ISSN: 2582-6980

October 2020 | Vol 1 | Issue 6

AGRI MIRROR : FUTURE INDIA

AIASA Agriculture Magazine

aiasanewdelhi aiasa5 AIASA www.aiasa.org.in

"A VOICE FOR AGRICULTURE"

ISSN: 2582-6980

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Cover page designed by -
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Container Gardening- An Overview

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Introduction

Gardening is the practice of growing plants for relaxation and utility. Mostly ornamental plants are preferred for their aesthetic value. Art of growing plants exclusively in containers instead of planting them in the ground is known as Container gardening. People prefer container gardening where they need an indoor garden experience. In addition, lack of fields and ground area paves way for using containers in gardening. These container gardens can thrive almost anywhere, bringing diversity to the most barren setting.

Construction and need of Container gardening

Container gardens can be easily constructed and maintained at minimal cost. Gardening in containers is ideal for those with little to no garden space or for gardeners who are unable to maintain a large garden area. From the school ground to the roof-top, the educational, recreational, ecological and aesthetic benefits of container gardening are being realized in many locations around the world. Moreover it gains an important role in home gradening.

Types of containers

Different types of containers used for gardening based on their material type. Fiberglass plant containers, Metal/Aluminum plant containers, Plastic plant containers, Ceramic plant containers, Terra cotta plant containers, Glass fiber reinforced concrete plant containers, Miscellaneous and distinctive plant containers. People purchase containers based on the material and budget.

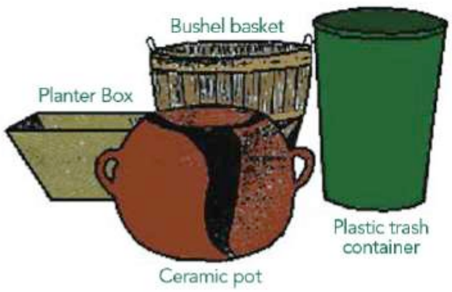

Fig 1: Model containers

Fig 2:Tulips in domestic use container

Container's specification

Plastic, non porous pots are ideal for plants which flourish in moist compost. Container type selected based on the style of the garden and is large enough for the roots of the plant to grow and heavy enough to balance the top-heavy growth. Drainage hole is must in any type of containers. Nowadays, shape of the containers gaining commercial value in the nurseries. Art work (Different colour paints and symbols) along with good shape attracts the customers. Care has to be taken during the selection of plants as well as containers (a small plant in a large container/ vice versa is most unimpressive).

Soil preparation

Compost is preferred as it has more nutrients and drains better . The compost is also heavier, which will prevent plants from being blown over in the wind. Plants like Rhododendrons, Azaleas and Camellias need special ericaceous compost which is ideal for acid-loving plants.

Method of planting

Layer of broken terracotta pot or even chunks of polystyrene put at the bottom of pots. This will prevent drainage holes from becoming clogged up with compost and soil from falling out. Filling of compost in the containers and mixing of handful of controlled release fertilizer granules is necessary. Depending on the formulation, this will feed the plant for several months. Shrubs grown in ericaceous compost can be given a special fertiliser for acid-loving plants.

Management

Containers need regular watering as shrubs have large root systems that take up a lot of water. In case of hot or dry weather, watering once or twice a day is recommended.After the initial feed has run out, give plants a boost with liquid feed. Repotting is done where the plants grows more vigour. Instead of re-pottting, perking annually by removing the top 5-10 cm of compost is followed for medium sized plants. Replace with fresh compost that has been mixed with a few controlled release fertiliser granules. Container-grown plants are more at risk from damage than plants growing in the border. Protect plants with fleshy roots, such as camellias and Hollies, by wrapping the pots with bubble wrap. Tender plants to be placed into a sheltered place such as green house in order to get rid of extreme weather conditions.

Special types of container garden

1. **Hanging basket garden**: Container gardens that are suspended overhead. Eg. Asparagus fern
2. **Bottle garden**: Waste bottles are utilized for growing. Eg. Money plant
3. **Terrarium**: A terrarium can also be formed to create a temperate woodland habitat or a cute jungle-like habitat. Many kinds of plants are suitable for these habitats including bromeliads, African Violets and Crassulaceaens.
4. **Window garden**: It is ideal for showing off plants in the winter. Vine type plants are recommended.
5. **Vertical garden**: Plants grown in vertically suspended panel in different modules where there is a lack of horizontal space. Asparagus fern, English Ivy,

Philodendron, Cacti, Herbs, Petunias, Impatients, African Violets and some of the succulents are the popular plants used in vertical gardening.

6. **Miniature garden**: Populary known as fairy garden is simply a mixture of miniature plants and flowers and small enhancements and accessories can really make an impact in the scenery. Small pebbles and coloured stones placed aesthetically added with Areaceans and succulents in dwarf stature.
7. **Table garden**: Drought-tolerant plants with short roots contributes to form a table garden.
8. **Dish garden**: Dish gardens are shallow planters designed for multiple plants in one pot or vessel. African violet, Dieffenbachia Dracaena, Kalanchoe, Pepperomia, Poinsettia, Rubber plant, Spathiphyllum are some of the recommened plants in dish gardening.
9. **Bonsai**: Big trees/Shrubs are maintained in dwarf stature in a shallow containers. Eg. *Ficusreligiosa*, Adenium, *Ficusbenjamina* etc.
10. **Aero garden**: It is a highly efficient gardening technology in which plants grown in water, nutrients and air. Flowers and vegetable crops grown commercially in aero-gardens.

Conclusion

Thus interior scaping is incomplete without containers. Container garden can be easily supervised without the risk of soil-borne diseases as well as the weeds. Moreover containers are movable, replacing is much easier. Special type of container gardening offers a fancy look to the shopping malls, corparate offices, kinder garden schools and in homes too. It opens a new vista for gardening in home and urban corporates areas where the space is limited.

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ISSN: 2582-6980

Somatic Embryogenesis in Cassava

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Introduction:

Cassava is used both as food and fodder crop. It is grown for their starchy tuberous roots, providing food for more than 500 million people and are cultivated mostly by the small-scale farmers in developing countries. Cassava can be grown easily and could be cultivated in adverse climatic conditions too. They are the source for low cost energy as cassava are found to be rich source of antioxidants, β- carotene, dietary fibre and minerals. Added it is also used in the manufacture of sago, biodegradable materials, beverages, paper and pharmaceutical products. Due to the increasing use in various industry, its demand has been increased several folds. So, there is a need to increase its production. Conventional breeding of cassava has been hindered due to its heterozygous nature, lack of genes in germplasm, allopolyploidy, long breeding cycle, unsynchronized flowering as well as low fertility. To complement conventional breeding, biotechnological approaches are been carried out. Somatic embryogenesis is identified as elite method for efficient regeneration for the development of totipotent tissues of casava. These cells are used further for large scale clonal propagation of cassava (Anuradha *et al.,* 2015).

Somatic Embryogenesis:

The embryo development process from the zygote is termed as embryogenesis whereas, the somatic embryogenesis is a process in which the somatic cells or the tissue develops into the differentiated embryo and regenerate into a complete plant (Le *et al.,*2007). Thus, it leads to the formation of bipolar structure with shoot/root axis and closed vascular system. The somatic embryogenesis had been induced in a variety of the explants namely leaf, stem, hypocotyls, root, seed, flower bud, nucleus and endosperm. It is of two types

1. **Direct somatic embryogenesis:** In this process the embryos are formed directly from the explant without the production of callus.
2. **Indirect somatic embryogenesis:** In this process the callus is first produced from the explants. Later the embryo develops from the callus.

Characteristics of Somatic Embryo:

- Origin is from single cell
- Bipolar structure (both shoot and root primordia) is present

- Absence of vascular connection between the explant and somatic embryos
- Somatic embryos can be easily separated from the explant tissue

Distinct Stages in Somatic Embryogenesis Development

Fig. 1: Stages in somatic embryogenesis development

Applications of Somatic Embryogenesis

- It replaces micropropagation for the quick propagation of the economically important plants
- Production of synthetic seeds
- It is a source for regenerable protoplast system
- Direct somatic embryogenesis produces uniform clonal material
- They are the source for protoplast isolation for some species
- Disease free planting material are obtained when nucellar embryos are used. The somatic embryo from the nucellar cells produce clones that are disease free
- As somatic embryogenesis develops from the single cell, non-chemical mutants might be obtained through the adventive embryogenesis in the tissue culture
- Repetitive somatic embryogenesis minimizes chimeric embryo formation

Limitations in Somatic Embryogenesis

- Production becomes difficult when carried out in large scale
- Quality is often too low
- Somoclonal variations occurs in indirect somatic embryogenesis
- Field conversion frequency is less (15-20%)
- Maturation and conversion of somatic embryo is difficult in many species
- Abnormalities like secondary embryogenesis, double and triple vascular system and pluri-cotyledons may occur.

Somatic Embryogenesis in Cassava

The following are the process involved in somatic embryogenesis in cassava (Syombua*et al.,* 2019)

1. **Plant material and the culture condition:** The *in vitro* cultures are established through culturing the surface sterilised 5cm long cuttings on media containing MS

salts with 3% sucrose, vitamins, 0.3% gelrite, pH 5.8 and are sub cultured for every 4 weeks. All the cultures except for the callus induction are maintained in growth chambers (16h/8h, 25 ± 2□C). The cassava stock and the regenerated plants are grown in greenhouse (27 ± 1□C).

2. **Induction of somatic embryogenesis:** Stem internodes (5 to 10 mm long) and immature leaf lobes from the eight weeks old *in vitro* plantlets were taken and cultured in the callus initiation media for eight weeks in dark (25 ± 2□C). Callus sub culturing is done every two weeks.
3. **Somatic embryos maturation:** 8 weeks old callus are transferred to the MS medium that are supplemented with hormones. Cotyledonary embryos are produced from the callus.
4. **Embryo germination and the plant recovery:** The callus harbouring the cotyledonary embryos and the shoots are aseptically transferred into the hormone free MS media that are supplemented with 0.8% activated charcoal for a period of 14 days. The embryos with root and shoot apices are transferred and are maintained for 4 weeks in culture media.
5. **Hardening:** Plantlets with shoot and root are transferred to the pots (filled with sterile peat moss) for 4 weeks in glass house. The surviving plants are later transferred to pots (Peat moss and soil). After 4 weeks, the surviving plants are transferred to soil.

Conclusion:

Somatic embryogenesis is a method of choice for regenerating cassava as conventional breeding is hampered due to various reasons. Additionally, somatic embryogenesis can be combined with mutation breeding and genetic transformation for mitigating some of the challenges associated with application of the conventional breeding for improving cassava genome.

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ISSN: 2582-6980

Bio Fertilizers Towards Sustainable Agriculture

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Introduction

Current soil management practices are mainly dependent on inorganic chemical fertilizers, which cause a serious problem to human health and environment. The utilization of essential microbes as a bio fertilizer has become very importance in agriculture for their wide role in food safety and sustainable production. The eco-friendly techniques inspire a wide range of supplication of plant growth promoting rhizobacteria (PGPRs), mycorrhizal fungi (endo and ecto), cyanobacteria and many other useful microorganisms led to improvement in nutrient uptake, plant growth and tolerance to plant stress.

Fertilizers have an important role in increasing crop productivity. However, chemical fertilizers are very high cost, non-environment friendly, causes eutrophication, reduces the organic matter and microbial activity in soil and are dangerous to health. Therefore, the use of bio fertilizers is helpful as they are natural origin, biodegradable in nature, organic and more cost-effective than inorganic fertilizers. For many years inorganic fertilizers are used to satisfy the soil requirement of nutrients and yield, but huge amount of these inorganic fertilizers are hazardous for environment, favorable microbes, and all living organisms as well, hence, eco-friendly and cost effective bio fertilizers can be used. Bio fertilizers consist of plant resins, organic matter and some special group of micro-organisms.

Bio fertilizer are the materials which containing live cells of effective microorganisms, which may be fungi, bacteria or protozoa, they have the capacity to improve the fertility of soil by fixation of nitrogen, solubilization of phosphorus, and sequestration of iron.

Bio fertilizers helps to increase the soil quality by supplying nutrients and improves the soil physical parameters by increasing the soil organic matter. The bio fertilizers contains micro-organisms, which are very important because they produce essential nutrients viz., nitrogen, potassium, phosphorus and other nutrients required for growth of the plants. Bio fertilizers are also produces some beneficial hormones viz., auxins, biotins, and cytokinins which are very important for plant growth and development. Bio fertilizers are also releases some antibiotics, which are beneficial for plants to protect against some disease causing agents. Bio fertilizers also helps in management of salinity and abiotic stress. Bio fertilizers are cost effective and environmental safe and it has huge scope in the field of research especially in the areas of organic farming. Bio fertilizers have a significant contribution of in growth and productivity of crops and protection against biotic and abiotic stresses, which leads to they have significant role in organic farming and sustainable agriculture. At present it is very much necessary to preserve and conserve our ecological system through minimizing inorganic inputs viz., chemical fertilizers**,** insecticides and pesticides so that it will be helpful to sustainable agriculture.

Types of Biofertilizers

i) Rhizobium. Spp.

R. leguminosarum

R. melliloti

R. lupine

R.trifoli

R.phaseoli

R.japonicum

ii) Azotobacter

iii) Azospirillum

iv) Azolla and Blue Green Algae

v) Phosphate-solubilizing Biofertilizer

vi) Phosphate-mobilizing Biofertilizer

vi) Zinc and Silicon-Solubilizing Biofertilizer

vii) ArbuscularMycorrhizalBiofertilizer (AMB)

One simple broadly disseminated classification is as follows:

A. Nitrogen Bio fertilizers

Bio fertilizers which fixes atmospheric nitrogen symbiotically and convert it into Ammonia (NH_3).Nitrogen bio fertilizers helps to improve the nitrogen content in the soil. Nitrogen is always limiting factor for growth of plant because nitrogen is a major nutrient and requires high quantity compare to other nutrients. Nitrogen fixing microorganisms are isolated from leguminous plants viz., lentil, groundnut, peas and pigeon pea etc. Different bio fertilizers have function in different soils, hence the selection of nitrogen bio fertilizer to be depends on the crops. Rhizobia can be used for legume crops, Azotobacter or Azospirillum for non-legume crops, Acetobacter is especially for sugarcane and blue-green algae and Azolla for rice.

B. Phosphorus Bio fertilizers

Like nitrogen, phosphorus is also one of the limiting factors for the growth of plant. Phosphorus bio fertilizers helps in improving and increasing the phosphorus content in the soil. Nitrogen bio fertilizers will depends on crop, while the usage of phosphorus bio fertilizers is not dependents on the crops.

Various uses of biofertilizers

1. ***Roles of biofertilizers***

   Make nutrients available.

   - ✓ Make the root rhizosphere livelier.
   - ✓ Growth-promoting substances are produced.
   - ✓ More root proliferation.
   - ✓ Better germination.
   - ✓ Improve the quality and quantity of produce.
   - ✓ Improve the fertilizer use efficiency.
   - ✓ Higher biotic and abiotic stress tolerance.
   - ✓ Improve soil health.
   - ✓ Residual effect.
   - ✓ Make the system more sustainable.
   - ✓ Supply mixture of nutrients
   - ✓ Maintain symbiotic relationship
   - ✓ Maintain microbial consortia in soil
   - ✓ Suppress soil born pathogenic diseases in crop

2. ***Liquid Bio fertilizers***

Now a days, bio fertilizers are provide to the farmers as carrier-based inoculants. Alternative to carrier based inoculants liquid formulations has been developed which has more benefit than the inoculants.

❖ ***Benefits:***

- Longer shelf-life (12–24 months)
- No contamination
- No loss of properties due to storage up to 45º C
- Greater potential to fight with native population
- Easy identification by typical fermented smell
- Better survival on seeds and soil
- Very easy to use by the farmer

- High commercial revenues
- High export potential.

❖ ***Ways of bio fertilizer application***

Bio fertilizers can be applied through following ways

1. Seed treatment or seed inoculation
2. Seedling root dip
3. Main field application

Seed treatment

Required amount of bio fertilizer is mixed with juggery and then have to mix with required amount of seeds. Then have to leave for some time for drying (shade dry) and can go for sowing. After shade dried within one day should go for sowing. Generally one package of rhizobium inoculant (250 g) is sufficient for treating 10 kg seeds.

Seedling root dip (KSB)

Bio fertilizers can also apply through seedling root dip. First we have to prepare suspension by using bio fertilizer and water. While transplanting the seedling have to dip in the suspension of bio fertilizer before 20 to 30 minutes of transplanting. Azospirillum and phosphate-solubilizing bio fertilizer have to dip for overnight then have to transplant.

Main field application

Bio fertilizers can also apply as main field application. Bio fertilizers have to mix with compost or farm yard manure in require quantity and then go for application in main field.

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ISSN: 2582-6980

Uzi Fly Management in Silkworm

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Introduction

Uzi fly, *Exoristabombycis* (Tachinidae: Diptera) is an important pest of silkworm. It is solitary endoparasite on late instar caterpillars (third and fifth) and pupae. The high yielding bivoltine hybrid larvae are highly preferred for parasitism by this fly. It causes 10- 30 per cent damage. It also attacks pupae and its attack on pupae and it was notified in a village (Bylanarsapura) in Karnataka during 1980.

Life cycle of uzi fly

- A female lays 500 - 600 eggs during her life time (18 - 22 days), each day laying about 20-30 eggs.
- Eggs hatch in 48 - 60 hours.
- The Maggot after hatching from the egg immediately pierces into silkworm body using the pro-thoracic hook attached to the mouth. The place of entry of maggot into silkworm body develops a black scar.
- The maggot feeds on the silkworm tissues for 5-7 days during which time it moults twice.
- The maggot comes out of silkworm body by creating an opening on the body (integument) and spends 12-20 hours time as post-feeding (post- parasitic) maggot and becomes pupa in dark places like cracks, crevices, corners of the rearing house, loose soil, etc
- Adult uzi fly emerges from the pupa after 10 to 12 days.
- Life cycle is completed in 17-22 days.
- Adult fly survives for 10 - 18 days (males) and 18-22 days (females).
- Adult fly feeds on pollen, rotten fruits, nectar, etc.

a) *Period of occurrence*

In the southern sericultural belt (Karnataka, Andhra Pradesh and Tamil Nadu), the uzi fly is prevalent throughout the year. In other parts of the country, it does not prevail throughout the year because of discontinuous rearing of silkworm and environmental extremities. Maximum infestation is recorded during rainy season followed by winter. The infestation is least during summer months.

b) *Symptoms of attack and extent of damage*

- The Uzi fly lays one or two cream coloured eggs (measuring the size of a pin head) on the silkworm larva. Generally, it prefers grown up larva (i.e., 4th or 5th instars) for egg laying.
- The eggs hatch in 48 to 62 hours. A black scar is formed at the point where the egg hatches and the uzi larva (maggot) enters the body of the silkworm using the

hooks (pro-thoracic hook) attached to the mouth. From this black scar, the pest attack can be identified.

- The silkworm loss due to this fly pest is 10-20% i.e., on an average 6 kg reduction in cocoon yield is observed for every 100 dfls of silkworm reared.

c*) Factors responsible for outbreak of Uzifly*

- Large scale and overlapping rearing of host (silkworm).
- Favourable climatic conditions (temperature range of 20 – 30°C and relative humidity of 60 – 90%) facilitates continuous host / silkworm rearing which in turn helps the host availability.
- Increased adult (uzi fly) longevity.
- Higher egg production and egg hatchability.
- Reduced activity of the natural enemies like parasitoids, predators and pathogens in nature.

Control measures

Preventive

- To prevent uzifly from entering the rearing room for oviposition a nylon net of fine mesh called 'uzinet' is spread all around the rearing stand leaving a space of 2 -3 ft. all around for ventilation or wire mesh may be provided in the doors and windows as a physical barrier.
- Maintain sanitation in the rearing room.
- Identify and collect the infested larvae by prominent black scars.
- Cracks and crevices in the rearing room should be plastered.
- The maggots and pupae found in the rearing trays, mountages, floor, cracks and crevices should be collected and destroyed.
- Flimsy and infested cocoons are identified and stifled to kill the uzi maggots.
- Care should be taken not to transport the infested cocoons to the market or uninfested areas.
- After procurement of the cocoons from the market, they should be stifled immediately.
- As a physical barrier on the body of silkworm larvae, levigated china clay can be dusted during mounting or spinning (3-4 g/ 100 spinning larvae/ sq. ft.) using fine muslin cloth.

Physical (using uzi trap)

- Dissolve one table in 1 litre of water and keep the solution in white trays both inside and outside the rearing house at window base from 3rd instar onwards up to spinning.
- Place uzi traps inside the rearing house/mounting hall after spinning up to 20 days under close-door condition to trap uzi flies emerging inside.

Chemical

- A commercial liquid formulation 'Uzicide' (containing 1% Benzoic acid) developed by CSR & TI, Mysore, kills the eggs without affecting the silkworm larvae (@500ml/ 7 trays of 90 cm dia.). CSR & TI, Berhampore have released Vijetha, a dust formulation having the same properties as uzicide and easy for operation.
- Spraying of Benzoic acid, Salicylic acid or Propionic acid (1%) is believed to protect against egg laying.
- Spraying of bleaching powder is also found to deter uzifly from egg laying and kill the already deposited eggs.
- Dissolve the uzicide tablets in the water (2 tablets/ lit.) to attract the adults.

Biological

- Mass culture and release ectopupalhyperparasitoid, *Nesolynx thymus* (Eulophidae: Hymenoptera) @ 1 lakh adults per 100 DFLs during night hours. Release the parasitoid in three split doses @ 8000, 16000 and 76000 / 100 DFLs during fourth, fifth instars and after cocoon harvest, respectively.
- Several other pupalparasitoids like *Brachymerialugubris, Dirhinushimalayanus, Spilomicruskarnatakensis* and *Exoristobiaphilippinensis* also occur on uzifly.

ISSN: 2582-6980

Information and Communication Technology (ICT) in Indian Agriculture

Article ID: 81

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Introduction

In India, more than 50% of the population rely upon agriculture for their basic and financial needs. Agriculture contributes about 16.5 per cent in country's GVA (Gross Value Added) and is the primary source of livelihood for rural population in the country (Anonymous, 2020). However, besides providing employment, livelihood security, food, nutrients and ecological securities, agriculture is associated with many problems like climate change, crop failure, rising input cost, low output price, less awareness about new technologies etc. Due to these problems, farming community in the country suffers from agrarian distress. In order to overcome such problems and improving the farming operations, we should aware farmers about latest technologies and market information which in turn will result in better crops production, high income generation and better standard of living of farmers. Agricultural extension plays a major role in order to aware farmers and spread agricultural information particularly in rural areas. At present, the ratio of the farmers to the extension worker is 1000:1, which is really very less as it is difficult for one extension worker to meet 1000 of people. Despite, large, well-educated, well-trained and well-organized agricultural extension manpower, around 60 per cent of the farmers in the country still remain untouched by extension agency of functionary (Singh *et al.*, 2017). Also, it requires high cost and is a time consuming process. Such type of cost factor in face-to-face information dissemination at the right time and the difficulties in reaching the target audiences has created the urgency to introduce ICT i.e., Information and Communication Technologies.

Information and Communication Technology (ICT)

The word ICT was coined by Stevenson in 1997. It is an integration of the technologies and the process to distribute and communicate the desired information to the target audience by using electronic means. Some commonly used ICT tools to promote agricultural related information include call centres, web portals, mobile apps, community radio, video, digital photography, GIS, e-mail, audio and video conferencing and even social media platforms like Facebook and WhatsApp. With the introduction of ICT, farmers are empowered with right information in right time and right place, which is essential in reforming traditional agriculture eventually contributing to the improved agricultural productivity and sustainability and also leads to improvement in the efficiency and viability of small and marginal holdings. Saidu*et al.*, (2017) reported that ICT facilitate agricultural growth and economic sustainability through better agricultural research, improvement in exchange of market information, profit gain, networking agricultural sector globally and strategizing economic growth for self-reliance and sustainability.

ICT provides reliable and locality based information services to the farmers. ICT with agriculture is resulted in new discipline called E-Agriculture, which become a budding field of research and application. E-agriculture is an emerging field focusing on the enhancement of agricultural and rural development through improved information and communication process. The ICT applications such as Warana, Dristee, E-Seva, E-Chaupal, E-Post, Dyandoot, Gramdoot, Lokmitra, e-Extension, AGRISNET, AGMARKNET, Agri Business Centres, e-KRISHI VIPANAN, Kisan Call Centres and TataKisan Kendra are quite successful in achieving their objectives.

Role of ICT in Agriculture

The various roles of Information and Communication Technology (ICT) for making farming work easy with better agriculture performance are given below:

Decision Support System

ICT has a major role in making proper decision, as it provide updated and recent information about agriculture, weather, new varieties of crops and new ways to increase production and quality control. This can be further utilised by the farmers in order to make accurate decision about various agricultural operations for increasing benefits. The decision support system facilitates farmers to get better results in crop planning, practising good agricultural practices for cultivating, harvesting, post harvesting and marketing of the produce. As reported by many researchers, majority of the farmers had opinion that 'question and answer service' was perceived as the best facility to get personalised solutions to their specific agricultural problems.

Widen Market Access

Indian agriculture marketing has many drawbacks, like, not to have proper place for selling inputs, complex distribution channels for marketing of agricultural produce, not to get updated information about prices and marketing of commodities. So, by the inclusion of ICT facilities, farmers connect directly to the consumers or other appropriate users for maximum benefits, thus, widening the marketing horizon for the farming communities. This can improve farmer's revenue, empower farmers for making good decisions about appropriate future crops and identify efficient marketing channels to sell their produce as well as to get inputs (Singh *et al.*, 2017b). Example of such ICT role is, Rubber Board provides the update of both national and international rates of natural rubber through SMS throughout the country by the rubber farmers and dealers in India especially Kerala State of South India.

Strengthen and Empower Farming Community

ICT has a great role in strengthening and empowering farming community through wide network and making collaborations with various government and private institutes and NGOs. Also, it helps in strengthening farmers' capacity through wide exposure to scientific farming and trade community.

Enhancing Agricultural Production

ICT can make a significant contribution in enhancing agricultural production. It also increases the efficiency, productivity and sustainability of small-scale farms. Farming is associated with many risks and uncertainties- pests outbreak, threats from poor soils, drought and erosion. These can be control by enabling ICT initiatives as key improvement stem from information about pest and disease control, especially early warning systems, new varieties, new ways to optimise production and regulations for quality control.

ICT in Animal Disease Management

The use of ICT in animal husbandry dates back to the period of arrival of computers. Different ICT tools such as internet, Geographical Information System (GIS), Global Positioning System (GPS), Database Management, Computer Aided Design (CAD), computer networking and Artificial Intelligence adds strength and efficiency to the ICT in animal disease management (Singh *et al*., 2017a).

Constraints of ICT Implementation in Agriculture Sector

- Some areas are lacking proper networking facility/telecommunication and ICT facilities especially remote areas, due to which ICT initiatives are unable to establish in these areas, hence, restricts the adoption of ICT initiatives.
- In India, a large number of farmers do not have proper skills to access the internet or ICT initiatives. Also, government is not making significant efforts to provide adequate ICT knowledge to farmers as there is lack of supportive government policies for the implementation of ICT tools in demanding areas. This restricts the adoption of ICT among farming community.
- Lack of infrastructure is a major constraint in adoption of new technology. It includes inadequate and unstable power supply in rural areas, mismatch between the design of MIS and smallholder farmers' perception towards their mobile phone's communication capabilities and so on.
- ICT is a community access system, not an individualised tool. Strong leadership from the community is essential for success of any ICT project. The complex and sophisticated software with enhanced human capital requirements are the causes of less response of farmers towards ICT technologies.
- Too much innovation can be an obstacle by blocking the use of older technologies which can often be more effective and by imposing an unacceptable cost. Manish *et al.* (2012) reported that ICT will only introduce new methods of doing the same traditional activities instead of changing lifestyle of rural communities.

- Farmers take advice mostly from their relatives, agriculture department instead of referring ICT initiatives for gathering information, because they believe more in human kind as compare to machines or tools.

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ISSN: 2582-6980

Customized Fertilizers - A Novel Approach to Increase Crop Productivity

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Introduction

According to FCO, customized fertilizer is the implication of the fertilizers best management practices and is generally assumed to maximize crop yields while minimizing unwanted impacts on the environment & human health. Fertilizer best management practices will make it easier for farmers, extension agents, crop advisers and researchers, to exchange their experiences and also to restrict the unwanted nutrient impact on the ecosystem. Application of customized fertilizer is compatible with existing farmers system can be comfortably accepted by the farmers. Production of customized fertilizers will ensure improved 'Fertilizer Use Efficiency' and will create a new "Virtual" source of nutrients, implying from the existing quantity of DAP, MOP, Urea, SSP and AS available and consumed in India, the agricultural produce output will increase. Simultaneously the distribution and availability of fertilizer will be better. Customized fertilizer satisfies crop's nutritional demand, specific to area, soil, and growth stage of plant. As the micronutrients are also added with the granulated NPK fertilizer the plants can absorb the micronutrient along with macronutrient which prevents nutrient deficiency in plant (Singh et al., 2019)

Objectives

Customized fertilizer is aimed at a balanced distribution of plant nutrients in the field and provides the best nutritional package for premium quality plant growth and yield. They are defined as multi nutrient carrier designed to contain macro and/or micro nutrient forms, both from inorganic and/or organic sources, manufactured through a systematic process of granulation, satisfying the crop's nutritional needs, specific to its site, soil and stage, validated by a scientific crop model capability developed by an accredited fertilizer manufacturing/marketing company. Such fertilizers also include water soluble specialty fertilizer as customized combination products. The objective behind the customized fertilizer is to provide site specific nutrient management for achieving maximum fertilizer use efficiency for the applied nutrient in a cost effective manner. The major provisions for the production of customized fertilizers lie in the promotion of site specific nutrient management (SSNM) to achieve the maximum fertilizer use efficiency of applied nutrient in a cost effective manner. The CF may include the combination of nutrients based on soil testing and crop requirement, which actually consists of 100% water soluble fertilizers grades. Nutrient requirement of the crop in a particular area is mixed physically and steam granulated by technology known as fusion blending. The farmers get all the required nutrients in terms of NPK with secondary and micro-nutrients in balanced proportion.

Benefits of customized fertilizers

Customized fertilizers have many advantages over other chemical formulations as depicted below:

- Customized fertilizers are generally assumed to maximize crop yields while minimizing unwanted impacts on the environment and human health
- Application of customized fertilizer is compatible with existing farmers system and hence, it will be comfortably accepted by the farmers.
- It safeguards improved fertilizer use efficiency (FUE) and texture ensures uniform distribution of nutrients
- It satisfies crop's nutritional demand, specific to area, soil, and growth stage of plant
- It promotes balanced fertilization, as the micronutrients are also added with the granulated NPK fertilizer and prevents multi- nutrient deficiencies
- It enhances crop productivity with improved benefit: cost ratio
- It ensures good soil health and also avoids or checks soil and underground
- water pollution

Principles and procedures to arrive at customized fertilizer grades

- Geo-referencing of chosen area
- Selecting sampling points based on appropriate statistical procedure
- Actual sampling and analyzing soil, plant and water samples mainly for nutrients
- Defining management zones and fixing yield targets
- Computing crop removal of nutrients
- Calculating nutrient requirement (amount and nutrient ratio)
- Blending of nutrients for a particular CF grade

Milestones in customized fertilizer production

Taking due cognizance of the above facts, initially four grades of customized fertilizers were created to provide a total nutrient package mainly for basal application.

Grade I: N10:P20:K10:S5:Mg2:Zn0.5:B0.3:Fe0.2

Grade II: N20:P10:K10:S5:Mg2:Zn0.5:B0.3:Fe0.2

Grade III: N15:P15:K15:S5:Mg2:Zn0.5:Fe0.2

Grade IV: N10:P20:K20:S3:Mg2:Zn0.5:B0.3:Fe0.2

These customized fertilizer grades are liable to change every three years as per the changing soil fertility and crop need. Altogether, 24 grades of these fertilizers have so far been notified. Leading fertilizer manufacturers *viz.* Tata Chemicals Limited (TCL), Nagarjuna Fertilizer, Coromandel International Limited and Deepak Fertilizers have been permitted to manufacture these customized fertilizers, although the response of companies for establishment of CF manufacturing unit was not encouraging. In order to promote and encourage manufacture of CF the companies were allowed to use subsidized fertilizers.

Customized fertilizer grades:

The grades of customized fertilizer which the manufacturing companies propose to manufacture and sell shall be based on area specific and crop specific soil testing results. The manufacturer may be in association with Agricultural Universities/KVKs concerned, shall also conduct agronomy trials of the proposed grade to establish its nutrient efficiency. The manufacturing companies, preferably in association with concerned agriculture universities/KVKs may continue to conduct agronomy tests of the proposed grades on the farm, for at least one season. The minimum nutrient contents in a specific grade of customized fertilizer, proposed to be manufactured, shall contain not less than 30 units of all nutrients in combined.

Table 1: Journey of customized fertilizer

Year	Development
2005	Concept paper was published in IJE and presented in FAI seminar
2006	FAI working group was constituted to work on CF
2007	1. FAI and DAC proposal on CF 2. CF formulations and field validation trials was carried out by Tata, Nagarjuna and Deepak 3. Series of CF workshops were conducted
2008	1. CF guidelines was issued by GOI on March 11, 2008 2. DAC approves 12 CF grades
2009	Tata Chemicals Limited initiated setting up of Hi-tech CF Plant at Babrala, Uttar Pradesh

2010	1. GOI extended support for raw materials availability 2. Tata's CF Plant started production on November 22, 2010 3. First CF product (N10:P18:K25:S3:Zn0.5) was sold at a price of Rs. 600/- per bag (1 bag = 50 kg)

Raw materials for manufacture

1. **Use of subsidized fertilizers:** All subsidized fertilizers can be used for manufacturing of customized fertilizers. Domestic manufacturer of subsidized fertilizers will supply the required quantity of such fertilizers, as raw material, to its own manufacturing unit for production of customized fertilizers

2. **Import of subsidized fertilizers:** Manufacturers can import subsidized fertilizers under the existing policy guidelines of GOI for the manufacture of customized fertilizers not exceeding its realistic requirements.

Methods of preparation of customized fertilizer

1. Chemical granulation: It is also called „slurry granulation" or „complex granulation. Here, fertilizer production start with the basic raw materials like rock phosphate, acids and ammonia rather than their salts like diammonium phosphate and urea. A large capacity manufacturing plants are needed to carry out chemical reactions. Infrastructure cost of handling and storage of acids and ammonia are huge due to difficulty in undertaking chemical reactions. It is less flexible to produce variety of grades.

2. Bulk blending: It is the simplest and cheapest option available for the production of customized fertilizers, which involves pure mixing of solid fertilizers in a ratio required to get the desired nutrient ratio. It only requires warehouse, weighing and mixing equipment. It has the advantage of smaller capacities of decentralized production uniquely suited to give the customer exactly the NPK ratio he requires. The physical standard should be such that the shape and size of all fertilizers, raw materials are similar and also high quality granular fertilizer material is needed, which are to be used in bulk blends. In Indian context, importing of the raw materials is needed because of these stringent specifications of raw materials, and for large scale production it is not suitable. However for the experimental purposes this is the most suitable method

3. Fluid application: Most suited method in the intensive farming system to obtain a higher yield. Two types of liquid formulations are there; clear liquids and suspension liquids. If it is suspension liquids, it needs constant agitation. It provides a dust free application method. A mixture of ammonia, phosphoric acid and micronutrients gives a good homogenous liquid fertilizer.

4. Compound or steam granulation: Raw materials are in solid form and uniform size reduction of this fertilizer material is the key to granulation. Agglomeration of granules can be attained by use of hot water or low pressure steam. Then the granulated materials should be dried and cooled by dehumidified air. Hygroscopic products like urea containing grades need dehumidified bagging plant also otherwise caking of the products will occur. This is the most suited method for the large scale production of customized fertilizers in India.

Major constraints to promote Customized Fertilizers

The available research information sounds well for upward revision of fertilizer recommendations as the existing fertilizerdoses (NPK) are proving to be sub-optimal for maximum economic yield. It is also evident that application of nutrients according to current recommendations is causing nutrient depletion particularly in respect of potassium and micronutrients. The current soil test based recommendations consider only the nutrient deficiency magnitude, not the yield targets(Harvirsingh et al., 2019). Only one recommendation being currently given without considering the yield target is proving to be suboptimal for higher yield targets, thus farmers are losing yield, produce quality and profits. The current fertilizer recommendations support only medium yield target provided the supply of nutrients other than NPK is not a limiting factor. In contrast, the deficiency of one or the other secondary and / or micronutrient deficiency is observed in all parts of the country. The most important issues which hinder themarketing of customized fertilizers are:

- High cost of customized fertilizers.
- Necessity of investing heavy capital in state of the art manufacturing facility for customized fertilizer.
- Limited awareness and very low affordability of customized fertilizers among the farmers.
- Uncertainty in response when fertility is restored in the field.

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ISSN: 2582-6980

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Genetic Regulation of Isozymes and Its Uses

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Introduction

Isozymes are now a common part of the scientific vocabulary, but their recognition is relatively recent, having been first announced in 1959 by Markert and Moller. Prior to that time, molecular heterogeneity had often been noted in enzyme preparations, but such heterogeneity was usually attributed to contaminants or to partially denatured or degraded enzyme molecules. During the 1950's there were occasional suggestions that this heterogeneity might not all be artifactual but might indeed reflect reality within the cell.

Isozymes are numerous and characteristic of many cells, tissues and organs, but what is their biological utility? Why are they such a ubiquitous aspect of the biochemical organization of cells? At one time it was believed that one gene coded for one enzyme, which was totally responsible for a single biochemical reaction. This simple molecular equation, one gene - one enzyme - one catalytic reaction, was a useful and stimulating generalization in the early days of biochemical genetics. But now we know that multiple varieties of an enzyme are needed to catalyze the same reaction, but under different metabolic conditions, or in different places in the same cell, or in different cells, or in the same cell at successive stages of differentiation. Apparently, isozymes have been tailored by evolutionary pressures to fit the fastidious requirements of the cell's metabolic machinery. Very few isozyme systems are well understood nowadays. One of the earliest contributions was the recognition that isozymes could exist in different cell organelles and in different metabolic compartments within a single cell. The location of isozymes in cell organelles is well illustrated by mitochondria.

Mitochondrial enzymes such as malate dehydrogenase are frequently different from the homologous enzymes in the cytosol even though both kinds of isozymes are encoded in nuclear genes. The distinction between organelle and metabolic compartments is not always sharp. RNA polymerases may fall in this ambiguous category; two isozymes are associated with the nucleolus and one at least with mitochondria, but the topographic location of the others is uncertain. All of them must have access to the DNA of the chromosomes or of the mitochondria.

IsozymesAs Genetic Markers

Isozymes provide rich material for investigating the structure and function of enzymes and for examining their role in cellular metabolism. They can also facilitate studies in cell differentiation, population genetics and evolution because they serve as excellent markers of gene function. In the field of evolution, isozymes are now extensively used to measure the frequencies of alleles in population and thus to allow an assessment of selection pressures in evolutionary movement. They have also made possible the development of the provocative concept of neutral mutation and have stimulated considerable investigation on the significance in evolution of alternative protein structures as exemplified by different isozymes. Alternative protein structures may be equally advantageous to a cell, provided that complementary changes have occurred in associated macromolecules. In other words, the advantage of a given enzyme structure is only relative and depends upon the molecular environment in which it must function.

One area in the study of evolution in which isozymes may be of critical importance relates to the acquisition of new genetic information during evolution. The possibility of a completely new gene arising de-novo today seems infinitesimal. New information probably arises through the duplication of genes and their subsequent divergence through mutation. This procedure can lead to the evolution of one enzyme into another and probably most enzymes arose this way. It seems clear that isozymes can be generated by the duplication of loci. For example, in salmonid fish having more than 10 isozymes of LDH have been demonstrated by many researchers. This extraordinary multiplicity stems from the tetraploid nature of these fish, which of course involved the duplication of the LDH-A and LDH-B genes for LDH. Genes for other enzymes in salmonids have also been duplicated with the generation of a corresponding isozymic multiplicity.

It should be possible to study the retention of homologous properties in enzymes, encoded in duplicated loci, as these enzymes diverge by mutation of the controlling genes. Nowadays we cannot study the sequence of molecular events that has already occurred during evolution, but we can probably discover each type of change that has occurred by a detailed molecular analysis of contemporary groups of related enzymes.

Used as Marker in Selectionin Self Pollinated Crops

- Pedigree method
- Bulk method
- Backcrossing and
- Single Seed Descent (SSD) method

In Cross Pollinated Crops

Isozyme can be used to estimate allozymes frequencies for calculating the amount of heterozygosity present in the population.

Used In The Study Of Quantitative Variation

i. To determine the degree of determination between taxa
ii. Germplasm classification
iii. Gene mapping
iv. Selection
v. Monitoring the genetic segregation and recombination in the distinct crosses
vi. Characterization of F_1 hybrid
vii. For detecting abnormal segregation
viii. Alleles at most molecular loci are usually co-dominant and thus all possible genotypes can be distinguished in segregating populations.

Isozymes as Selection Criteria in Heterosis Breeding

i. Difference – enzymes/proteins are composed of two or more peptide chain.
ii. Functional activity – Multimer structure.
iii. Gupta and Singh (1977) studied esterase isozyme pattern of F_1 hybrids and parents and found that four cathodal bands were correlated with grain weight.

Monitoring Gene Introgression

Isozymes can be used as tools for detecting alien introgression from wild germplasm to cultivated species. When isozyme polymorphism is observed between wild species and cultivated species, isozyme analysis can be used to detect the introgression genes from wild germplasm and recovery of the recurrent parent background.

Advantages of Using Isozyme as Marker

i. Isozymes rarely exhibit epistatic interactions so that a genetic stock containing an infinite number of markers could be constructed.
ii. The process is non-destructive since only small amounts of plant tissue are needed.
iii. Any plant tissue can be used as samples, including leaves, roots, pollen and callus, so that the technique is very versatile.
iv. It is also possible to screen plant at seedling stage and retains only desirable genotypes, therefore, save time and money.

Linkage OfIsozyme Genes To Traits

If the gene of interest is recessive, isozyme-based selection is particularly useful because the recessive gene can be followed without having to do progeny test. Indirect selection through isozymes can be of value in gene pyramiding i.e. for the incorporation of two or more independent genes, which give a similar phenotype. Several studies have

ISSN: 2582-6980

determined linkage of isozyme loci to morphological, physiological and quantitative traits.

Conclusion

Isozyme technique is simpler than that of other molecular techniques. As direct products of genes, isozymes would be better makers than that of molecular markers that are not the genes of interest.

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ISSN: 2582-6980

Bioremediation of Polluted Soils

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Introduction

Soil is a three dimensional, natural dynamic body consisting of mineral and organic constituents occurring on the surface of the earth, which is developed by the pedogenic processes and provides a suitable medium for the plant growth. Soil is never in the static state and some changes in physical, chemical and biological properties take place continuously due to various pollutants which are being deposited in the soil.

Polluted soils are the site where various unwanted compounds are disposed off through any causing agent (which includes agricultural practices, heavy metal pollutants, radioactive materials, domestic and municipal wastes, industrial and mining wastes) which cause contamination of soil and some major changes in the physical, chemical and biological properties of soil. Bioremediation of polluted soils is the process of using naturally occurring plants or microbes to convert waste material into harmless substances. The process makes use of the technologies that promote and accelerate destruction, transformation, removal, or stabilization of pollutants**.**

Bacteria species involved in bioremediation

The major requirement for the microbes are an energy source and a carbon source. The most common bacterial species involved in bioremediation process includes *Pseudomas, Arthobacter, Alcaligenes, Corynbacterium, Flavobacterium, Achrombacter, Micrococcus, Nocardia*and *Mycobacterium.*

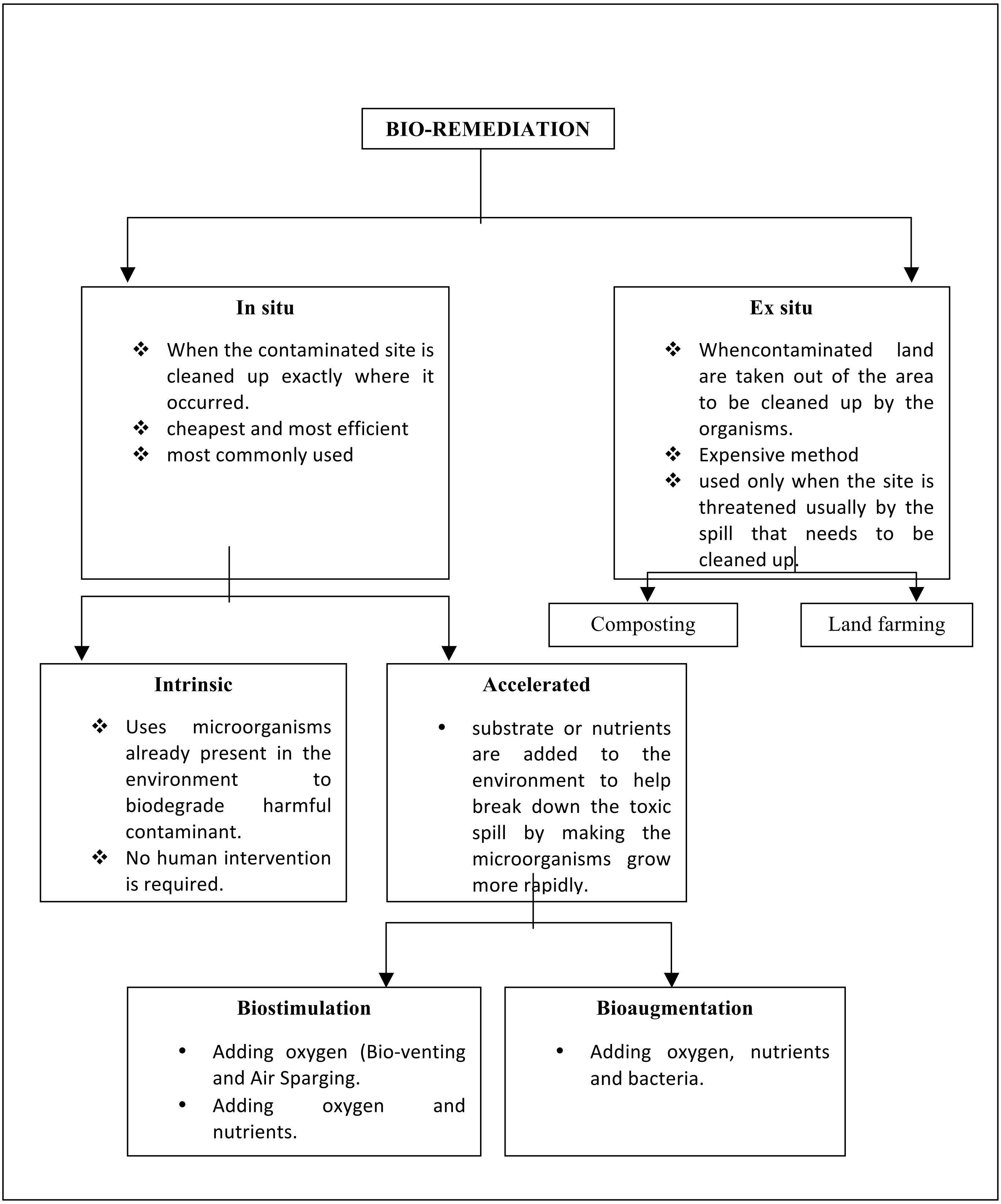
BIO-REMEDIATION
In situ
When the contaminated site is cleaned up exactly where it occurred.
cheapest and most efficient
most commonly used
Ex situ
Whencontaminated land are taken out of the area to be cleaned up by the organisms.
Expensive method
used only when the site is threatened usually by the spill that needs to be cleaned up.
Composting
Land farming
Intrinsic
Uses microorganisms already present in the environment to biodegrade harmful contaminant.
No human intervention is required.
Accelerated
substrate or nutrients are added to the environment to help break down the toxic spill by making the microorganisms grow more rapidly.
Biostimulation
Adding oxygen (Bio-venting and Air Sparging.
Adding oxygen and nutrients.
Bioaugmentation
Adding oxygen, nutrients and bacteria.

Fig. 1: Types of bioremediation

Desired qualities of microorganisms for bioremediation

- Genetic stability
- Enzyme activity
- Growth in environment of choice
- Competition ability within that environment
- Non pathogenicity
- Absence of toxic metabolism

Principles of bioremediation of soil

Bioremediation is the process of use of living organisms (basically microorganisms or plants) to degrade or detoxify substances or contaminants present in the soil, into less toxic forms. These substances if not degraded can affect human health and the environment adversely. These microbes can either be in situ or may be isolated from somewhere else and brought to the contaminated site. Microorganisms enzymatically attack the contaminants and as a result of metabolic processes convert them to harmless products.

Depending on the degree of saturation and aeration of an area, different techniques are employed which helps in bioremediation process. The various techniques are summarized in Fig. 1.

Remediation time

In situ bioremediation time depends on the extent, depth, and concentration of the contamination. It varies from 1 - 6 years. Ex situ remediation for easily biodegradable contaminants or when bioreactors are used can take as little as 1-7 months. Optimum environmental conditions for the degradation of contaminants are given in Table 1

Table 1: Factors affecting bioremediation

Parameters	**Condition required for microbial activity**	**Optimum value for an oil degradation**
Soil moisture	25-28% of water holding capacity	30-90%
Soil pH	5.5-8.8	6.5-8.0
Oxygen content	Aerobic, minimum air filled pore space of 10%	10-40%
Nutrient content	N and P for microbial growth	C:N:P = 100:10:1

Temperature	15-45 degree Celsius	20-30
Contaminants	Not too toxic	Hydrocarbon 5-10% of dry weight of soil
Heavy metals	Total content 2000 ppm	700 ppm
Type of soil	Low clay or salt content	

(Source - Vidali, 2001)

Advantages of bioremediation

- Permanent reduction in risk as there is complete destruction of target contaminants.
- The result of the bioremediation process is usually harmless products like carbon dioxide, water, and cell biomass.
- Cost effective and less expensive than other technologies.
- Sustainability
- Eco friendly approach

Limitations of bioremediation

- Only biodegradable compounds can be completely degraded by bioremediation.
- It often takes longer time than other technologies available.
- The bacteria only survive in the top 2m of the soil.
- In the soil, there is complex mixture of contaminants which includes solid, liquid and gaseous pollutants and it is difficult to use bioremediation technologies for such sites.
- Identification of bacteria or microbes requires high level of research.
- There is spontaneous mutation in some bacterial populations after remediation efforts.

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ISSN: 2582-6980

Trader's Preferences on Quality Attributes of Indian Mango

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Introduction

India is the home of 1000 mango varieties comes in various shapes, sizes and colours with a wide variety of flavor, aroma and taste. It is the special product that substantiates the high quality standards and bountiful nutrients packed in it. India is a prominent exporter of fresh mangoes to different countries. Mango is exported to 51 countries from India. The total quantity and value of export were 40012 tonnes and of Rs. 285.43 crores respectively during 2019-20. The export of mango to major importing countries is shown in Table 1. The share of mango exports to the total mango production in India was only 0.53 per cent during 2003-04 and 0.22 per cent during 2019-20. The main reason for the low exports is the lack of expected quality of importing countries and non-availability of surplus for export. Hence there is a need to systematically identify the relative importance of each of the quality attributes of exportable mangoes which influence demand for mangoes in the world market.

Quality Requirements of Mango for Export

The quality standards required for fresh mango export are given in Table 1. The table indicates that the major varieties preferred for mango exports are Alphonso and Kesar. The fruit size of both the varieties ranges from 200 to 300 grams for export to Netherland and England, whereas the same ranges between 200 to 250 grams for Central Eastern countries. It is noted that one package of mango fruits exported to Netherland and England should contain 2.5 kilogram per dozen. For exporting to any country, mangoes should be stored at the temperature of 13^0 centigrade.

Table 1: Quality Requirements for Fresh Mango Export

S.No	Variety	Country		
		Netherland	**England**	**Central East**
1	Alphonso	250-300 g	250-300 g	200-250 g
2	Kesar	225-250 g	225-250 g	200-250 g
3	Package	2.5kg/1 dozen	2.5kg/1dozen	1 dozen
4	Storage Temperature	13^0 Centigrade	13^0 Centigrade	13^0 Centigrade

5	Export	Air	Air	Sea

Source: Farmers manual on Schemes and Services of Agricultural Marketing and Trade

Agricultural Marketing and Trade Department, Chennai,

Packaging and Export functions of Fresh Mango from India

For exporting, fresh mangoes are enclosed in a clean, white, soft, expandable and netted type polystyrene sleeve to prevent bruising before packing in a box. Mangoes must be packed in insect-proof boxes. If ventilated boxes are used, all the ventilator openings of the box should be covered with insect-proof screen and all the sides of box should be sealed with adhesive tape to prevent any entry of pests. The materials used inside the package must be new, clean and of a good quality such as to avoid causing any external or internal damage to the produce. The use of materials, particularly of paper or stamps bearing trade specifications is allowed, provided the printing or labeling has been done with non-toxic ink or glue. Mangoes have sensitivity to refrigeration, freezing and ethylene exposure and shall be packed in each container in compliance with the recommended International Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables. The detailed chain of events involved in fresh mangoes export is portrayed in Figure 1.

Fig.1: Chain of events of fresh Mango export

ISSN: 2582-6980

Quality attributes for Export of Mango

The various quality attributes preferred by Mango traders are furnished in Table 2. The important quality attributes considered by the traders were variety, size, colour, shape and flavor. Quality has a strong influence on exports. Among all attributes studied variety was found to have the greatest influence on the trade of mango as it accounted for 38.86 per cent of relative importance and Alphonsa, Kesar and Banganapalli were the preferred varieties. The most preferred by the traders was Alphonsa variety. The size of mango is yet another important factor influencing the traders with a relative importance of 22.78 per cent. The colour of mango influenced the traders with a relative importance of 18.62 per cent. Among the levels of colour attribute, colour between green to yellow had a high utility followed by brown to red and yellow to red.

Shape of mango is one of the attributes influencing the export traders with a relative importance of 14.53 per cent. Ovate oblique has higher utility than other shapes. The least important attribute is the flavour which has a relative importance of 5.21 per cent. Among which, high and medium flavoured mango received high utility values.

Table 2: Quality Attributes of Indian Mango

S. No.	Characteristic	Level	Relative Importance (%)
1	Variety	Alphonsa Kesar Banganapalli	38.86
2	Size	200-250g 250-300g 225-250g	22.78
3	Colour	Green to Yellow Brown to red Yellow to red	18.62
4	Shape	Ovate oblique Oval oblong Elongated	14.53
5	Flavour	High Medium Low	5.21

Conclusion

The export quantity share of fresh mango to the total production in India is low. India, having huge production base has a potential to export fresh mangoes to foreign markets. The export of fresh mangoes from India is confined mainly to neighbouring countries. The success of mango exports depends heavily on the quality of mangoes. It is revealed that the important quality attributes considered by the traders were variety, size, colour, shape and flavor for mango export. The variety has the greatest influence on the trade of mango. The size of mango is yet another important factor influencing the traders. The quality attributes preferred by the traders of mango are Alphonsa variety, 200-250 g size and yellow to green colour and ovate oblique shape with high flavor. The study helps to enlighten some important policy implications. There is a need for setting up a mango marketing federation with a quality assurance cell which should look into and maintain international standards. Quality standards should be regularly monitored and forward (credit, input supply) and backward linkages (marketing, storage, infrastructure facilities etc. in the production and marketing of mangoes needed to be developed. The government at both the state and central levels should invest in creating infrastructure facilities for export of mangoes. Alphanso and kesar varieties have great demand in domestic and international markets. At the same time quality attributes such as colour, shape, size and flavour should also be maintained in newly evolved varieties so that India can increase its presence in the international market.

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ISSN: 2582-6980

Impact of Ocean Warming on Indian Monsoon

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1. Introduction

Northern hemisphere summer monsoon rainfall has intensified during the last three decades and increasing rainfall of 9.5 per cent was observed with every degree of increasing global temperature in the wake of global warming (Wang *et al.,* 2013). Recent studies also pointed out that the occurrence of extreme rainfall event frequency increasing over South Asia due to warming phenomena (Goswami*et al.,* 2006).

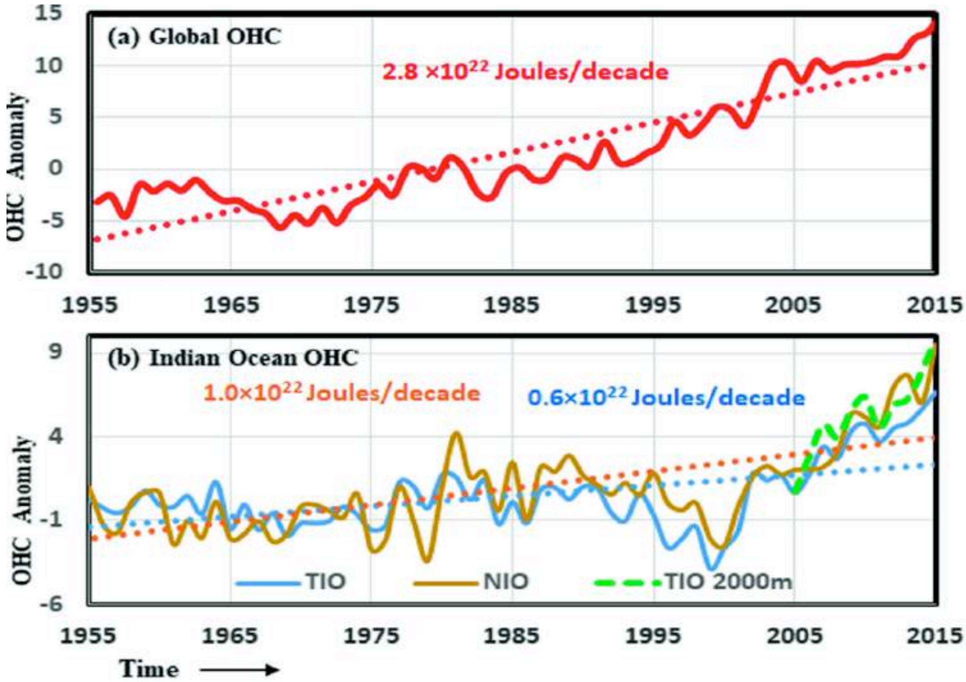
On the contrary, Roxy *et al.,* 2015 in their study found that substantial diminishing trend was observed over the central-east and northern regions of Indian summer rainfall during 1901–2012 which includes the basins of the Ganges-Brahmaputra-Meghna and the Himalayan foothills, where farmers still practised rainfed agriculture. It was observed using long-term reflections and coupled model experiments indicating the decreasing pattern of land-sea thermal gradient over South Asia caused by rapid warming in the Indian Ocean leading to warming over the subcontinent as well.

The El Nino- Southern Oscillation (ENSO) is regular unpredictable variation occurring by winds and sea surface temperatures fluctuations over the Pacific Ocean which influences the global weather systems. El-Nino is coupled with positive phase of ENSO with abnormally high sea surface temperatures at central and eastern Pacific regions which is associated with inadequate amount of rainfall than normal amounts in India. Recent studies revealed that even a tiny increase in surface temperature of the Indian Ocean could lead to El Nino pattern occurrence in the near future (DiNezio*et al.,* 2020).

2. Observed Variability Trends of Global and Indian Ocean Heat Content

Ocean tends to collect the largest part of solar energy received by earth. Ocean Heat Content at Indian ocean had significantly increased over the years since 1950's. The trend was observed that OHC has increased an average of 2.8×10^{22} Joules per every decade over the period of 1955–2015, over the same period greater raise of net heat content was observed at 0.62×10^{22} Joules per decade and 1.0×10^{22} Joules per decade in tropical and north Indian Ocean basins respectively. Particularly, it was observed that after 2000 both Tropical Indian Ocean and North Indian Ocean has increased abruptly. This finding clearly makes us to understand that there is a slowdown in Pacific SST warming, defiantly unusual warming in the Indian Ocean and an accelerated OHC rise, which is coupled with La Nina climate (warm monsoon season) stimulates heat transport around the globe (Liu *et al.,* 2016). The trend is clearly depicted in the Fig. 1.

Additional atmospheric heat is observed back to the ocean. As a consequence of this action, upper ocean heat content has increased significantly over the past two decades. more than 90 percent of the ocean warming has occurred between 1971-2010 and the average heat-gain rates between 0.57-0.81 watts per square meter during1993–2018. It is observed that after 1990's the heat gain showed an increasing trend over the years due to climate change by various anthropogenic sources (Fig. 2).



(Source: Cheng *et al.,* 2017)

Fig. 1: Observed Trends in Variability of Global and Indian Ocean Heat Content TIO- Tropical Indian Ocean (blue) and NIO- North Indian Ocean (yellow)

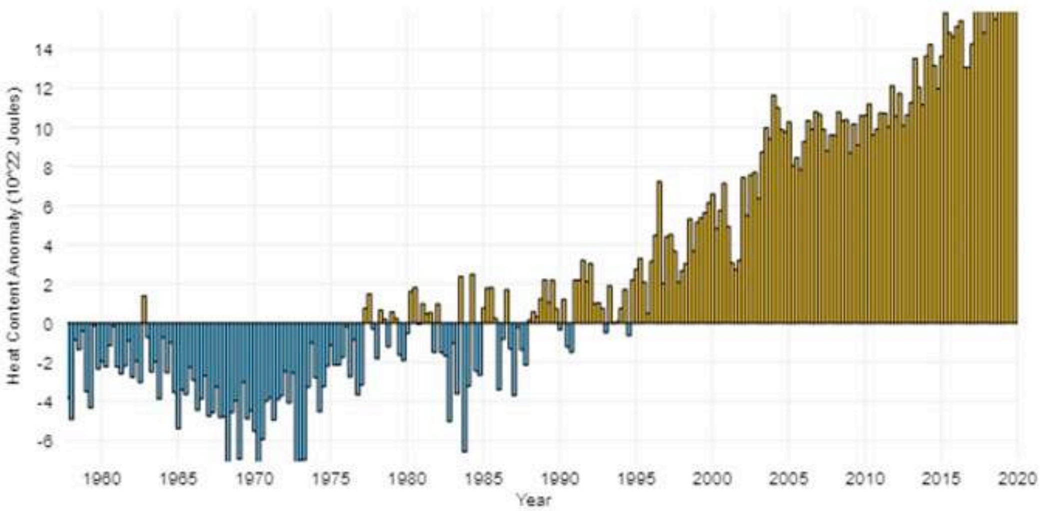


Fig. 2: Long-term average global ocean heat content (1955-2020) in the top 700 meters of the ocean (Source: NOAA Climate.gov)

3. Consequences of Indian ocean warming

Speedy warming of the Indian ocean alters the cropping pattern and land use systems around the country due to changes in Indian summer monsoonal rainfall behaviour. According to Mishra *et al.,* 2012 substantial decline was observed in Indian Summer Monsoon Rainfall (ISMR) over central India and parts of north India due to reduction of tropospheric thermal contrast which is usually associated with Indian Ocean warming. Meanwhile, instant warming in the Arabian Sea caused widespread extreme rains over Western Ghats and central India, since warming generates intensified oscillations in the monsoonal winds which brings enhanced moisture from the Arabian Sea towards the Indian subcontinent.

Ocean warming influences the rainfall pattern on the different stages of Indian monsoon during the developing and decaying of El Nino season. Due to westward extension of North Western Pacific (NWP) anticyclone, regions such as central and east India experience strong negative precipitation anomalies during onset phase of monsoon whereas, Tropical Indian Ocean (TIO) warming induces positive precipitation anomalies during withdrawal phase of monsoon which is forced by enduring Indian Ocean warming. This process is otherwise known as Indian Ocean Dipole (IOD) (Chakravorty *et al.,* 2016). The phenomena of Indian Ocean Dipole (IOD) is depicted in Fig. 3.

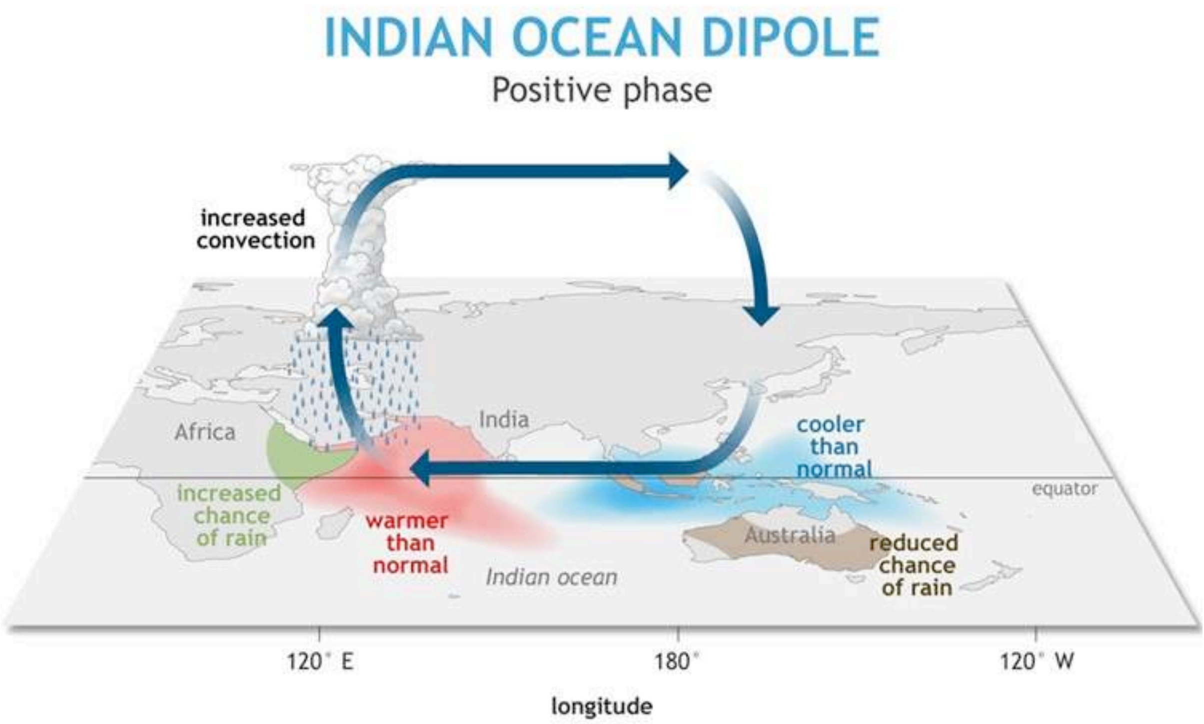


Fig. 3: Positive Phenomena of Indian Ocean Dipole (Source: NOAA Climate.gov)

Occurrence of tropical cyclones due to differential warming of the Indian and Pacific oceans witnessed that more than 80per cent fatalities happen by Bay of Bengal (BOB) region cyclones whereas, fatalities are very meagre by Arabian Sea region cyclones (5%). Tropical cyclones forms from evaporation at the ocean surface which is due to increase of SST and strong OHC. Intensity of tropical cyclones has increased recently which is due to the increasing temperature during post-monsoon period at Bay of Bengal (BOB) and pre-monsoon period at Arabian Sea (AS) (Beal *et al.*, 2020).

Conclusion

From this paper it is concluded that, land-mass climatic condition is strongly regulated by ocean atmospheric conditions in the Indian Ocean region. Hence, this paper highlighted the key points of Indian monsoonal behavioural patterns influenced by the warming oceans. The temperature increase has caused both EL-Nino and La-Nina years based on its strongness. Climate change triggers El-Nino pattern strongly over years. Also, the warming trend of oceans resulted in frequent and intensified cyclones, which could be attributed both to climate variability and climate change. Hence, this paper tends to understand the consequences of climate change scenario owing typically to the Monsoon arena.

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ISSN: 2582-6980

Maintenance of Seed Purity – Nucleus and Breeder Seed Production

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Genetic Purity during Seed Production

a) Providing adequate isolation to prevent contamination by natural crossing or mechanical mixtures.
b) Rouging of seed fields, prior to the stage at which they could contaminate the seed crop
c) Periodic testing of varieties for genetic purity
d) Avoiding genetic shift by growing crops in areas of their adaptation only.
e) Certification of seed crops to maintain genetic purity & quality seed.
f) Adopting generation system (The seeds produced is restricted to four generation only i.e. starting from breeder's seeds.) and the seeds can be multiplied up to three more generations i.e. foundations, registered and certified.

Control of seed source

For raising a seed crop the seeds should be required from an approved source and from an appropriate class is necessary. Four classes of seeds are generally recognized in seed certification namely breeder seed, foundation registered and certified. These classes are recognized by AOSCA i.e. Association of official seed certifying agencies.

1. **Breeder's seed:** Is a seed or vegetative propagating material which is directly controlled by sponsoring breeder of institution & which provides increases of foundation seeds.
2. **Foundation seed**: is a seed stock so as to maintain specific genetic identity and purity and may be designated or disturbed by agriculture experiment station. Production must be carefully supervised by representatives of the station. Foundation seed is the source of all other certified seed classes, either directly or through registered seed.
3. **Registered seed:** Registered seed is the progenies of foundation and it is handled so as to maintain genetic identity and purity and that has been approved by and certified by certifying agencies.

4. **Certified seed:** Is the progeny of foundation, registered or certified seed, that is handled to maintain genetic identity and purity and that has been approved by and certified by certifying agencies.

Preceding Crop Requirements

Preceding Crop Requirements has been fixed to avoid contamination through volunteer plants and also from soil borne diseases. (Volunteer plants mean plants grown in the field from previous crops).

Isolation

Isolation is required during seed crop production to avoid contamination due to natural crossing and diseases infection by wind and insects from neighbouring field and also during sowing, harvesting, threshing and handling of seeds to avoid mechanical mixtures. The isolation distance is different from crop to crop and from different classes of seeds. i.e. certified seeds & foundation seed plots.

Rouging of seed fields

The off-time plants i.e. plants offering in their characteristic from those of the seed's variety is another source of genetic contamination. Their continued presence would certainly deteriorate the genetic purity of the variety. The removal of such type of plant is referred as "rouging". There are three main sources of off- type described below.

1. The off-type plant may be arising due to presence of recessive genes in heterozygous condition at the time of release of variety. (The recessive genes may also arise by mutation).
2. Off-type plants are due to volunteer plants or from seed produced by earlier crop.
3. Mechanical mixtures also constitute the major source foe off- type plants.

Seed certification

The genetic purity in commercial seed production is maintained through a system of seed certification. The objective of seed certification to maintain and make available crop seeds, tubers, bulbs, etc. which are of good seeding value and true to variety for seed certification purpose well experienced and qualified personal are required from seed certification agency & they carry out field inspection at appropriate stage of crop growth. They also make seed inspection variety the seed crop/seed lot is of the requisite genetic purity and quality. After harvest crop, they variety the quality and at the processing plants they take samples for seed testing and also for grow-out-test.

Grow- out – test

Varieties being grown for seed production should periodically be tested for genetic purity by grow – out – test, to make sure that, seed being maintained in their true form.

Seed Purity

When a farmer buys a seed from any recognized institute or company, he expects to receive a good quality seed and not a mixture of other crop seed, weed seeds, straw etc. It is not possible to remove all these admixtures completely with the use of cleaning machine is & some seeds always remain present and there is necessary to take purity test or analysis, to determine how much % of the admixture is present in the seed.

Nucleus and Breeders seed production

The initial handful of seeds obtained from selected individual plants of a particular variety, for the purposes purifying and maintaining that variety, for the purposes and purifying and maintaining that variety, by the originating plant breeder and its further multiplication under his own supervision, or the supervision of a qualified plant breeder, to provide Breeder's Seed constitutes the basis for all further seed production. The varietal purity of subsequently multiplied foundation, registered and certified seed largely depend upon the quality of the nucleus/breeder's seed. Unless the nucleus/ breeder's seed is of highest purity and quality the seed multiplied from it cannot be regarded as of satisfactory genetic purity. Unsatisfactory genetic purity, especially in cross pollinated crops, could ultimately severely affect the performance of a variety. It is therefore, of utmost importance that the nucleus/breeder's seed is produced in such a manner that satisfactory genetic purity, identity and the other good qualities of seed are maintained.

Methods of maintenance of nucleus and breeder's seed in self fertilised crops

Methods of maintaining nucleus seed/breeders can be conveniently divided into the following two groups.

1. Maintenance of Nucleus Seed of Pre-released or Newly Released Varieties

The procedure outlined by Harrington (1952) for the maintenance of nucleus seed of pre-released or newly released varieties is described below:

a. Sampling of the variety to obtain nucleus seed. New numbers, lines or selection which are highly promising, on the basis of performance in breeding nurseries and yield trials, should be sampled for seed purification. These samples provide a beginning for purifying new varieties and for possible increase and distribution to farmers. Not more than fifteen new varieties in any one crop at a station should be sampled in one year.

b. Table examination of samples: The two hundred plants of each sample should be threshed separately and the seed should be examined in piles on the table. Discard any pile appearing obviously off type, diseased or otherwise unacceptable. The seeds of each two hundred plant samples or less is now ready to be sown in a variety purification nursery called as nucleus.

c. Locating and seeding of nucleus: Each nucleus seed should be grown on clean fertile land at an experiment station in the region or in area in which this new variety could be grown, in the event of its release. The land must not have had a crop of the same kind in the previous year.

d. Inspection of nucleus two-row plots and removal of off types: Throughout the season of growth, from the seedling stage until maturity, the nucleus plot should be examined critically. Differences in the habit of early plant growth, leaf colour, rate of growth, time of heading, height head characteristics and diseases reactions should be looked for. If a plot differs distinctly from the average in the preheading stages of growth, it should be removed before heading.

e. Harvesting and threshing of nucleus; each remaining plot, of which there should be at least 180 out of the original 200 should be harvested individually with a sickle and tied in a bundle. The total bundles of each nucleus should be labelled and stored until the current years yield rests for trials are obtained. The nucleus bundles of any new variety should be discarded, if it is found unworthy of being continued.

Later the seed should be cleaned in a fanning mill or by hand methods, the grain from each nucleus plot being placed in a pile on the seed table. The 180 or more piles of seed of one nucleus must be examined for approximate uniformity of seed appearance, and any pile, which appears to be off type discarded. All the remaining piles of the of seed should be masked together in one lot. This should treat with fungicide and insecticide, bagged, labelled and stored as "Breeder's Stock Seed" for use in the next year. Breeder's stock seed is the original purified seed stock of a new variety in the hands of the plant breeders.

2. Maintenance of Breeder's Seed of Pre-released or Newly Released Varieties

a. Breeder's stock seed from the nucleus should be sown on the clean, fertile land, which did not grow a crop of the same kind in the previous year. The space required for the seeding the breeder's stock is about 1.2 ha in the case of wheat and as much as 3 ha in the case of transplanted rice.

b. The field should properly isolated.

c. The best farm procedures should be used in the sowing, raising and harvesting of breeder's stock.

d. It should be produced at the experiment station in the area in which the new variety has been bred.

e. The seeding should be done in such a way as to make the best use of the limited amount of seed available and to facilitate roguing. The row spacing should be sufficient to permit examination of plants in rows for possible mixture or off types.

f. Roguing: All plants not typical of the variety should be pulled and removed. There should be very few plants to rogue out if the previous year's nucleus breeder's stock seed was well protected from natural crossing and careful roguing was done and there were no impurities during cleaning etc. The rouging should be done before flowering, as was done for the nucleus/breeder's stock seed.

g. Harvesting the breeder's stock: In the breeder's stock is harvested and threshed, the equipment used must be scrupulously clean and free from seeds of any other varieties. This cleanliness should be extended to cards and bags as well as threshing machine itself. The seed should now be about 99.9 per cent pure as to variety. These breeder's seed is ready now for increase of foundation seed.

Maintenance of breeder's seed of established varieties: The breeder's seed of established varieties could be maintained satisfactorily by any one of the following methods:

a) By raising the crop in isolation. The breeder's seed of local varieties could be maintained by growing them in isolated plots and by very rigorous roguing during various stages of crop growth, where the various plant characters are observable.

b) By bulk selection. The genetic purity of established varieties could be satisfactorily improved by bulk selection. In this method 2,000 to 2,500 plants typical of the variety are selected, harvested, and threshed separately.

Carry-over Seed

The breeder must carry-over at least enough seed to safeguard against, the loss of variety if there is a complete failure during the foundation seed multiplication phase. In addition, the breeder should further safeguard variety by arranging to have a portion of the seed originally released stored under the ideal conditions.

 ISSN: 2582-6980

Nutrient Film Technique

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Essentially the Nutrient Film Technique (NFT) is a water management method of growing crops in a thin film of water containing plant nutrients. Originally, this technique was developed by Dr. Allen Cooper in Glass House Crop Research Institute at Little Hampton in 1965. The nutrient film technique provides ample scope in the domain of soil less cultivation of crops and more so greens as the method involves growing plants in channels where in a thin film of nutrient solution around the roots is maintained . Nutrient film technique system (or NFT system) is also fairly popular with hydroponic or aeroponic growers due to its simple and effective design. It is used to grow greens, mini potato tubers and commercial edible flowers and found to be an important dimension of land resource management as it dwindling due to unprecedented population growth.

Description of the System:

Basically, in this method, plants are placed on capillary matting which are adhered with a thin layer of soil in the gullies. These gullies are lined with plastic film to hold water and capillary matting is enriched with plant nutrients to facilitate better rooting.

The system consists of one tank (4000-6000 lit) and several plastic gullies with plant roots on the soil at right angles to the tank. The tank is made out of soil compacted and overlaid with plastic film. It is erected to stand a couple of feet above the level of gullies. The gullies are small furrows about 8.5 to 10 cm deep. From water source, water is pumped into the tank. A small plastic tube is used to siphon water from the tank into gullies. The capillary matting made of narrow strips of sack cloth is used for attracting and guiding the roots towards the gullies.

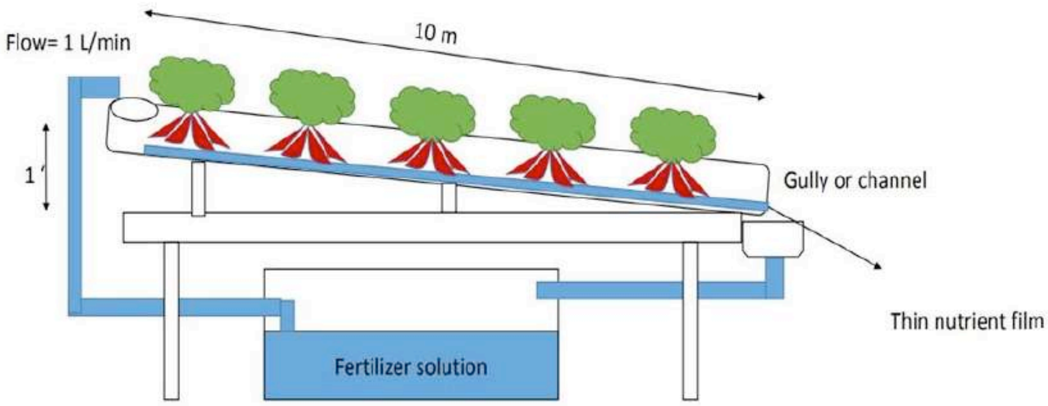

Fig. 1: Description of NFT system

Components of NFT system:

- A reservoir to contain the nutrient solution
- Nutrient pump
- Tubes to distribute water from the nutrient pump to the NFT growing tubes
- Channel for the plants to grow in
- Net pots to contain plants and growing media to start seedlings in
- Return system (tubing, channel) to guide the used nutrient solution back to the reservoir

In the NFT system, there are 2 main components: the grow tray (or channel) and the reservoir that contains water and nutrients. In the grow tray, there are net pots that contain the growing media (perlite, coconut, rockwool) to hold the plants and reserve nutrients from the nutrient solution. But in reality, most growers don't use growing media in the NFT system as the roots have had enough moisture, nutrients, and oxygen from the system.

The plant roots grow into a dense mat in the channel and the foliage sits on top, sometimes provided with support by a trellis system. The NFT system uses a pump to deliver water to the grow tray and a drained pipe to recycle the unused water nutrient solution.

The grow tray is placed at an angle (supported by a rack or on a bench) to let the water flow down towards the nutrient return pipe. The excess nutrient solution will flow out of this pipe and move into another channel or tube, where it is re circulated through the system again.

The roots of the plants hang down to the bottom of the channel where they come into contact with the shallow film of the nutrient solution and absorb the nutrients from them. The thin film of the nutrient solution allows the plants to be watered but not entirely soaked. This thinness also allows the upper part of the roots to remain dry and have access to oxygen in the air.

Commercial utility

Nutrient film technique is now, popular as hydroponic technique in cultivation of vegetables where in a very shallow stream of water containing all the dissolved nutrients required for plant growth is re-circulated past the bare roots of plants in a watertight channels which are similar to gullies in conventional method (Fig. 2). However, NFT can be customized to meet home needs (Fig. 3) as a kitchen gardening component to harvest quality produce over an extended cropping season.

Crops suitable for NFT:

Short period growing crops such as Lettuce, can be grown in rigid PVC gullies 100mm wide by 50 mm high (4" x 2"), to a maximum length of 18 meters long. Longer term crops and those with a larger root mat, Tomato, Cucumber, Strawberry and Beans are grown in gullies 150mm x 75 mm (6”x3”), made in either rigid PVC, or in disposable plastic film, such as Panda film (black inside, white outside).

Fig. 2: Recirculation of nutrient solution in the system

Advantages of NFT:

- Maximum efficient use of water and nutrients as only 25 % of water required by conventional method is sufficient
- Easy to disinfect roots and setup.
- Easy to observe root quality and health.
- Consistent flow prevents salt buildup in root area,
- Re circulation minimizes groundwater contamination.
- Very modular and expandable.
- Possibility of better plant growth and yield.
- Bulk growing media is not required

Downside of NFT:

- Clogging of channels as roots a grown in confined channels
- A failing pump can kill an entire crop within a few hours.
- Does not work well with plants that have large tap-root systems.
- Doesn’t do too well with plants that need a lot of support.

Thus, nutrient film technique is a potential method which needs to be more popularized to circumvent the land resource constraint. It has a great scope in harvesting quality produce to attract premier price

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Rice cum Fish Farming – Ingenious Technologies to Empower The Farmers

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Introduction

Accelerated growth of human population poses many challenges, especially food scarcity, malnutrition, limited means of irrigation and reduced land resources, in addition to deteriorating environmental quality. To tackle the ever-increasing pressure on food and the environment, sustainable intensification of agricultural production systems is needed today. Rice, a major food crop, feeds nearly 50 % of the world 's population. It was established as a major crop that consumes large quantities of available water resources while paddy fields emit large quantities of greenhouse gas, methane. Thus, solutions need to be sought to improve the management of rice production systems.

What is rice – fish system?

A rice-fish management is an innovative rice field or rice field / pond complex whereby rice is grown simultaneously or alternately. Fish may be intentionally stored (fish culture) or, when flooding occurs, may enter fields naturally from nearby rivers (rice field fisheries), or both of both.

Co-culture of rice and aquatic species combining animal production (e.g. fish, shellfish, crab, shrimp and ducks) in paddy rice systems was suggested as a strategy for optimizing the use of land and water resources to provide both grain and animal protein. Fish production in rice fields is nearly as primitive as the practice of rice cultivation itself. Rice farming with-fish farming is a type of duo farming system in which rice is the sole enterprise and fish are taken to initiate extra income.

Methane Emission

A minimum of 10-20 per cent of atmospheric methane comes from paddy fields. This is significant, because methane's global warming potential (GWP) is 25 times higher than carbon dioxide. Investigation has shown that the rice-fish culture system can reduce methane and other GHG emissions. Aquatic creatures, especially bottom feeders (crabs and carps) interrupt the soil layers by their activity or sometimes by their quest for food, and thus influence the production processes of CH4.

Conversion of aerobic digestion

Aquatic creatures potentially increase diluted oxygen in field water and soil, which transfers anaerobic digestion to aerobic digestion and helps reduce CH4 emissions. Recent times it has been estimated that methane emissions from the rice-fish farming system are 34.6 per cent lower than those from a rice monoculture farming system.

Soil fertility enhancement

The rice-fish method also helps to restore soil fertility and prevent soil degradation, which is a major global environmental problem. The rice-fish system requires only a small amount of pesticide and fertilizer since it is a system with low inputs.

Economical benefits

The economic aspect of this system indicates that its adoption has led to an increase in economic efficiency of farmers. According to a survey, the net income from rice-fish cultivation exceeded that of rice monoculture by more than 50%.

There were higher rice yields from the rice-fish method, lower labor inputs and lower material inputs. Fish production also increased net income as opposed to a single rice crop. This approach socially links the aquaculture sector to the agricultural industry, which is not possible in the case of monoculture. A co-culture system provides farmers a forum for exploring new ideas and sharing their expertise and experience in developing the agricultural and aquaculture industries. With these advantages, farmers are willing to embrace co-culture technology as it enhances their economic status and is encouraged to increase contacts between different stakeholders, providing or exchanging useful skills and technical knowledge.

In India, agriculture is the Indian economy's lifeline and contributes almost one-fourth of total gross domestic product and feeds two-thirds of the population. This method of co-culturing rice-fish will certainly boost farm productivity, reduce environmental degradation and improve farmers' quality of life.

Probably the method of raising fish from the rice fields started with the start of rice cultivation itself, because the waterlogged rice fields create a natural habitat for fish. Rice-fish farming has an excellent future in this area. Studies have shown that rice-fish cultivation is a viable, environmentally sustainable, low-cost, low-risk additional economic activity with several benefits including increased revenue and increased fish supply for the rural farming community. Because of its negligible use of chemical fertilizers, pesticides, and other chemicals, it is recognized as the most suitable zone for organic farming in some area.Nowadays rice-fish system is in urgent need of conservation and promotion. A full recognition of its multi-ecological functions must be achieved, such as its role in preserving biodiversity, protecting food security, enriching the soil and lowering greenhouse gas emissions.

Co-culture systems have beneficial effects on farm income, as well as reducing greenhouse gas emissions, and improving the livelihood of poor rural people and progressive farmers. Further improvement of this approach is potentially competitive and environmentally friendly for the agricultural sector.

The main objective of this sustainable farming practice is

- To determine the relative profitability of using rice-cum-fish cultivation compared to monoculture of rice.
- Determine the impact of rice-cum-fish farming on increasing yields, overall prices, fish consumption and jobs compared to monoculture.
- Identify the big problems in the implementation of integrated rice-fishing
- Determine the effect of different fish combinations on the yield of fish in the system of rice-cum-fish cultivation with a view to recommending the result to prospective rice / fish farmers.

Benefits of rice cum fish culture system

- ✓ Improves the soil fertility & soil health.
- ✓ Increasing economic yield per unit area.
- ✓ Reduction in production costs.
- ✓ Decreases farm input requirements.
- ✓ Multiple income sources.
- ✓ Minimize the use of chemical fertilizers
- ✓ Provides balanced nutritious food for the farmers.

Technology engaged in rice cum fish farming

Site selection, Soil quality, Bund preparation, Field levelling, Pond construction, Flooding and Weeding of Paddy, Fertilization of Rice Fields, Source of fish seed, Stocking of fish seeds, Stocking of Fish Fingerlings, Water Quality Monitoring, Growth Rate, Harvesting and Marketing

Area Coverage

Agronomy	Entomology	Veterinary & Animal Husbandry
Horticulture	Nematology	Dairy
Soil Science	Genetics & Plant Breeding	Poultry
Seed Science & Technology	Plant Physiology	Fisheries
Microbiology	Plant Pathology	Policy Paper
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Research Associates/ Assistant Professor or Equivalent and Professionals including Company Representatives/ Agricultural Oficer and Others	*550*	*600*
Life Membership Charges (Unlimited Articles for 10 Years)		
Masters/ Ph. D., Scholars/ Project JRF/ Young Professionals/ Project SRF	*2800*	*3000*
Research Associates	*3600*	*4000*
Assistant Professor/ Teaching Assistant/ Any others Professionals	*4500*	*5000*

ALL INDIA AGRICULTURAL STUDENTS ASSOCIATION

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