Online ISSN 2582-368X

AGRIALLIS

SCIENCE FOR AGRICULTURE AND ALLIED SECTOR

A Monthly Magazine

VOLUME 4, ISSUE 10
OCT. 2022

www.agriallis.com

Growing seed

Editorial Board

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Article Id
AL04165

HOW BIOTECHNOLOGY WILL BRING THE NEXT AGRICULTURAL REVOLUTION AND RECENT DEVELOPMENTS IN THE FIELD

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Agriculture has come a long way, from simply harvesting wild strains of cereals and domesticating them to commercial cultivation of genetically modified plants. One of the most significant events in the development of modern agriculture was the green revolution (1940s–1960s), during which the overall yield of crops was drastically increased by the introduction of high-yielding varieties and the application of chemical fertilizers and pesticides. After the green revolution, it seemed that food production could keep pace with worldwide population growth.

But now the ever-rising human population is facing the same threat of food crisis again. Due to extensive use of chemical fertilizer and high-yielding varieties, we have created new problems for us and the environment, Loss of soil fertility, erosion of soil, soil toxicity, diminishing water resources, pollution of underground water, salinity of underground water, increased incidence of human and livestock diseases and global warming, Extinction of Indigenous Varieties of Crops, are some of them. Therefore, we have to find new and sustainable ways of enhancing food production for the growing population, while also taking into account the current climate change situation and environmental issues our world is experiencing.

The green revolution during the 1940s relied mainly on plant breeding and crossing to develop high-yielding varieties. However, using only those conventional breeding techniques will not be sufficient to maintain the food supply at the current population growth rate. In the last few decades plant biotechnology and genetic engineering have acted as a very useful tool to supplement the drawbacks of conventional plant breeding. In both traditional and genetically engineered plant types, biotechnology tools assist in the production of better

kinds. Not only that, the use of biotechnological tools has helped in the detection and diagnosis of plant diseases, thus assisting in crop protection.

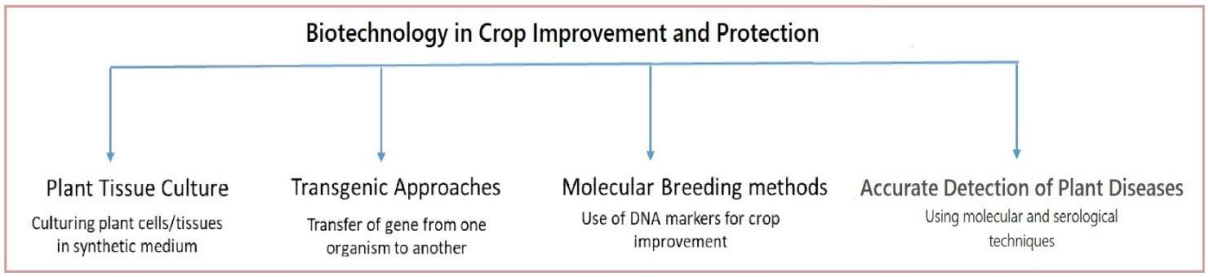

Fig 1: Approaches of Biotechnology in Agriculture

Biotechnological Approaches in Agriculture

Agricultural biotechnology refers to the use of biological organisms or a range of tools for the improvement of plants, animals, microorganisms, or food derived from them. The application of biotechnology in agriculture has benefitted farmers, producers, and consumers. Following are some biotechnology tools used in agriculture:

A. Plant Tissue Culture

Plant tissue culture, in its broadest sense, refers to the in vitro growing of live plant cells, tissues, or organs (seeds, embryos, single cells, protoplasts) on a nutritional medium in an aseptic environment. Plant tissue culture techniques include micropropagation, somatic embryogenesis, somaclonal variation, meristem culture, anther culture, embryo culture, protoplast culture, cryopreservation, and secondary metabolite generation.

B. Transgenic Approaches/Genetic Engineering

Biotechnology is widely employed in the production of genetically modified (GM) crops, in which one or more genes coding for desired features have been added through the genetic engineering process (GE). The gene used to create the transgenic might come from the same species or species and organisms unrelated to the recipient organism. Transgenic technology is the method of transferring genes from related or unrelated species to desired agricultural plant species for genetic study and direct DNA modification. This gene technology is also known as recombinant DNA technology or genetic engineering.

Mainly there are two techniques for introducing foreign genes into plants. The first technique employs *Agrobacterium tumefaciens*, a soil-borne, Gram-negative bacterium that

causes crown gall disease in several species. This bacterium possesses a plasmid containing tumor-inducing genes (T-DNA) as well as other genes that aid in T-DNA integration into the host genome. This is accomplished by deleting the majority of the T-DNA but retaining the border sequences (24 bp) that integrate a foreign gene into the genome of cultivated plant cells. The second approach is a "gene gun," which bombards plant cells with gold particles containing foreign DNA. Some of these particles get past the plant cell wall and into the cell nucleus, where they cause damage to the DNA.

Over the last 15 years, the combination of recombinant DNA technology with tissue-culture techniques has resulted in the effective transformation and generation of transgenic in a wide range of agricultural plants.

C. Marker Assisted Selection

Marker-assisted selection (MAS), where DNA markers are used to guide, support, and streamline plant breeding efforts. Molecular marker-aided genetic analysis aids in gene identification by studying DNA sequences to identify genes, QTL (Quantitative trait loci), and molecular markers; and to correlate them with the organism. Molecular marker-aided selection aids in the identification and tracking of previously recognized DNA segments across generations. Molecular marker-assisted breeding uses molecular markers, linkage maps, and genomics to modify and improve plant or animal traits based on genotypic assays.

D. Detection of Plant Diseases using Molecular Approaches

Recent improvements in molecular biological methods have improved the identification and diagnosis of new, emerging, previously reported, and re-emerging fungal plant diseases. Polymerase chain reaction (PCR)-based tests, isothermal and post-amplification tools, hybridization methods, and next-generation sequencing (NGS) techniques are well-known for diagnosing phytofungal diseases. These molecular-based techniques have effectively detected and diagnosed symptomatic and asymptomatic diseases caused by culturable and unculturable fungal pathogens in single and co-infections of significant field, horticultural, floricultural, ornamental, and forest plant species. When the sample load is insufficient to detect, quantitative PCR has been widely employed in the quantification and identification of causal organisms.

Recent Developments

Let's now discuss some of the most recent innovations supporting the development of agricultural biotechnology.

- In more recent times**, omics technologies** like as metabolomic and transcriptomic-assisted breeding have been applied in MAS. The future of agricultural biotechnology will heavily rely on developing new techniques to aggregate and evaluate various data kinds in order to optimize the knowledge accessible to breeders.

- **Genomics** is the most powerful approach for interpreting crop species' stress response with adaption features or identifying underlying genes, alleles, or quantitative trait loci.

- Recent breakthroughs in genotyping, sequencing, and phenotyping platforms (phenomics) have turned molecular breeding into **genomics-aided breeding** (GAB). Marker-aided selection (MAS) and genomic selection are the most often employed methodologies for genomics-assisted breeding (GS). SNP arrays, which are very inexpensive and automatically genotyping assays, are being used for high throughput genotyping. It is commonly utilized in crop genetic investigations, including as genome-wide association studies (GWAS), linkage map building, genomic selection, population structure analysis, and gene mapping.

- **Site-directed nucleases (SDN) for targeted gene insertion or replacement-** Agrobacterium tumefaciens-mediated and DNA-coated particle bombardment transformation technologies have a few limitations, such as the possibility for endogenous gene disruption or misexpression of neighboring genes via trans- or cis-gene regulation. Another disadvantage of using numerous transgenes is that they would likely integrate into various chromosomes and segregate independently, complicating downstream breeding. To overcome these possible flaws, researchers are looking at using SDNs to precisely introduce DNA elements into the plant genome at specified DNA breaks using the plant's DNA homology-guided repair process. Multiple inserted genes can be integrated at a single genomic safe harbour, a designated chromosomal location with minimum positional effects, to optimize transgenic effectiveness without disrupting essential cell activities.

- **RNA therapeutics: RNAi and antisense-** RNAi (RNA interference) is a gene silencing method that uses double-stranded RNA to suppress protein synthesis in target cells. Antisense technology achieves the same outcome using single-stranded RNA. Antisense technology has produced promising results in the development of FlavrSavr, a tomato cultivar with improved shelf-life.

- **Clustered Regularly Interspaced Short Palindromic Repeats** (CRISPR)/Cas9 (CRISPR-associated protein 9) genome editing technology has shown considerable promise in tackling new agricultural difficulties fast. Recently, Haque et al. showed the potential of CRISPR/Cas9 for improving crop resilience against new pests and abiotic challenges in tropical regions. It is capable of accurately altering the genome sequence of any creature, including plants, to obtain the desired characteristic. Several techniques, such as optimizing promoters to drive and express Cas9 and utilizing various fluorescence reporters and selection markers, have recently been investigated to enhance plant transformation by CRISPR/Cas9. The CRISPR/Cas gene-editing method may produce heritable, targeted alterations while simultaneously addressing concerns about the presence of foreign DNA sequences by producing transgene-free plants.

- **Loop-mediated amplification (LAMP)**a modification of PCR is currently showing success in the detection of fungal diseases and has aided in the identification of Alternaria spp., Colletotrichum spp., Fusarium spp., Verticillium spp., Puccinia spp., Botrytis spp., etc. NGS may be used to find novel and emerging diseases by sequencing fungal genomes on several platforms with no prior knowledge of the pathogen's sequence.

Conclusion

From the green revolution to the gene revolution, agriculture has come a long way. Every day, it evolves at a breakneck pace. With the capacity to understand and manipulate the genetic composition of organisms using biotechnological methods, we can meet the rising demand for food by developing novel crop varieties with a higher yield, improved resilience to biotic and abiotic stresses, and environmental sustainability. The application of biotechnology in agriculture has not only increased crop yield but also lowered production costs by reducing the necessity for inputs (pesticides) and improved farmers' lives.

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Article Id
AL04166

BEST MANAGEMENT TECHNIQUES IN SHRIMP CULTURE

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Fish or shellfish are produced by aquaculture, primarily for human use. It involves ongoing engagement with the environment because it is done in ponds, cages, or open water bodies. If aquaculture is practiced in a way that is both socially and environmentally appropriate, it can be a sustainable activity. Aquaculture production systems that are sustainable operate in harmony with the environment and other living organisms, make use of renewable resources whenever possible, give animals living conditions that are as similar to those found in their natural habitats as possible, and are sensitive to the human and social environment of the area. Using better management practises, sustainability can be attained (BMPs). BMPs (Best Management Practices) include legal observance, social responsibility, effective site selection and farm construction, as well as excellent management, practises for farms, from pond preparation to harvest and post-harvest management operations. Better output, productivity, and profitability would follow the adoption of BMPs, as well as increased environmental and social obligations.

Guidelines for Better Management Practices in Shrimp Farming

- Increasing demand for the shrimp products is leading to high stocking densities and usage of more chemicals in the aquaculture sector. If the process continued, aquaculture will be dropped into an unsustainable condition. BMPs are the only approach to overcoming the problems.

- BMP can be defined as a set of guidelines that are developed, based on risk factor studies, in consultation with the practitioners and relevant stakeholders on the evaluation of current issues. Production should be increased to meet the demand; at the same time, we should keep sustainability in mind. BMPs should besimple, science-

based, cost-effective and appropriate to their context if farmers are to adopt and implement them. Some important BMPs steps.

1. Preparation of Pond Bottom and Water Management before Stocking

- Sludge removal and disposal away from the pond site.
- Ploughing on wets oil if the sludge has not been removed completely and water filtration.
- Using twin bag filters of 300 µm mesh size and ensuring a water depth of at least 80 cm at the shallowest part of the pond.
- Waterconditioningfor10to15daysbefore stocking

Fig 1: Preparation of pond bottom

2. Post Larvae Selection and Stocking

- Selecting PL of uniform size and Colour, which are actively swimming against the water current, testing (with nested PCR) PL for WSSV (using batches of 59 PL pooled together Negative test results indicate, with 95% confidence, that the prevalence of WSSV infected PL is less than 5% in that population).

- Eliminating weak PL before stocking, using formalin (100 parts per million [ppm]) stress for 15 to 20 minutes in continuously aerated water, on-farm nursery rearing of PL for 15 to 20 days.
- Stocking from the first week of February to the second week of March (early spring) ensuring a transportation time for PL of less than six hours from hatchery to pond site.
- Stocking into green water with stable algal blooms and avoiding transparent water during stocking.
- Fillinggrow-out ponds with water from reservoirs that have been left to 'age' for at least 10 to 15 days.

Fig 2: Post Larva Stocking

3. Water Quality Management

- Periodical monitoring and management of salinity, pH, dissolved oxygen and microbial load.
- Chemicals used in maintaining the water quality are…

- Zeolite–soil conditioner.
- Benzal Konium Chloride(BKC)–disinfectant.
- Iodine compounds.
- Lime.

- The water depth at the shallowest part of the pond should be atleast 80cm.

Fig 3: Water quality management

4. Pond Bottom Management

- Check on weekly basis, especially at the feeding area for black soil, benthic algae and bad odors.
- Rapid consumption of feed in the check trays can be a cause of bottom sludge.
- If soil is black, exchange water and reduce feeding.
- Black soil are a should be agitated care fully during the water exchange.

5. Feed management

- Excessive feeding is dangerous than under feeding.
- Check trays should be introduced after one week of stocking.
- If any sized inference occurs, use two different size pellets atleast for 7 days.
- First in, the dicatorofaseriousdis ease problem: is an abrupt decline in feed consumption and low dissolved oxygen.

Fig 4: Feed Management

6. Feed and Health Monitoring

Gutcontent color	Probable food item	Probable cause(s)
Light golden brown	Manufactured feed	Normal
Black, dark brown	Benthic detritus, sediment	Under-feeding; inadequate feeding frequency
Green	Benthic algae	Under-feeding
Red, pinkish	Cannibalized body parts from dead shrimp	Diseaseeventinpond
Pale, whitish	None(disease condition)	Gregarines, or some other disease condition

7. Health Monitoring

- Daily visual inspection of the animals.
- Sampling once a week for general health condition.
- Monitor soil and water quality.
- Regular removal of benthicalgae, exchanging water only during crucial periods (e.g. periods of low oxygen, algal bloom crash).
- Weekly checking of pond bottom mud for blackish organic waste accumulation and bad smells.
- Regular shrimp health checks, and weekly health and growth monitoring, were using a cast net.
- Removal and safe disposal of sick or dead shrimp.

Fig 5: Health Management

8. Handling the Disease Outbreak

- Check the water and soil quality.
- Remove dead animals and bury them.
- If mortality is increasing, emergency harvest can be carried out.
- Inform the neighbor farmers and FDO immediately. Drain the water only after treatment with bleaching powder and aged up to 5-7 days.

9. Harvesting

- If newly Molted shrimps are >10% avoid harvesting.
- Don't feed the shrimp 6hrs before harvesting.
- Pre-harvest testing is done for antibiotic residues.
- Harvesting is done only after the receipt of the test report, and the report is submitted to the buyer along with the shrimps harvested.
- Chill killing and thereafter shipped to the processing plant in insulated carriers packed in ice.
- The water should be discharged after ensuring the standards prescribed.
- Four harvest outcomes were considered

    - Days of culture.
    - Productivity.

- Shrimp size.
- Shrimp survival.

Fig 6: Harvesting

10. Record Keeping

- To identify problems in the pond environment
- Useful to learn from the past experiences
- To estimate the production cost and to find out the net profit or loss

❖ Advantages of BMPs in shrimp farming

- ✓ Reduces the risk of disease occurrence.
- ✓ Improves growth performance.
- ✓ Decreases operational cost.
- ✓ Improves environmental conditions.
- ✓ Attains food quality standards.
- ✓ Fetches higher market prices.
- ✓ Facilitates stainability, among the others

Conclusion

An in-depth understanding of the many aspects of BMP adoption in small-scale shrimp farming systems was provided by this study. Farmers tend to selectively adopt BMPs that they believe are essential for the success of the crop and for higher economic returns, whereas the capital-intensive BMPs that require additional investment were poorly adopted.

A variety of factors, including the farmer and farm site-specific characteristics, influence farmers' adoption decision choices.

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Article Id
AL04167

AZOLLA: A SUSTAINABLE FEED SUPPLEMENT

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The world's largest livestock population resides in India. Certain new techniques must be modified to satisfy the input needs for the production of livestock and their byproducts in order to meet the demands of the expanding human population in the present and the future. Even though India produces more milk than any other country in the world on average, this needs to be improved. This could be because of poor nutrition caused by a lack of access to high-quality fodder and feed. For effective livestock production, this has led to the discovery of alternative sources of high-quality unconventional feed and fodder. The discovery of the amazing plant Azolla during the quest for substitutes for concentrates, fodder, and feed for many types of animals has the potential of delivering a sustainable feed for livestock and poultry.

Image: Growing azolla

Only 4% of the area of fully cultivable land is dedicated to the production of fodder, which has led to a dramatic reduction in the supply of fodder. As a result, cattle in the majority of India rely on agricultural wastes, which have low nutritional quality, high levels of crude protein, and high levels of fibre, as their main source of food. These issues, along with the rising demand for animal products brought on by urbanization and rapid population growth, made it necessary to conduct studies in India to improve the use of crop residues and the diets of both ruminants and non-ruminants in order to increase growth, production, and animal health. Utilizing readily accessible, marketable feed is not always economical and lowers net income.The country's needs cannot be met by the usual feed sources, including roughage and

concentrate. A multi-dimensional approach, which includes the use of unconventional feed resources as a complement or replacement for standard feed, without affecting the quality, in conjunction with appropriate technologies, can help to achieve desirable livestock growth and production. in order to bridge this enormous gap between demand and nutrient supply and ensure optimum livestock production throughout the year. Profitability in animal husbandry is heavily influenced by feed costs, which are the biggest cost in the industry. By limiting manufacturing costs through the use of selection strategies to improve feed effectiveness and maintain the right growth rate and body weight, a significant boost in profitability might be achieved. When cultivated in these conditions, azolla can operate very well since it uses little land, requires little labour, and consistently produces high-quality nutrients.

Importance of Azolla

Azolla is a member of the Azollaceae family and is a dichotomously branching, free-floating water fern. It grows naturally in ditches, marshy ponds, and moist soil. The fern Azolla is home to the symbiotic blue-green algae *Anabaena azolla*, which fixes and absorbs nitrogen from the atmosphere. The BGA symbiont can grow and develop because of the carbon source and hospitable environment provided by azolla. It is incredibly rich in minerals, including calcium, phosphorus, potassium, ferrous, copper, magnesium, vital amino acids, vitamins (Vitamin A, B12, beta carotene), growth promoters, and proteins. On dry weight basis, it is made up of 25–35% protein, 10-15% minerals, and 7–10% of a mixture of amino acids, bioactive compounds, and biopolymers. The amount of oil and carbohydrates in azolla is quite minimal. As a result, Azolla's bio-composition makes it one of the most cost-effective and effective feed supplements.

Azolla as a Feed

For a range of animals, including pigs, rabbits, chickens, ducks, and fish, azolla is used as a food supplement. It is gathered in enormous amounts and used as pig and cattle fodder. When broilers were fed Azolla, their growth and body weight results were comparable to those obtained when using a maize-soybean meal. After producing biogas, the digested slurry from azolla could be used as pond fertilizer. Milk yields and fat content could be maintained at the same levels as with conventional feeds when Azolla was utilized as a feed additive in lactation cows.

Table 1. Comparison of chemical composition (% DM basis) of Azolla meal with other feed

Parameters	Azolla	Berseem	Cowpea
Proximate composition			
DM	**88.72**	87.26	88.69
OM	**75.79**	87.96	90.89
CP	**25.63**	18.51	17.68
EE	**4.12**	2.24	3.29
Total Ash	**20.21**	12.04	9.11
NFE	**33.57**	39.21	47.27
Cell wall constituents			
NDF	**46.89**	59.15	53.14
ADF	**33.81**	37.18	29.66
Cellulose	**16.02**	30.04	24.39
Hemicellulose	**13.08**	21.97	23.48
ADL	**10.11**	6.67	4.95

Source: Sharma *et al.*, 2015

Table 2. Comparison of protein fractions (% CP) of Azolla meal with other feeds

Feed	Protein fraction					
	A	B_1	$A+B_1$	B_2	**B_3**	C
Azolla	11.98	4.63	16.61	12.39	**55.80**	15.20
Berseem fodder	21.08	7.30	28.38	18.38	**44.89**	8.59
Cowpea fodder	16.59	19.61	36.20	18.14	**30.77**	14.65

A- Instantaneously degradable; $A+B_1$- highly degradable in the rumen; B_2- less Degradable; B_3- very less degradable; C- neither degraded in rumen nor digested in lower tract

Source: Sharma *et al.*, 2015

Table 1 compares the chemical composition of *Azolla microphylla* with that of different proteinaceous diets. Azolla had a higher level of crude protein (CP) and EE than Berseem and Cowpea. Azolla had a significantly lower Crude fibre (CF) concentration than berseem and cowpea. Due to the high total ash content, Azolla had a significantly lower Organic matter (OM) content than other areas. Cowpea had the highest level of Nitrogen Free Extract (NFE), followed by berseem and azolla. Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) content in azolla meal was lower than in berseem. Compared to azolla, cowpea fodder contained more NDF and less ADF. Azolla had less cellulose and hemicellulose than berseem and cowpea feed did. Azolla has a greater acid detergent lignin concentration than berseem and cowpea. Azolla has a high plant protein content and a low percentage of crude fibre, which suggests that it is a rich source of nutrients.

In Table 2, fraction A includes Non-protein Nitrogen (NPN) compounds like NH_3, AA, and peptides (instantaneously degradable), and ($A+B_1$) represents the soluble portion, which is highly degradable in the rumen. Fraction B_2 is less degradable, whereas B_3 is very less degradable, and fraction C is the portion of the protein that is neither degraded in the rumen nor digested in the lower tract, and In Azolla, the part B_2 was the lowest. Azolla had the highest level of B_3 percent, which was followed by berseem and cowpea.

As compared to berseem and cowpea, fraction A, B_1 and B_2 were lower in azolla, indicating less rumen digestion. Azolla had the largest B_3 percentage, a protein linked to plant cell walls, nevertheless. In the small intestine, B_3 fraction is thoroughly digested but slowly destroyed in the rumen. Even though Azolla had a greater C fraction, it was still on par with cowpea fodder. A feed or fodder's protein fractions serve as a gauge for the protein's quality. These percentages are also associated, either favourably or unfavourably, with the protein's ruminal degradability and post-ruminative digestibility. The table demonstrates that Azolla had lower fractional values for A, B_1 and B_2, and a larger fractional value for B_3, indicating a smaller proportion of rumen-degradable protein and a higher proportion of undegradable protein in Azolla.

Azolla: Its Cultivation

Azolla production is dependent on a number of factors, including the location of the nursery and sunshine accessibility. Azolla can be produced more effectively in plastic-covered, cement structures that receive the ideal amount of light and shade. This can be built in the backyard of a house, in the corners of a cattle stable, or in an open area with enough sunshine. Azolla can also be utilized as green manure in rice fields, provided that 10% of the area is reserved for azolla cultivation. Any area of the cattle shed with enough sunlight can be used to produce azolla for livestock, especially milch animals. It can be cultivated in a compact brick and cement tank-like construction. The structure's depth should be 20 cm, and its length can be customized to meet the needs. A typical structure for caring for one dairy animal measures 2.5 m long, 1.5 m wide, and 20 cm deep. In addition, the structure receives 15 kg of well-sieved soil and 2-3 kg of farmyard manure, and the water level is always maintained at a depth of 10 cm. A 10 cm layer of soil and farmyard manure mixture should be applied. Farmyard manure is applied because it is a good source of carbon, and soil is applied to contain and supply nutrients to azolla. A nutrient mixture containing phosphorus, potassium, magnesium, and other nutrients is applied. The dairy cattle who eat the azolla

benefit from this mixture of nutrients, particularly the micronutrient application. 2-3 g of carbofuran are introduced the day before the vaccination and thoroughly mixed. The substance is allowed to settle before being examined for the development of foam on the water's surface. Water is left undisturbed and foam is removed overnight. If horticulture is being done in a hot climate, shade net should be placed over the building. Following that, 200 g of Azolla are injected into the water.In the summer, it is important to ensure that there is a minimum of 10 cm of water in the soil and to give shade with green fabric or coconut leaves to prevent excessive water loss and to block off too much sunshine. Azolla totally covers the water after 10 to 15 days. A net is used to extract it, and a small amount is left in the water to act as an inoculant for future production.

Precautions

1. The Azolla-producing unit should be placed in a shaded area with enough sunshine, ideally under a tree and avoid standing in direct sunlight.
2. The pit's corners should all be at the same level in order to maintain a constant water level.
3. When necessary, plant protection measures against pests and diseases should be implemented.
4. To avoid nitrogen build-up in the bed, 25 to 30 % of the water must also be replenished with new water once every ten days.
5. After replacing the soil and water, Azolla should be re-injected at least once every six months.

Harvesting

A plastic tray with 1 cm^2 mesh-sized holes should be used to harvest azolla so that any excess water may be drained. The tray should be stored in a bucket that is half full with water. To get rid of the stench of cow poo, wash Azolla. Separating the little plantlets that drain out of the dish is another benefit of washing. You can refill the original bed with the plantlets and water from the bucket. To feed cattle, the freshly gathered azolla should be combined 1:1 with commercial feed. Azolla as such can be fed to poultry, including both layers and broilers. However, it is advised to start by blending Azolla 1:1 with regular feed for a week. Livestock may be fed Azolla alone, without the addition of regular feed, after a fortnight of receiving it mixed with regular feed.

Other uses of Azolla

1. Azolla offers a variety of advantages to plants and the environment in addition to serving as a nutrient supplement for cattle.
2. The use of Azolla as a green manure or biofertilizer in rice fields has become extremely essential due to its quick multiplication rate and rapid decomposition capability.
3. Azolla pinnata has a remarkable capacity to concentrate metals such as cadmium, nickel, lead, and nutrients from contaminated or sewage water. It also decreases the heavy metals iron, copper, and chromium from polluted water.
4. Azolla (or a mixture of Azolla and rice straw) can be anaerobically fermented to produce methane gas, which can be used as fuel.
5. The remaining effluent, which contains all the nutrients that were originally incorporated in plant tissues with the exception of a small amount of nitrogen lost as ammonia, can be used as fertilizer.
6. When Azolla-Anabaena is cultivated in a nitrogen-free environment and/or a water medium containing nitrate, the nitrogenase in the symbionts develops hydrogen using water as the source, making Azolla a non-polluting, high-energy fuel.
7. Due to the high protein content is used successfully in western countries as a salad and traditional cough medication.

Conclusion

In addition to its usage as a biofertilizer for wetland paddy, azolla is a good source of nutrients with high-quality protein and low crude fibre content, making it an appropriate feed supplement for cattle, fish, pigs, and poultry.

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Article Id
AL04168

PHYSIOLOGICAL DISORDERS OF TOMATO

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Tomato is one of the most popular protective foodstuffs because of its high lycopene content and widely grown vegetables in the world, ranking second in importance to potato in many countries. Though widely grown, tomatoes are subject to a number of pests, diseases and physiological disorders. Environmental stresses produce several common physiological disorders of tomatoes. Any deviation from the normal behaviour of the plant is known as disorder, which is caused either due to the deficiency or excess of any of the nutrients essentially required by the plant for its normal growth and development or due to exposure of the plant to any of the factors *i.e.* nutritional, environmental and cultural in suboptimal or supra-optimal range. Any kind of abnormality in economically important part of vegetables or other parts that contribute to yield and quality of vegetable is termed as a physiological disorder. Physiological disorder is the abnormal growth pattern or abnormal external or internal conditions of vegetables due to adverse environmental conditions such as deviation from normal state of temperature, light, moisture, nutrient, harmful gases and inadequate supply of growth regulators. Separately from living organisms, there are a number of non-living factors that contribute disorders of vegetable crops. These are the biotic factors such as environmental extremes, nutrient deficiencies and toxicities, damage crop production steps, soil and water conditions. Below are descriptions of the different physiological disorder symptoms, causes and possible remedy of tomatoes.

1. Blossom End Rot (BER)

Symptoms

- BER is an important physiological disorder in tomato.
- Fruits are generally more sensitive to BER 7-10 days to 21 days after anthesis.
- The lesions appear at blossom end of fruit when it is green.

- The water soaked spots that appear at the point of attachment of the senescent petals later enlarge rapidly.
- The affected portion of the fruit becomes sunken, leathery and later dark coloured due to the attack of several microorganisms.
- This disorder never develops at stem end due to more calcium since it is supplied through stem.

Fig. 1: Blossom End Rot (BER) on tomato

Reason

- It is due to deficiency of calcium, water deficit, excess of moisture and use of ammonium sulfate fertilizers.

Remedy

- Conservation and maintenance of uniform supply of water.
- A single foliar spray of 0.5 per cent calcium chloride solution at the time of fruit development.
- Application of nitrogenous fertilizers in the form of urea.

2. Fruit Cracking

Symptoms

- There are four types of fruit cracking *viz.*, radial, concentric, circular and burst.
- Radial cracking mostly occurs at ripe stage while, concentric cracking occurs at mature green stage around the shoulder of the fruit.

Fig. 2: Fruit cracking on tomato

Reason

- Cracking is very common during rainy season, especially when the rains follow a long dry spell.
- The presence of water on the surface makes the fruit more conducive to cracking than soil moisture.
- Radial cracking is associated with high elasticity of fruit skin.
- Cracking is also associated with wider spacing.

Remedy

- Fruit cracking can be minimized by growing resistant varieties like, Punjab Chuuhara and Sioux.
- Picking fruits before full ripe stage.
- Application of 10-15 kg ha^{-1} borax in soil at planting or spraying boran @0.25 per cent at fruiting stage.
- Maintaining proper soil moisture particularly at ripening stage.

3. Cat face

Symptoms

- Distortion of blossom end of the fruit. Such fruits have ridges and furrows, indentations, blotches and malformation at blossom end.

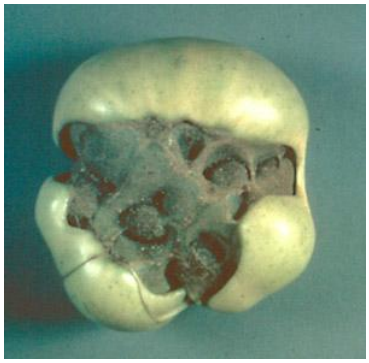

Fig. 3: Cat face on tomato

Reason

- Internal external stress at the time of critical development of tissues causes cat facing.
- Faulty pollination and fertilization.
- Low or high temperature.
- It is associated with uneven distribution of seeds in locules of fruit.

Remedy

- Cat face can be minimized by delaying pruning, balancing the internal nutrients and regulating the temperature.

4. Sunscald

Symptoms

- Fruits with blistered and water-soaked appearance. These patches may have a secondary infection of fungus, which show black dark spots.

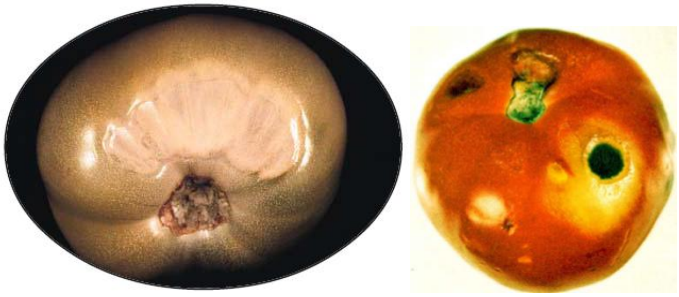

Fig. 4: Sunscald on tomato

Reason

- The tomato fruits exposed to sunlight either at green mature stage or near ripens are scaled during extreme temperature.
- Continuous falling of sunrays increases the temperature of that portion up to 40-50˚C or more.
- High temperature along with high light intensity, favours sunscald.
- In North India sunscald is serious problem in hot summer months (May-June).
- Cultivars with sparse foliage lead to sunscald.

Remedy

- Growing cultivars with dense foliage.

5. Blotchy ripening (BR)

Symptoms

- Presence of greenish yellow and whitish patches particularly at stem end portion is known as blotchy ripening.
- It is also known as gray wall, vascular browning, cloud, waxy patch, green patch, green back and internal browning.

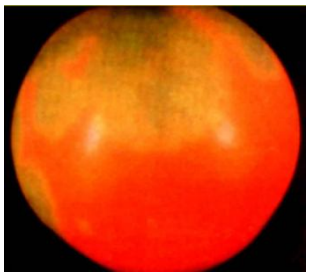

Fig. 5: Blotchy ripening in tomato

Reason

- Due to an imbalance of nitrogen and potassic nutrients in soil and water deficit.
- Excess of potassium in soil may lead to blotchy ripening.
- It is also due to the collapse of the parenchymatous cell of the pericarp.
- Faulty and uneven pollination also causes blotchy ripening.
- Water deficiency with high transpiration rate also develops this disorder.

Remedy

- Increment of potassium calcium ratio.
- Regulation of intensity and duration light and temperature.

6. Green Shoulder or Green Back

Symptoms

- The stem end portion of the fruits is turned green.

Fig. 6: Green shoulderon tomato

Reason

- Due to high temperature.
- Genetically governed.

Remedy

- Reducing the temperature.
- Growing varieties with very dense foliage.
- Green shoulder can be minimized by application of nutrient solution containing potassium.

7. Silvering

Symptoms

- Pale-silvery green patches appear on the leaves, stem and fruits.
- The main shoot is affected more and the growth is checked, as a result, the side shoot grow faster.
- The upper leaves turn silvery and tips of the plants become severely deformed.

- The symptoms appear after the development of 7-8 flower clusters.

Fig. 7: Silveringon tomato

Reason

- It is due to changes in sub-epidermal layer of apical meristem.

Remedy

- Termination of growth of main stem of tomato plants between the third and sixth trusses.

8. Puffiness

Symptoms

- It is also known as hollowness, tomato puffs, tomato pops and pocket.
- Puffiness is characterized by flattened surface of the fruit and the locules are not filled with pulp, placenta and seeds.
- The affected fruits are light in weight, hollow with flat sides.

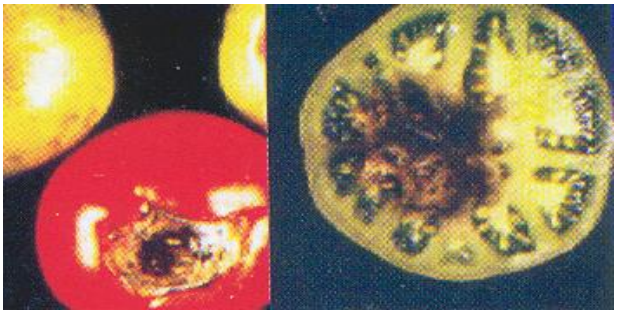

Fig. 8: Puffiness in tomato

Reason

- Puffiness also due to poor fertilization and abortion of ovules.
- It is controlled by more than one gene

9. Gold Fleck and Fruit Pox

Symptoms

- Gold colour flecks appear on the fruit surface and chlorophyll is not properly disappeared.
- The sub-epidermis or outermost cortex is transformed into spongy mesophyll tissues.
- When fruits ripen, the flecks change from dark green to golden yellow colour.
- Fruit pox is characterized by small lesions on the fruits that usually brown, rough and slightly raised or sunken.

Fig. 9: Gold fleck and fruit pox on tomato

Reason

- Gold fleck is genetically controlled.

Remedy

- Summer shading lowers the incidence of this disorder.

10. Cold / Frost / Low-Temperature Injury

Symptoms

- The injured plants show dark blackish colour.
- The fruits show the symptom of whitish yellow colour, which later become sunken and affected by fungus.
- The injured fruits become soft, water-soaked and dull in colour.

Fig. 10: low temperature injury in tomato

Reason

- It is due to low temperature / cold / severe frost.

Conclusion

The change in climate is affecting the incidence of physiological disorders in vegetable crops, particularly tomato. Therefore, it is necessary that the growers or farmers should learn to identify the various physiological disorders that occur in their agroecological zones or areas and should be able to manipulate the environment and use locally available resources to control the particular disorders. Evaluating the tomato cultivars suitable to the different agroecological zones/ areas along with manipulating sound horticultural practices, can check the devastating effects of physiological disorders in tomato. Comprehensive knowledge about the causes and management approach of different physiological disorders in tomato will not only aid the quality production to tomato growers,but also it will be useful for researchers to generate innovative ideas to control these disorders through biotechnological interventions, breeding strategies or by understanding a physiological basis to overcome it.

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Article Id
AL04169

COVER CROPS FOR SOIL FERTILITY AND EROSION CONTROL: A REVIEW

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Soil erosion and degradation is a serious problem globally, especially in the less developed tropical and sub-tropical countries (Lal, 2001). For instance, it has been calculated that between 1980 and 1990, 494, 748, and 243 Mha, respectively, of land in Africa, Asia, and South America were damaged by human-induced soil erosion (Oldeman *et al.*, 1991). As a result, the production and quality of the soil diminish.

Cover crops (CCs) can be added to crop rotation cycles as a strategy to boost production while reducing soil erosion and managing soil and its nutrients sustainably (Dabney, Delgado and Reeves, 2001). Cover crops (CCs) can offer a variety of benefits for the soil, agricultural production, and the environment (Blanco-Canqui *et al.*, 2015).

Cover crops are defined as the crops which are used to cover the ground surface. These crops are cultivated to prevent from soil erosion and limit the loss of nutrients from deep layers due to leaching and surface runoff (Kaye and Quemada, 2017). In order to increase agricultural production and productivity, cover crops are sown in between the main crops.

According to the Soil Science Society of America Glossary of Terms, CCs are defined as a "close-growing crop that provides soil protection, seeding protection, and soil improvement between periods of normal crop production, or between trees in orchards and vines in vineyards. When ploughed under and incorporated into the soil, CCs may be referred to as green manure crops" (SSSA, 2008).

Cover crops are grown due to the numerous benefits they provide, including protecting the soil from wind and water erosion (Dabney *et al.*, 2001). Both living CCs and their leftover deposit on the soil can prevent soil moisture from evaporating by covering it. Cover crops can also improve soil porosity through bio-pores created by roots and increased

earthworm activity, which enhances water infiltration into the soil and decreases runoff (Ruan *et al.*, 2001; Lal *et al.*, 1991). In comparison to no cover crops (NCCs), cover crops have been shown to improve soil physical properties by decreasing soil bulk density (Blanco-Canqui *et al.*, 2011; Haruna *et al.*, 2018), enhancing soil organic carbon (SOC) and aggregation (Steenwerth and Belina, 2008), increasing the proportion of macro pores, increasing water retention saturated hydraulic conductivity and water infiltration, and decreasing soil loss (Cercioglu *et al.*, 2018). This review places special attention on the role of cover crops in retaining soil moisture, reducing soil erosion, enhancing soil and water quality, and bringing about economic benefits.

Soil Erosion Control

In essence, cover crops are planted to prevent soil erosion. These are the best erosion control technologies and environmental preservation techniques. The pioneering work done in Belgium with various cover crops, such as white mustard (*Sinapis alba*), phacelia (*Phacelia tanacetifolia*), oats (*Avena sativa*), ryegrass (*Lolium perenne*), and fodder radish, illustrates the significance of cover crops for limiting soil erosion (*Raphanus sativus sub sp. oleiferus*). The findings showed that the root densities of cover crops ranged from 1.02 kg m3 for phacelia to 2.95 kg m3 for ryegrass. Crop species with fibrous root system (e.g. ryegrass, rye and oats) show high potential to control soil erosion while cover crops with thick roots (e.g. white mustard and fodder radish) are less effective in preventing soil erosion (De Baets *et al.*, 2011).

Soil Moisture Content

In the maize-soybean cropping system, it was found that using cereal rye (*Secale cereale L.*) as cover crop improved soil water (Qi and Helmers, 2010). Similar results were obtained in a 7-year research that used repeated winter rye as a cover crop in the maize-soybean cropping system, which was proven to be successful in preserving soil moisture and raising the soil water table. Reduced evaporation from the soil surface, moisture conservation from irrigation and rainfall, and improved soil moisture availability for succeeding crops are all benefits of using cover crops. Cover crops increased water retention in soil at water potentials related to field capacity and plant available water by 10– 11 per cent and 21 – 22 per cent, respectively (Basche *et al.*, 2016).

Winter annual rye cover crop helps to increase water at field capacity and hence winter annual rye and hairy vetch increase available plant water content (Villamil et al., 2006). Cover crops act as a hindrance between the soil surface and precipitation especially rainfall, it enables to reduce the rainfall intensity that falls on the ground. Through soil pores, which are created by soil macrofauna and reinforced by cover crop root growth, water drips slowly into the ground. Soil water storage is recharged as water infiltration rises rather than draining off (Sharma *et al.,* 2011; Sammis *et al.,* 2012). Another study from the University of California found that cover crops such brome grass, native plants, and strawberry clover can reduce the strength of the soil's surface by 38 per cent to 41per cent, as well as improve soil infiltration rate by 37 per cent to 41per cent and total water uptake by 20 per cent to 101per cent (Folorunso*et al.*, 1992).

Soil and Water Quality

A 25-year study on conventional tillage demonstrates that cover crops can improve soil permeability, soil organic matter, macroporosity, and cotton production. Oats and rye, which are winter cover crops, can increase soil organic carbon in a corn-soybean farming system (Kaspar *et al.,* 2006). Cover crops increase soil water content with the crop biomass and infiltration. However, it also involves decreasing water content through transpiration. Additionally, cover crops assist in preserving soil quality and reducing surface runoff (Qi and Helmers, 2010). Another study that used cover crops under no-tillage (NT), mould board plough (MP), and chisel plough (CP) treatments in annual corn and soybean cropping systems was carried out in Southern Illinois for 12 years. The yield of both treatments with and without cover crops is the same, but the soil organic carbon content of the cover cropped plots was higher (Olson *et al.*, 2014).

Economic Consideration

Winter rye was used as a cover crop for cotton in an experiment that gave yields ranging from $26 to 355 with an average of $81/ha (Schomberg *et al.*, 2014). It was found that cover crops in a no-tillage system and minimum tillage would be $25.60/acre and $15.10/acre, respectively. It is suggested that cover crops may be beneficial in future as continuous use of cover crops improves soil organic carbon, physical properties and level of organic matter (Schnitkey*et al.*, 2016). Economics of cover crops depend on the soil type, weather conditions, region and also the management practices. The economics of cover crops are influenced by the soil type, climate, geographic location, and management techniques.

Utilizing hairy vetch as a cover crop in the cotton production in Northwest Louisiana, the economic effects of short-term and long-term adoption of cover crops were evaluated. Benefits for nutrient credits include decreasing the need for fertilizer (N, P, and K), reducing erosion, spending less on herbicides, and increasing the yield of cash crops after cover crops. The long-term use of cover crops has been demonstrated to improve soil water retention and fertility. An additional benefit for using long-term cover crops resulted by an increase of $13/acre/year as compared to short-term analysis. Overall, total net benefits found to be $1354/acre/year for adoption of long-term cover crops (Adusumilli *et al.*, 1016).

Conclusion

Review suggests that cover crops have excessive ability to contribute to sustainable agriculture production. By minimizing soil erosion (both water and wind erosion), which in turn increased soil hydraulic characteristics (water infiltration), and by boosting the soil organic carbon, cover crops improve the general health of the soil. However, varied advantages of utilizing cover crops depend on the species chosen (legumes, non-legumes, grasses, and brassicas), when the crop is planted and harvested, and how it is harvested (mechanical or chemical). For example, it has been discovered that cover crop species with fibrous root systems are more successful at controlling soil erosion than those with tap roots. After extensive use, cover crops are typically advantageous since research shows that their extensive use has led to cost-effective utilization. Numerous aspects need to be researched, such as the allelopathy effect of employing cover crops, the usage of various cover crop combinations, and their management techniques for enhancing soil health and quality.

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Article Id
AL04170

INTERNATIONAL ALLIANCE: FREEDOM FROM HUNGER

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Hunger listens not to reason nor cares for justice nor is bent by any prayer. Scientific breakthroughs together with synergetic socio-economic infrastructures and poor-friendly policies along with a strong and determined political will only can solve the problem of hunger. Therefore, a combination of all these in a national perspective but with the international alliance is essential in our country to eliminate hunger in the long run and reduction of hunger as a short term national policy.

Poverty is the min root cause of hunger. Lack of purchasing power of nutritious food is the basic issue. In India 320 million people live bellow poverty line. Nearly 50 per cent of children below five years are malnourished, one third of the new born are to low weight. The vulnerable groups include small and marginal farmers, landless labour, urban poor, etc. Within these groups women and children are more effected. Hunger has its own complexities along with poverty such as higher population growth, low agricultural production and productivity, unemployment, starvation, etc. The fact is that as income rises, consumers spend more money on food.

The vitamin A supplementation coverage rate, the GNP, purchasing power parity are very low compared to the world figures also apart from those of USA. The human development index shows India to be in 124th rank while USA is in 6th position. The percentage of children under five years suffering from underweight, wasting and stunting also shows higher figures than the world average. The GNP per capita and the purchasing power parity reveal a much lower values than the world average Unless the economic growth is improved, we cannot reduce the poverty coupled with malnutrition and hunger.

Malthusain Theory and the Green Revolution

Famine leading to hunger, starvation and finally to death was profounded by Malthus as an important natural check in controlling population growth. However, the green revolution in India was achieved with great success inspite of population growth. This was possible due to steep increases in the food grain production fourfold from 50million tones in 1950 to above 200 million tones as of now. The revolution happened because of collaboration with premier research institutes of CGIAR, viz., CIMMYT and IRRI concerned with wheat and Rice improvement, the primary sources of food together with changes in public policies and political will coupled withwisdom.

Equitable Food Access

India though self sufficient in food grain production due to the green revolution, the irony of millions of hungry stomachs persisting year after year taunts of nation. The issue is regarding the accessibility of food and more specifically of nutritious food. Noble laureate Amartya Sen prefers to call it as “issue of food entitlement”. The lack of purchasing power of food by those below poverty line (35 per cent of population) thus making it possible to have huge buffer stocks in Food Corporation of India is to be seriously pondered over. This has implications of economical dimentions together with political, social and environmental in nature. Hence food for all require alliance on many inter-related fields.

Towards Building a National Food Security with International Alliances

The components of national food security would be production and productivity security, buffer stock security, social security and nutrition security. Solving one and all of these components could better be done through International alliances for flow of collective wisdom as well as for enhanced international development assistance through basically agricultural and rural development. The central and state government’s involvement in the development of research, extension, infrastructure development, marketing, public distribution system, rural development, etc can be boosted with international alliances.

International Alliances

FAO: Food and Agricultural Organization is the premier international organization to fight hunger. FAO is supporting the National Agricultural Research System through various programmes supporting the national production system, rural development and related areas for promoting overall production and nutrition.

WFS: World food Summit (1996) has been striving to bring a general awareness regarding the issue of hunger and obtain support of public, private, NGO's etc. However, prevention and preparedness are given priority.

CGIAR Institutes, IMF, World Bank and UNDP

The various institutes under the consultative group on International Agricultural Research, vi., ICRISAT situated in India, CIMMYT, ICARDA, CIAT, IITA, ILRI, etc for the improvement of wheat maize, dryland crops and livestock etc., International Food Policy Research Institute, International Monetory Fund, World Bank and the United Nation's Development Programme, etc are contributing directly or indirectly to eliminate/reduce hunger.

WFP: World Food Programme supported by FAO and the UN caters to the needs of poor countries including India from time to time and has been a source of hope for the downtrodden. This programme needs to be strengthened and expanded too in pursuit of relentless fight to end hunger.

International alliance with IRRI: Rice being the staple food of Indian subcontinent and the whole of Asia, the Indian NARS (National Agricultural Research System) has close cooperation with IRRI (International Rice Research Institute) based at Phillipines.

New Concepts of Rice Development

Super rice: IRRI is developing "Super Rice" which embodies a 25 per cent genetic potential yield gain over the existing high yielding varieties. The new plant type of rice is being touted as the foundation breeding material for the next green revolution in developing countries. The traditional tall paddy varieties typically has a total biomass of around 12 tonnes per hectare, of which the harvestable grain matter was 30 per cent. The first generation HYV's

enhanced the biomass to about 20 tonnes, with a harvest index of 505. Super rice would enhance these further to 22-23 tonnes and 55 per cent respectively.

Golden rice: This type of rice is being developed for higher nutritional values. The enhancement of protein and the essential amino acids for betterment of nutritional security is the aim of this development. The problem of malnutrition and under nourishment would be reduced with golden rice. In countries where rice is the staple food, even a small increase in nutritional value will contribute significantly to the health of people.

SYS Net programme: The world needs 50 per cent more rice in another 20 years and if succeeded about four billion people in Asia will be able to have enough food. However, in a solution of this great demand, systems research network for ecological land use planning in Tropical Asia-SYS net was formed. Farmers, scientists, politicians, bearcats, community leaders formed this system to discuss the management of natural resources and to plant for the future. The great success is that all the stakeholders discuss with each other and find an acceptable way out. SYS net was created in 1996 by a team set up at IRRI.

The National Agricultural Research Systems (NARS) of India Malaysia, Vietnam and the Phillippines are involved along with the Wageningen University and Research Centre in the Netherlands. After seeing the system in action, high ranking Malaysian officials wanted the system methodology applied to their national planning programmes. It has been recommended for adoption by provincial governors and research managers throughout the phillipines.

Scientists with SYS net experience have become more flexible. They are changing from supply driven to demand changing from supply driven to demand driven research. They are more willing to ask and better able to respond to what ent-users need and this is an enormouse change.

Flood Prone Rice Research Consortium

About 13 million hectares of rice land mostly in south and southeast Asia experiences uncontrolled flooding and hence produce low yields. To evaluate and adopt promising technologies through farmers participatory Research, IRRI helped to establish Flood-prone Rice Research Consortium in 1999. Scientists from India, Bangladesh, Thailand,

Srilanka and Vietnam have joined this consortium with the international fund for agriculture development providing financial assistance.

WTO: India is a signatory to the world trade organization. WTO rules govern 97 per cent of world trade with an impact on the global food economy. India should and is using the WTO's rule-based system to protect its interests in economic and political adversities. Advisory centre on WTO law was established in 2001 as an independent organization. This provides low cost legal counseling services to disadvantaged members. These initiatives need encouragement and expansion. Enhancing the enforcing the rulings under the dispute settlement mechanism needs to be found. The very recently held WTO meeting held at Cancun in Mexico faced tough time in trying to resolve the differences in matters of farm subsidies between the development industrial nations and the developing agricultural nations, India taking a lead role.

NATP: National Agricultural Technological Project in India is underway with funding from World Bank. Positive results are being obtained which in the long run would help in reducing hunger.

FFW Mid Day Meals Programme, etc

Food for work programme is a long term programme launched to temporarily remove the hardships of hunger in the poverty sticken people of the drought prone areas with assistance from NGO's world bank etc. Similarly the Mid-Day Meals programme tends to feed the poor children studying in government schools. These programmes need to be strengthened with more international alliances from philanthropic organizations.

Regional Alliances at the Sub-Contient Level

SAARC: South Asian Association of Regional Cooperation was established in 1985. This alliance comprises of seven countries viz. India, Bhutan, Sri Lanka, Bangladesh, Nepal, Pakistan and Maldives. Agricultural development with rice as the focus and fight against hunger is prior in the associations agenda. SAIC (SAARC Agricultural Information Centre) is an offshoot of SAARC agricultural development and publishes information on matters of agricultural importance every quarter. SMRC (SAARC Meteriological Research Centre) is working on meterology while SHRDC (SAARC Human Resource Development Centre)

promotes development of training, skills and other activities related to human resource development. The SDC (SAARC Documentation Centre) is involved in documentation of the developmental activities of the member countries.

Conclusion

The budget allocations for agricultural and allied sectors needs to be increased further. Specific priority for international alliances is the need for the day and this concept needs further support and expansion, so as to takle the components of the National Food Security effectively. This strategy would better promote in an enlightened and collective wisdom, sustainability in agricultural production rural development a long term strategy for increasing food production and nutritional security while conserving and managing natural resources. The aim is to meet the needs of the present generation without damaging the interest of the future generation by promoting development. The environment is not to be degraded. Technology is to be appropriate, economically viable and socially acceptable. However, accessibility of food to all is to be taken care of.

With globalization, the concept of international alliances can be taken in our favour for solving the food problem. Policy issues for various organizations like WTO are to be created and those formed modified including the subsidies issue, etc to suit our agricultural development and farmers interests. Wholistic technology, collective wisdom and more money would flow in through these alliances the goal of which is to start with reduction and finally to eliminate hunger (IA).

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Article Id
AL04171

A STUDY ON OUTSTRETCHED, MENACE AND GOVERNANCE OF *Parthenium hysterophorus*

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Parthenium hysterophorus also commonly known in Indian languages like chatak chandani, nakshathra gida, osadi, gajari-kasa, phandriphulli and safed topi is a luxuriant weed sometimes called as carrot grass, congress grass, fever few, star weed etc. (Bhowmick, 2000) besides the common name in English Santa-Maria (Reported by: Botanical Society of England and Ireland, 2015) belongs to Asteraceae (Compositae) family is one of the most harmful alien invasive annual weed which is herbaceous and errect in nature responsible for both economical and ecological problems (Khaket *et al.*, 2015). It is native to the North American tropics (Reported by: United States Department of Agriculture, 2010). Parthenium is a C_3-C_4 intermediate plant (Mahadevappa, 2009a) and particularly the species hysterophorus has a chromosome number of 2n=18 (Hakoo, 1963). It is a weed of semi-arid, subtropical, tropical, and warmer temperate regions and is most aggressive in degraded pastures in semi-arid environments. Parthenium thrives in alkaline, clay-loam to heavy black clay soils (Berry, 1984) but it tolerates a wide range of soil types with favorable pH being 5.5-7.0 and can emerge at wide range of temperatures ranging from 10 to 25 degrees Celsius (Tamado and Milberg, 2002). The rainfall of amount 500 mm annually favors their germination and growth (Chamberlain, 2004). Drought also creates favorable conditions due to less pasture coverage beside countries prone to flood can also be threatened by its growth due to the plant's wide range of adaptability towards various climate and soil conditions. Integrated managemental approaches proved more successful in controlling parthenium plants.

Distribution

Today parthenium has spread over 40 countries due to its fast-spreading ability and wider adaptability under various climatic conditions such as Australia, Gulf of Mexico, Central America, South, and Northern America, West Indies, and Oceania along with other

countries of the pacific region (Navie *et al.*, 1996). It has been reported from Asian countries like Bangladesh, Israel, Pakistan, Nepal, Southern China, Sri Lanka, Taiwan, and Vietnam. Recent studies showed its invasion of African countries like New Caledonia, Papua New Guinea, Seychelles and Vanuatu, Kenya and many districts of Uganda have been infested in the last few years (Dhileepan and Senaratne, 2009). In India, it arrived in 1955 through the import of food grains under the US PL 480 scheme which was a food treaty between the US and India (Vertak, 1968) and later, identified and reported by Rao (1956) in Poona now Pune, Maharastra. During 1810, it was reported that Parthenium was first maintained at Botanical Garden, Shibpur, Howrah (West Bengal) in India under the programme of collection and *ex situ* conservation of alien plants (Mukhopadhyay *et al.*, 1993). Also, accordingly it was first reported in Arunachal Pradesh, India in 1810 (Gnanavel, 2013). Since then it spread to each corner of the country. In about 50 years, it has established its roots throughout India under the climate of extreme cold and heat. During 1975, it was first observed in few quantities near Dankuni rail yard, Hooghly, West Bengal (Mukhopadhyay *et al.*, 1993). Now it covers approximately 35 m ha of land in India which is a serious issue (DWSR Annual Report, 2010c). It is being observed in the northern parts of India like Kargil region of Jammu & Kashmir, Himachal Pradesh, southern regions of India at Port Blair in Andaman & Nicobar along with Kanyakumari, in the western regions of Gujarat, Maharashtra and finally in the eastern states of West Bengal, Assam etc. (ICAR-DWSR, 2012, Lok Sabha, 2014) which is an indication of its widespread in India. Due to the lightweight of seeds, they are easily dispersed through various means such as air, water, agricultural implements, grains, stock feed, pasture feeds, humans, animals, vehicles, etc. (Monaco *et al.*, 2001). The seed germination occurs from 8^{o}-30^{o} C. Parthenium is an annual, herbaceous, errect, fast-maturing plant that forms a basal rosette of leaves during the early stage. It is having shorter life span as it germinates, grows, and produces seeds within 50 to 80 days a single plant can produce 15000-25000 seeds and an average of 1,00000 in large plants can be seen and so considered as a luxuriant seed producer which is their only mode of reproduction (Gnanavel, I., 2013) and can annually complete up to 3-4 life cycles from (February-May, June-September and October-January) or more with each seed viability up to 4-6 years has been observed in many cases even when buried while the seed on surface does not have or little dormancy are recorded (Navie *et al.*, 1996). The weed has the potential to produce as high as 1, 54000 seeds per m^2. The plant seeds can germinate from up to 0-3 cm deep.

Ill effects of Parthenium

Parthenium hysterophorus causes both ecological and economical damage to the environment. In India, about 4-7% of people are having clinical symptoms due to contact with parthenium and 42-52% suffers without showing any symptoms as reported by Towers and Rao, 1992. The sesquiterpene lactones in parthenium which is a bitter glycoside parthenin (Maishi *et al.*, 1998) cause allergic reactions when people or animals come into its contact. It is poisonous, allergic, and problematic to both humans and livestock (Kaur *et al.*, 2014). The plants and their pollen dust, when coming in contact with humans, causes several health issues such as dermatitis (Morin *et al*., 2009), infections, skin rashes, allergic bronchitis asthma, allergic reactions on the sole, severe dermatitis, allergic eczematous, allergic papules, hay fever, and depression in human (Mahadevappa, 2009). The allergens found in parthenium are parthenin, coronopilin, tetraneuris, ambrosin. The pollen mainly causes bronchitis in human beings. Similarly, the plant also causes a problem in livestock as these are not palatable for grazing animals such as bitter milk, tainting of milk, meat taint as reported by (Lakshmi and Srinivas 2007), (Ayele, 2007) if eaten with grass or pasture causes ulcers in the mouth (Aneja, K.R., 1991). Dermatitis with skin lesions also occurs in grazing animals along with anorexia, pruritus, diarrhea, edema, alopecia, skin depigmentation. It produces toxic chemicals parthenin, hysterin, caffeic, hymenin, ambrosin, vanillic, ferulic, kumarin, chlorogenic, phenolics acid which exert a strong allelopathic effect on other crops thus prohibiting the growth of other crop plants and reducing the palatability of food grains grown in parthenium infested areas. Parthenin is an allelopathic chemical that is a water-soluble phenolics compound that inhibits the germination and growth of a wide variety of crops. Parthenium plants reduce the yield of field crops by 40% and 90% in forage crops as per report (Ghosh *et. al.*, 2018). It has been reported that pollens of parthenium affect brinjal, tomato, maize, beans, capsicum etc., regarding their fruit setting thus reducing the yield causing economic loss to the farmers (Directorate of Weed Science Research, ICAR, 2010).

Utilization of Parthenium

- Parthenium can be an excellent source of plant nutrient as it contains N, P and K along with other macro and micro nutrients such as Ca and Mg (Khan *et al.*, 2011). Parthenium can be converted into compost which contains 1.05-1.21% of N, 0.84-0.89% of P and 1.11-1.34% of K as reported by ICAR-DWSR, 2017. Pit system method of compost preparation is safe and reliable method to convert parthenium into

compost which can result in increasing yield and productivity of field crops. The dosage for use as basal application is 2.5-3.0 t/ha and for vegetables 4-5 t/ha is sufficient in adding nutrient to the field as reported by (Directorate of Weed Science Research, Jabalpur, 2012). Parthenium manure or mulch should be made from those plants which are in vegetative stage i.e., before flowering. 5t/ha of parthenium mulch is sufficient to increase soil fertility status and crop productivity as reported by (Dolai *et al.,* 2019).

- Parthenium contains many treatments for different ailments such as used by different tribes for skin rashes, fever, anemia, ulcerated sores, facial neuralgia (Venkataiah *et al.,* 2003). It also act as an analgesics in muscular rheumatism aqueous extracts exhibits hypoglycemic activity acting as an antidiabetic medicine, treat fever, diarrhoea, neurologic disorder, dysentery, urinary tract infection. *P. hysterophorus* leaf paste showed wound healing action when applied externally as reported by Kumar *et al.,* 2011.

- Parthenium act as an herbicide against Digitaria sanguinallis, Cynodon dactylon, Cyperus rotundus, Portulaca oleracea, Ecchinochloa crusgalli, Xanthium stramorium etc.

- It is a good antifeedent for Spodoptera litura and Callosobruchas aculatus can be controlled by parthenium (Datta and Saxena, 2001).

- There are several other benefits from parthenium. It is a cost effective source for removal of heavy metals like cadmium, nickel, nitrates, phenols and dyes which causes serious ailments in humans released from industries (Patel, 2011).

Managemental Approaches

There are various methods for controlling parthenium plants in our surroundings. Scientists and researchers are still finding new methods for complete eradication so to minimize crop loss in India. After so many years of research, they discovered a few methods which are effective in checking their growth in India.

1. **Mechanical or Physical** method: Burning is not a permanent method but is effective in non-cropped areas or before sowing of the crop in agricultural lands as burning can damage necessary crop plants along with heavy fuel consumption is observed

(Kushwaha, V.B.; Maurya, S., 2012). But not a useful control strategy for parthenium, however, scientists suggest that burning for other purposes will not result in an increased infestation of parthenium as long as the pastures are allowed to recover before the stock is introduced. Parthenium can be uprooted before flowering and seed setting as after seed setting when the plants have uprooted the seeds spread on the ground causing the serious infestation. Ploughing the parthenium plant while in the rosette stage before the seed appears is effective in its control. Hand weeding is not safe as it is hazardous to human health also it is labour intensive and consumes time (Kushwaha, V.B.; Maurya, S., 2012).

2. **Cultural method**: Researchers found some plant species which can gain upper hand by competitive replacement of parthenium can be achieved like planting with *Cassia tora*, *Cassia sericea*, *Cassia occidentalis*, *Croton bonplandianus*, *Croton sparsiflorus*, *Amaranthus spinosus*, *Sida acuta*, *Tephrosia purpurea*, *Cassia auriculata*, *Stylosanthes scabra*, *Alternanthera sessilis*, *sida acuta*, *Chenopodium album* etc., (Gnanavel, I., 2013) which can positively reduce parthenium infestation by checking their growth. At the roadside, the children's park Marigold plant (*Tageta* spp.) can be grown along with Croton spp., Amaranthus spp. by simply broadcasting their seeds @ 2500 g ha^{-1}. Marigold is also grown in crop rotation in Indian fields during the rainy season.

4. **Chemical method**: Weeds in non-cropped areas, open wasteland, and along railway tracks could effectively be managed with the post-emergence application of total killer herbicides (Paraquat 25 WSC at 1.0 kg a.i. ha^{-1}) in combination with 2, 4-D sodium salt 80 WP at 1.5 kg a.i. ha^{-1} (Bhowmick *et al*., 2017). Apply post-emergence herbicides like 2,4-D Sodium Salt @ 1.5 kg a.i. ha^{-1} or oxyfluorfen (ready mix) @ 2 g $liter^{-1}$, Dolai *et al.*, 2014b reported earlier on this matter. Spraying of diuron 80 WP @ 15 kg ha^{-1} , Glyphosate 71 SG + Oxyflurofen 23.5 EC @ 2g $liter^{-1}$ of water or Glyphosate 71 SG @ 3kg ha^{-1} + 2,4-D EE @ 500 g ha^{-1} if 2-3 sprays are applied in repetition per year as reported (Ghosh, *et al.*, 2018).

5. **Biological method:** Researchers have tried different natural agents from time to time then in 1983 biological control was initiated in India with the introduction of the Mexican beetle Zygogramma bicolorata (leaf-feeding beetle) from Mexico (Jayanth, K.P., 1987) which came to be most successful. The moth zygogramma emerges in the

late spring and remains active till autumn. The beetles hibernate in winter and feed only on the foliage and are available in june-july. Mexican beetle is no doubt an excellent agent for parthenium control in any season except in high humid condition and winters as it was observed that in winter and humid condition the egg laying grubs infest less quantity of parthenium plants due to their lack of adaptation in such climatic condition (Dolai *et al.*, 2016). Other bio-agents such as stem galling moth (*Epiblema stenuana)* are also introduced. *Listronotus sestosipenis (*seed feeding weevil), *Smicronyx lutulentus* (seed feeding weevil), *Bucculatrix parthenica* (leaf mining moth), *Carmenta ithacae* (stem boring moth) etc., all have excellent parthenium controlling capability (Javaid, A. and Shafique, S., 2010). A fungus Puccinia abrupta var. partheniicola urediniospores are also introduced to control parthenium (Fauzi *et al.*, 1999) along with *Fusarium s*pp., *Alternaria s*pp., *Rhizoctonia solani, Colleotrichum capsici* (Laxmi and Srinivas, 2007).

6. **Preventive approach:** As per the report o**f** Dolai and Bhowmick, 2018, parthenium free crop seeds, stock feeds, vehicles and farming implements are necessary to avoid its spread to non-infested areas. Checking of parthenium infestation during drought periods is also important**.**

7. **Legal Control:** Karnataka was the 1st state in India to adopt legal act for the management of parthenium. Necessary preventive actions must be adopted by both state and central government to restrict its growth and spread in wastelands, roadsides, canal sides, railway tracks, irrigation bunds etc. Awareness among people should be build up by the State/Central government by declaring it as a noxious weed and implement proper law on it as per report by (ICAR-DWR, 2020).

Conclusion

As a result of its allelopathic tendency toward crop plants and the generation of allergens that are harmful to both humans and animals, parthenium control is extremely important. This write-up discusses about parthenium's positive and negative effects on the environment and living things, as well as the health risks, crop losses, and control measures for this noxious weed. Here, we'll talk about integrated control methods, but there may be other ideas out there. Although biological control methods are typically used, additional eco-safe, cost-effective strategies should be added to promote sustainability. Due to their excessive competition with parthenium, many plants are employed to control it, but only

marigold has been widely used due to its ease of availability and aesthetic appeal. To further understand its biology, behavior, competitiveness, and eco-safe management, more research should be done. A community-based strategy is important to control parthenium because of its great reproductive potential. The National Parthenium Awareness Week is recognized during the second week of August. Similarly, the State Parthenium Awareness Week may be observed in each State depending on the level of Parthenium infestation there.

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Article Id
AL04172

HYDROGELS: PLAYING A CRITICAL ROLE IN THE BASIC NEEDS OF PLANTS

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The term hydrogel refers to a three-dimensional crosslinked polymeric network made of synthetic or natural polymers that can hold water within its porous structure. The presence of hydrophilic groups in the polymer chains, such as amino, carboxyl, and hydroxyl groups, contributes significantly to the water holding capacity of hydrogels. At physiological temperature and pH, these polymeric materials do not dissolve in water but swell significantly in an aqueous medium. Hydrogels can be made from almost any water-soluble polymer, with a wide range of chemical compositions and bulk physical properties. Because of their ease of manufacture and self-application in clinical and fundamental applications, hydrogels have been widely used as drug carriers. Hydrogels have a variety of biomedical applications.

What is Hydrogel ?

Hydrogels are three-dimensional swollen networked structures, a class of hydrophilic homopolymers or copolymers covalently or ionically group material formed by loosely crosslinked networks capable of absorbing large amounts of water or biological fluids without dissolving in water. In 1954, Wichterle and Lim of Czechoslovakia created the first original polymeric hydrogel network.

A polymer can be divided into 3 groups:

- Acrylamide sodium acrylate co– polymers–cross–linked polyacrylamides.
- Vinyl alcohol–acrylic acid co– polymers (polyvinyl alcohols)
- Starch–polyacrylonitrile graft polymers (starch co–polymers)

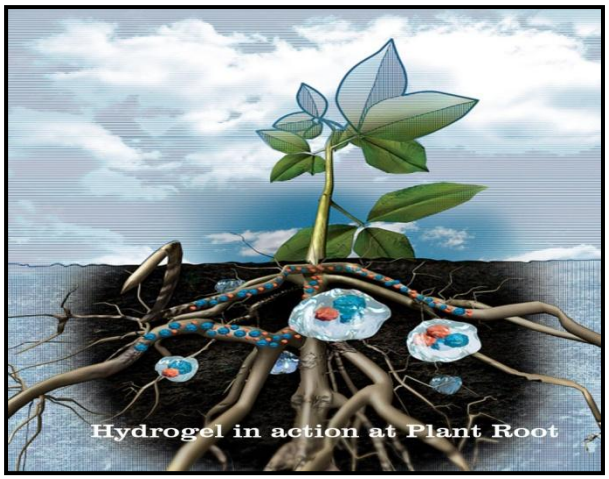

Fig.1(a): Action of Hydrogel in Rhizosphere

Fig.1(b): Hydrogels

Mechanism of Hydrogel Formation

Polymers are carbohydrate materials that, due to their availability, presence of modifiable functional groups, biocompatibility, and other properties, have been widely used to make physical and chemical hydrogels. By selecting the type of monomer or polymer and the type of hydrogel formation reactions, hydrogels can be tailored to a specific application. Chemical crosslinking and physical crosslinking are the two methods used to create hydrogels.

Types of Hydrogels

1. Pusa Hydrogels: It is a semi-synthetic superabsorbent polymer which fulfils the basic requirements of plants and widely used in agriculture. It is mixed with the soil on which the seeds are sown. It sicks to the roots of the trees and when the soil moisture falls as the temperature rises. The pusa hydrogel absorbs water and expands to 300 times its original size

2. Super Absorbent Polymers (Water Absorbent Polymers): The super absorbent polymers (SAP) are a non-toxic, natural, starch-based biodegradable material. It absorbs water more than a hundred times of its weight within a short time. The SAP has high water absorbance power and release 95% of absorbed water in soil. The SAP is a sugar like hygroscopic substance which becomes swell by absorbing water and form a gel like stuff. SAP is also called as Slush powder.

3. Water Retention Polymers and Potassium Polyacrylate: Water retention polymers are particularly useful in rainy and dry season, for better absorbency and retention power. This hydrogel is use to preserve their crop from seasonal variability. It can maintain the high growth of crops in a changing climate. Potassium Polyacrylate is a unique type of hydrogel which is applicable in seasonal crops., In transplanting and cut flowering, for bare toot dipping, agriculture, gardening, horticulture, landscape.

Salient Features of Hydrogels

- It increasing the agriculture productivity by improving of water use efficiency.
- Crop irrigation and fertigation requirements are reduced.
- It helps the plants withstand in moisture stress
- Seed additives to support seed coatings or seed germination
- Dipping of seedling roots before establishment
- Enhances the physical properties of soils and soil less media.
- Suitable for semi-arid and arid climatic regions.
- Water absorbs at minimum 350 times its dry weight and gradually released.
- At high temperatures, it exhibits the maximum absorbency (40- 50o c)
- Coated protecting agents' herbicides and pesticides for slow release.

Table 1: Hydrogel Characteristics and Potential Applications.

Sr. No	Parameters	Characteristic and Potential Applications
1.	Appearance	Amorphous granules
2.	Chemical constitution	Cross linked anionic polyacrylate, Cellulose based Grafted
3.	pH	7.0-7.5
4.	Particle size	20-100 mesh (micro granules)
5.	Sensitivity of UV light	Not sensitive
6.	Stability at 50°C	Stable
7.	Stability	~ 2 Years
8.	Temperature	40-50 °C
9.	Recommended dose	1-2 kg acre-1
10.	Depth	6-8 inches of soil (For clay soil 4 inches from soil surface)
11.	Toxicity in Soil	None

Additional Features

- Absorbs water 400 times of its dry weight and slowly releases it.

- In semi-arid and arid soils, it exhibits high absorbency temperature ranged from 40-500C.
- Increases the percentage of seed germination and seedling emergence rate.
- Reduces the need for irrigation and fertigation requirements, as well as amount of urea to be applied,

Application of Hydrogel in Tissue Culture Engineering

Hydrogels composed of highly hydrated polymer networks are similar to ECMs, which have received considerable attention for tissue engineering and regenerative medicine applications. To date, various hydrogels derived from natural or synthetic polymers have been used to repair damaged osteocortical joints or articular cartilage tissue. Alginate is a naturally occurring polysaccharide polymer derived from brown seaweed and various bacteria. One of alginate's distinguishing characteristics is its ability to physically crosslink by divalent cations such as Ca^{2+} at room temperature, making it useful in a variety of biotechnological methods such as moulding, spraying, and 3D printing.

Conclusion

Agricultural sustainability is essential for improving food and water security, especially in the face of climate change. It is obvious from the above context that hydrogels are very useful in Indian environment, as yield are improved tolerating the vagaries in monsoon with fewer schedules of irrigation. Hydrogels in modern agriculture farming have recently gotten a lot of attention from both researchers as well as among farmers. The hydrogels are used in areas where rainfall and irrigation are scarce. Hydrogel practices in the water stressed areas for improve agricultural productivity with preserving the environment sustainability. This will benefit the farmer by lowering his cultivation costs while also improves nutrient use efficiency and water use efficiency. Hydrogel has the potential to be an effective soil conditioner in arid and semi-arid regions. Hydrogels are good soil conditioners that can help to improve water use efficiency, plant yield and health. It would enhance soil texture, mitigates the effect of soil salinity on plants, release of stored water in dried soil and provide the required porosity for optimum flow of air and water.

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Article Id
AL04173

ROLE OF AGRICULTURE IN TRANSFORMING LIVES

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Since nearly 70% of Indian population still remained dependent on Agriculture for their livelihood survival hence it can be considered a vital part of sound economic management of the country. Early man domesticated several crops such as cereals, fruits, vegetables and animals and evolved a settled agriculture system from a nomadic pastoral life. In this course of agricultural development man preserved many species of crops and animals those being selected on the bases of high nutrient content and their reliable harvests. Presently, the agricultural system got fully developed and is being supplying stable food items to the huge population of the world that kept the people away from starving. Apart from so many innovative agricultural technological developmental processes, in recent years, mass information through media changes in agriculture and allied industry has also been accelerated. Now a day's the role of information technology in rural economic management has become quite evident and its extensive application in rural agriculture system successfully revealed its effective role in promotion and development of rural economy. However, as compare to other sectors of economy the development in Indian agricultural sector is still relatively slow due to lack of proper infrastructure. Since it has been seen, that information technology has effectively improved the efficiency of agricultural production system. Therefore, the Agricultural economic management information is taken as the pivotal theme of this study vis a vis the traditional agricultural economic management as the control group. This article emphasizes the requirements of developing agricultural economic management system and its impact on the growth of a nation.

Agriculture and Poverty:

In India, nearly 70% of the farming households adopted agriculture and its allied activities for their primary source of income. Progress in the field of agriculture and allied occupations has not only been revealed to stimulate economic development in respect of

industrial sector but also leads to create additional jobs and overall growth upliftment of the peoples. Per unit increased in agricultural productivity not only found to link with raising farm incomes, increases food supply, reduces food prices but also provide greater employment opportunities in both rural and urban areas. Higher incomes may be a boon in increasing the consumer demand for goods and services produced by sectors other than agriculture. Hence, such linkages (or the multiplier effect) between growth in the agricultural sector and the other economic sectors has enabled developing countries to divert their work force to work in other sectors where growth is higher and wages are better. Such kind of diversion of peoples from agriculture sector to other industrial sector is also important for overall development of a developing country. Moreover, such kind of diversion is more relevant in case of rural areas where nearly 70% of the rural population is bound to live below poverty level.

Role of Agriculture in Economic Growth and Transition of India

The role of agriculture in India's economic growth and its contribution toward social hierarchy has always been remained crucial since the beginning of civilization. A brief history of its development through the ages is given below.

Early Stage

In earlier days, agriculture contributed a large share in gross domestic product (GDP) of the country during those days' poor's used to spend a high percentage of their income on food items. As soon as the agricultural productivity increases simultaneously the nonfarm sector also got developed that caused less dependency on agriculture sector worldwide except those areas where the nonfarm sector did not developed properly. Hence, constant growth in agricultural sector played a key role toward wider growth of the country as well as poverty reduction however the degree of growth remained dependent on the changes in productivity status of a farm as well as the size of farms. For adequate growth there should be increases in land and labour productivity and initially land and labour productivity must rise to reduce poverty thereafter land productivity should raise at faster rate so that it could create additional employment on a farm to benefits the poor as well as to create demand for nonfarm goods and services. As soon as the growth increases it create more employment opportunities in other economic sectors too and labour moves outside of agriculture sector that caused rise in labourers wage rates. Once this stage is achieved then increase in labour productivity is essential to maintain regular food supplies as well as the prices rise. Hence, higher

productivity in agricultural sector is proved to be an initial step or engine of growth that can leads to greater income for a country. Though, historically it is evident that no one of the poor countries has reduced poverty only through agriculture but in the first instance almost none have achieved it without increasing agricultural productivity. Thus agricultural growth is an essential complement for growth of other sectors.

Modern Agricultures Opportunities

Depending on their location farmers, in begging grew a large variety of foods viz., cereals, fruits, vegetables and animals but presently due to advent of rail and other rapid transport facilities in the 19th century this habit of farmers eventually got changed and as a result a shifting in farming methods took place. Now a day's more emphasis is being given by farmers on production of high yielding varieties of few reliable grain crops thereby a reduction in global hunger could be achieved. Today, agriculture also relies on global trade. Since the human population in world would approach nearly to 10 billion of people by 2050 therefore, to meet out the demand of food of such a huge population a continued growth in agricultural sector is essential. According to an estimate over 60 percent of world population either directly or indirectly engaged in agriculture and its allied activities viz., farm equipment manufacturers, food processing plants, transportation, milk and milk produce industries, infrastructure and manufacturing units etc for their livelihood survival hence agriculture sector offer grave opportunities in developing nations to lift out people from poverty.

Developments in Farming Sustainability

Though, in one way modern agriculture provide some short of food security but huge reliance upon few crops also invites some of the challenges and crop failure due to climate change is more important. Now a day's modern farming approaches are also focus to fight against malnutrition and obesity besides the various human health and food security aspects to accomplish this better crop diversity is needed and this would also lead to create markets for new crops. In order to secure the food and water supply more environmentally friendly farming techniques of set climate challenges developed by inclusion of drought tolerant crops, and encourage better livestock health is needed to protect local ecological systems. It is observed that sustainable farming methods not only create better food diversity but also preserve water with more efficient manner. In this way organic agriculture could be a way forward for sustainable food supplies and to safeguard our environment. Farmers engaged in

organic farming work to improve soil fertility by rotating crops, using cover crops and tilling the soil and remained less dependent on pesticides and other chemicals thereby quality and cleanliness of sallow ground water also got maintained. Hence organic farming not only encourages biodiversity in crops and maintain more natural environments in and around farms but also create better habitats for flourishing of flora and fauna in field.

Agriculture Improves Farming Communities

In present day scenario rapid expansion of farmers markets is also a positive development in agriculture. Farmers market not only offers better opportunity for small farmers to interact directly with consumers but also eliminates the need for long distance transportation thereby the food system remains within the local economy moreover locally grown food demand rises due to its cheaper and healthier food options. This kind of market facility not only found beneficial to local consumer but farmers also get benefitted by being getting new opportunities to sell their crops moreover their children can also learn from this transaction as first hand experience. This kind of farmer's interaction with market machinery can also be beneficial to entire communities to whom they serve. Agriculture always plays an essential role in the economy of entire world it's not only provide foods for the entire population of a country but also offers opportunities to farmers to connects and interacts with all the related industries of that country. It is usually believed that in countries where agricultural sector is very stable the country is more social, political and economically stabile. However, it was also seen that in developing countries where peoples are much more depend on agriculture for their living beings are much poorer as compare to those where they work in other sectors of the economy. Therefore, to improve the economic condition of agricultural force in these nations there is a need to bring out improvement in agricultural sector because it had grave ability to create job opportunities to its citizens. In case of under developed and developing countries agriculture not only contribute to nearly 30-60% of their total GDP but also employs about70 percent of the total work force of that country. Therefore, in developing countries agriculture industry can be considered a major source of employment as compare to other sector of economy and further improvement in this sector would definitely benefit in decreasing their unemployment rate. This increase in job opportunities is not only on farms but also in processing, advertising and packaging industries of agriculture product. Apart from job opportunities the agriculture sector also helps to fully utilize the unused land. However, in cases of most of the African countries viz., Mozambique, Tanzania and Zambia, only 12% of arable land is being cultivated and a huge portion of land remained unused. For

development of this unused land though the African Union (AU) has appealed to the governments of various African countries to allocate 10 percent of their total spending for agriculture development but unfortunately only 4 or 5 countries have successfully reached that target. Obviously, developing countries do not have enough money to develop the unused land. Due to low crop area coverage these countries neither to have the enough food to feed their population nor have enough foreign exchange to replace the shortfall by purchasing foods from the international market. If any kind of natural disaster that caused losses of crops and livestock or high food prices in the international market occurred the situation got worsen and government live the people to starve. Thus, in order to feed people in a big way, agriculture must strengthen as it can reduce hunger as well as increase the food security of developing countries. Food security is an immediate and future main concern for all developing countries. A stable agriculture industry also plays a crucial role in insuring food security of the nation. This is an issue that related to the whole society and sufficient action must to be taken from now on. In other words, agricultural sector is the major source of employment and livelihood survival in most of the developing countries.

Conclusion

To provide enough food as well as the job opportunities to galloping population of the world it is highly imperative to evolve and develop the agriculture sector by including both agriculture as well as the allied industries not only in the developing countries but also in the countries of entire globe. Countries in those agriculture sectors is under developed not only come out to have a very low GDP but also suffers with widespread chronic mal nutrition in their population. Citizens of those countries could not meet out their basic needs for food items for their daily life. Therefore, economic progress in the agriculture based industries is very imperative to boost out the incomes and enhancing the food supplies to the poor. A further development in agricultural sector can only be possible if everyone in the society willing to take the responsibilities to sustain a society that have sufficient food supply for our future generation. Since, the food security issue relates to the whole society therefore necessary and efficient action in this direction should be taken immediately without further delay. It has been seen via various reports that information technology can effectively make up for the lack of economic information management in agricultural production. In addition, government should increase capital investment in personnel training to promote agricultural economic management information.

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