge quantity of quality food items is located in the front line needs of today's global India mostly to tackle such sub continental population explosion. Moreover, the modern farming itself is raising a few eye-catching questions with some prominent circumstantial evidences which need to be resolved more promptly as well as urgently, for the sake of human survival.

## Transition from inorganic to organic:

Now, according to several scientific experts, the soil hemisphere has been deteriorated through the prolong usage of inorganic molecules and the crop production scenario is also getting depleted accordingly. The environmental pollution causing due to modern agriculture is also another embarrassing shadow of the game. Everyone, starting from the researchers to the policy makers, even a few innovative farmers is becoming worried about the present undulating evidences of crop productivity status obtained from perspicuous statistical data set and thereby they are expressing their uncomfortable ideas by writing or questioning in some eminent newspapers, TV talk shows, or in blogs of *"Facebook"*. By doing the filtration of expert ideas or opinions, it can now be claimed for the moment from a scientific ground that a dramatic shift from inorganic to organic is the only and only close ended solution of such a burning problem. This is rather the most effective prescription to encounter the issue and that is the need of the hour in a real sense.

## A Little glimpse of Organic Farming:

FAO suggested that "***Organic agriculture*** is a unique production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity, and this is accomplished by using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs". To be honest, in 21st century, society has recognised the need to shift from a mass production, mass consumption and mass disposal society to a sustainable and recycling society.


*(Figure Source:TNAU Agritech Portal)*

Organic strictly excludes all sorts of usage of inorganic substances such as chemical fertilizers, synthetic pesticides but on the other hand, it welcomes all kinds of organic and biological products and activities to restore a place in the package of practices as reflected in the above figure.

Essentially organic culture is contamination-free; it ensures the standard of the food items. It also keeps the consumers' health well; on the other hand, it protects the environment from being toxic. If the organic is not at all included in the crop establishment programme, the issue of ***"Sustainability"*** will not be resolved any time.

## Prominent Limitation of Organic culture:

The question of sustainability of the food grains production is not an age-old talk, but rather is going to be a part and parcel of the modern peasantry. The productivity of the major crops has reached a plateau; thereby the "law of diminishing return" has already come into play. This is the prime as well as the basic point of concern of the scientific world because the population explosion is in vogue in today's India. Moreover, it can strongly be proclaimed that the level of production will go down in future slowly if the farm people will continue the usage of several inorganic variable inputs in such a tremendous and vigorous fashion. So, simply here the sustainability issue is arising and being ultra prominent.

The shifting towards the organic is the one and only answer of such question of sustainability in the present context according to the various research findings. Organic farming itself contains immense importance and significance in the path of maintaining sustenance of the so called "agro-production". But the real problem lies here. If all the farms will begin the organic culture by shifting radically at this present moment, will it be possible to meet up this ever increasing food demand, after ignoring all kinds of residual effect? The answer could easily be stated – "No". Such a mammoth production cannot be strictly achieved only through organic. The product obtained from the organic farming is of superior quality and hygienic as well but those cannot be distributed amongst all. Even from such a stance, a dark and horrible genocide can be expected in the form of a blotchy famine.

## A Common Indian Farmer's View:

Facts placed in this part of the article basically envisage some critical views of a common rural peasant or a member of farming community. What does he/she think in a real sense? Indian Farmers hardly understand the hardcore scientific theories as these are beyond the level of their understanding. The facts or the issues relevant here is nothing but the *point of "visibility"* i.e. they will only and only believe on the visual affluence, not on some virtual story. They hardly wish to realise or know the very facts of sustainability in farming, environmental pollution, residual toxic effect of pesticide on the human physique etc. which are in vogue in today's world. The simplest principle lies in their minds, rather more and more intensely, is – "The more the synthetics will be in practice, the more the production will be there and simultaneously, the more will be the production, the more earnings will be there." This is one of the darkest aspects of Indian peasantry. Farmers cannot realise the law of life.

Again, from the point of crop protection, marginal, small, medium farmers do use the synthetic molecules rampantly and that can also be clearly analysed with the facts of visibility. As a farmer is getting quick responses from the application of chemical pesticides, he will opt that one. Bio pesticides show the slow responses usually, in spite of having notable positive as well as beneficial properties. Common farmers are quite reluctant to use these bio agents due to its lower degree of visibility. Moreover, the application of FYM and the others organic manures are getting erased from the farming scenario day by day which is a serious antecedent of future colossal losses in the farming landscape. It is highly important to deal the peasants very delicately towards the scientific mainstream. It is also not clear to the farmers that what the exact proportion should be between the organic and inorganic methods in their practice and that is the real beginning of a dilemma concerned here.

## Problem related to Extension service:

The most notable handicap of the Indian farming is the weak extension effort and a vivid communication gap. Indian extension system is not having a glamorous history at all and that is the reason exclusively for which we are here at the present moment. Unfortunately, Indian farmers are not at such a stand from where they can easily investigate as well as identify the multi various hardships of their production activities until they are rather being informed by the extension functionaries. Farming industry is changing day by day and the new scientific strategies are to be inserted in the modern peasantry in this climate change era. The sophisticated as well as determined intervention of the skilled extension personnel is greatly important to create the climate smart agriculture and organic way of farming, without any exception, is really a better option in this particular direction. Extension personnel will be able to clarify the facts to the common peasants in the notably distinguished style, so that producers can perform accordingly by keeping a holistic ambition.

## CONCLUSION

The concerned dilemma is all about the scientific choice between the organic and inorganic farming from the practical standpoint and more about the percentage share of implementation of these two in a real sense. Now the quandary arises particularly due to the lack of expert guidance to the main players of the farming industry and that is the major problem which needs to be addressed urgently. If the farming community will take an absolute shift towards the organic, the outcome is hardly to be accepted. Besides, if they remain sticky to the inorganic farming, which is in vogue now a days tremendously, the future result is far beyond the healthy prediction of scientific bodies. Obviously a strong balance is of immense importance towards this specific arena. Even though there is a controversy regarding the implementation of organic cultivation to a much greater extent, all scientific forums have already certified the necessity of organic in the present farming without any doubt. Now, it becomes mandatory to make the cultivators well realised and understood these facts on behalf of the extension service providers so that the sustainability issue will be maintained properly. That is actually a crucial task towards the achievement of the goal of zero hunger.

# Market– led extension: Challenges and Opportunities

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Over the past few decades, India became self-reliant in food production and this was as a result of production led extension system among others. Emphasis was made on transfer of 'package of practices' from research station to farmer's field resulting in increase in food production. The success of this system brought to lime light the long standing problem related to marketing as well as challenge of realizing optimum returns on farmers investment as farmers became self-aware of the need to shift from 'seed to seed' to 'rupee to rupee'. Till today most of our farmers sells their produce in 'as is where basis' without being aware of market situation. However, capacity building of farmers towards equipping them with crucial information about markets is of paramount necessity. Extension system should not only focus on the Agricultural production but should also lay emphasis on marketing for holistic development of the farmers. Market Led Extension builds emphasis on the focus shift from 'content' to 'function' stressing the need of Agriculture extension to be more than just a delivery vehicle for agriculture technology. It is the market ward orientation of agriculture through extension includes agriculture & economics as the perfect blend for reaching at the door steps of farming community with the help of appropriate technology market ward orientation of Agriculture through extension.

## PROSPECTS OF MARKET LED EXTENSION

Market Led Extension has a great potential in paving wave for optimum production on a sustainable basis considering the current trend of challenges in process of food production globally. Over the years 'lab to land' had been much emphasized in our country now it is time to focus on farm to fork. Due to WTO, the countries around the world are no longer confined to domestic production alone. The countries with competitive advantages are looking forward to dump their output anywhere in world. However, with the new functionary role of extension personnel under Market Led Extension, future success can be guaranteed for Indian Agricultural Development. The following are some of the expected functionary role of extension personnel.

This includes SWOT analysis of the market, Organizing commodity based farmers' interest groups and farm management capacity building, Backward and forward linkage, Farmers exposure to market intelligence and guidance for quality decision about market. Therefore key answer to the above questions will empower farmers in both production market oriented knowledge which is the sole responsibility of Extension functionaries through Market Led Extension

## Challenges in agricultural marketing system

- **Storage of farm produce:**

Whether storage takes place on the farm or in silos off the farm, increases in the value of products due to their time utility must be sufficient to compensate for costs at this stage, or else storage will not be profitable. Among the less tangible costs is the risks attached to storage. Another risk is that demand could fall with adverse effects on prices.

- **Grading:**

There are differences between grades and this has to be communicated to the market. By the same measure, buyers require a mechanism to signal which grades they are willing to purchase and at what premium or discount. Prices vary among the grades depending upon the relative supply of and demand for each grade. Since the value of a commodity is directly by its grade, disputes can and do arise. The absence of grades and standards restricts the development of effective and efficient marketing systems.

- **Standardization:**

This function simplifies buying and selling as well as reducing marketing costs by enabling buyers to specify precisely what they want and suppliers to communicate what they are able and willing to supply with respect to both quantity and quality of product. In the absence of standard weights and measures trade either becomes more expensive to conduct or impossible altogether

- **Market intelligence:**

Generation of data on the market intelligence would be a huge task by itself. Departments of market already possess much of the data. Hence, establishment of linkages between agriculture line departments and Departments of Market strengthens the market-led extension.

- **Financing:**

In almost any production system there are inevitable lags between investing in the necessary raw materials (e.g. machinery, seeds, fertilizers, packaging, flavorings, stocks etc.) and receiving payment for the sale of produce. During these lag periods some individual or institution must finance the investment. The question of where the funding of the investment is to come from, at all points between production and consumption, is one that marketing must address.

- Market size is large and continuously expanding, but marketing system not kept pace
- Private trade is 80% marketed surplus
- Direct marketing "farmer – consumer" is negligible

## Roles of Agricultural Extension personnel in Market-led Extension

- Educating the farming community to treat agriculture as an entrepreneurial activity and accordingly plan various phases of crop production and marketing.
- **Advice on product planning:** selection of crops to be grown and varieties suiting the land holding and marketability of produce will be the starting point of agri enterprise. Extension system plays an important role in providing information in this regard.
- SWOT analysis of the market: The farmers need to be made aware of this analysis for planning production and marketing.
- Organization of Farmers' Interest Groups (FIGs) on commodity basis and building their capabilities with regard to management of their farm enterprise.
- Capacity building of FIGs in terms of improved production, post harvest operations, storage and transport and marketing
- Creation of websites of successful FIGs in the field of agribusiness management with all the information to help other FIGs achieve success.
- Organization of study tours of FIGS: to the successful farmers/ FIGs for various operations with similar socio-economic and farming systems as the farmers learn more from each other.
- Supporting and enhancing the capacities of locally established groups under various schemes / programmers. These groups need to be educated on the importance, utility and benefit of self-help action.
- Enhancing the interactive and communication skills of the farmers to exchange their views with customers and other market forces for getting feedback and gain the bargaining during direct marketing.
- Establishing marketing and agro-processing linkages between farmers' groups, markets and private processors
- Direct marketing: farmers need to be informed about the benefits of direct marketing.
- Acquiring complete market intelligence regularly on various aspects of markets.
- Regular usage of internet facility through computers to get updated on market intelligence
- Publication of agricultural market information in news papers, radio and Television besides internet
- Production of video films of success stories of commodity specific farmers

## CONCLUSION:

Market led extension has the capacity to change the living standard of Indian farmers. This can be achieved by improving the market intelligence of the farmers. Market intelligence makes the farmers be aware about the prices of their products in nearby markets and the best prices in any other markets. And also helps to know about the value addition for their different products, which can increase the value of their products.

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