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Growing seed

Editorial Board

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LAND USE PLANNING AND IT'S IMPORTANCE

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Typically, the term "land" refers to a portion of the earth's surface that contains all of the physical, chemical, and biological characteristics that affect how the resource is used. It speaks of soil, spatial variation, landscape, climate, hydrology, vegetation, and wildlife, as well as any land improvements, drainage plans, terraces, and other agro-biological and mechanical management techniques measures. The phrase "land usage" refers to more than only forestry and agricultural use; however, the use of the land for habitations, businesses, roadways, and other human activities. Land use can only be considered sustainable in this sense if it is accomplished in such a spatial distribution or arrangement of the various uses so as to ensure biodiversity and protect the eco-balance throughout the system. For this process to work, rational land use planning is essential. According to Bunting (1987), sustainable soil management preserves the soil's inherent fertility and enables the long-term cultivation of supplies of food, fibre and other natural resources. It suggests that the natural environment should be maintained and managed in a way that takes into account, preserves, or restores the energy flows between the soil, water bodies, and atmosphere. In this regard, "sustainable land use" is a broader phrase than "sustainable soil use."

It is anticipated that by 2050, there will be at least 9 billion people on earth and 8 billion at the very least by 2025 (FAO 1995). Therefore, it is evident that achieving food security and the quality of life will continue to present significant obstacles to maintaining the environment in the upcoming years for technicians, scientists, and decision-makers. The primary endeavour of food is produced via agriculture; hence advancing sustainable agricultural development and the way in which we respond to these difficulties will be critical. Since ancient times, agricultural engineering has used scientific concepts to the best

possible use and management of natural resources, and as the new century approaches, its significance is growing.

This significance is increasing for at least two reasons. First, the prudent utilisation of land resources will play a crucial part in the food supply for upcoming generations. Second, there is a growing demand for various land uses dramatically rising, particularly in the industrialised world. The land needs to be farmed, forestry, wildlife, infrastructure, outdoor leisure, landscaping and industrial activities, as well as greater land resources, are needed for urban growth. To achieve this, sensible land use Planning will help to ensure agricultural sustainability by finding a balance between these various demands while protecting the environment and increasing production (Hamdy*et* al., 1999).

Principles of Land Use Planning (FAO 1993)

On the basis of the central idea, land use planning should be based on the following principles:

a) Both the process and the substance of land use planning are adapted to the local conditions. Due to the frequently failure of planning methods, implementation tactics and global models, these land use planning methods are automatically applied and taken over without consideration. LUP, however, is not a standardised. a process that is used consistently over the world. The material is based on a preliminary study of the local or regional situation.

b) Rural communities or organisations can frequently offer intricate indigenous knowledge of the environment. If this is the case, such local expertise need to serve as a foundation for preparing a sustainable land use and putting it into action.

c) Traditional rural societies have unique approaches to tackling and resolving issues, disputes about land use. Such strategies are used in the land use planning process to must be acknowledged, comprehended and taken into consideration.

d) The populace should actively engage in the LUP process. The outcomes of only when plans are created can planning and the implementation of measures be sustained, not behind or even against the people, but with and for the people. Thus, planning is not just a subject for professionals, but it ought to be done in collaboration with those who will be impacted. To ensuring that those touched by self-help initiatives have a sense of ownership must participate in the planning process from the start.

e) The primary duty of LUP is to begin a process of cooperation and communication that "all participants the opportunity to establish their goals and interests in the discussion ". The participation-oriented LUP includes the following key components: identification of the different participant groups and a comparison of their access to and utilisation of land resources. Additionally, their standing in the social hierarchy (gender approach) and their abilities as participants or members, there must be a consideration for authorities and other organisations.

Research and Development

National and international research must now be more effectively concentrated than in the past issues with managing and planning for land usage in the past. The only method to provide land in this way is utilising users and planners with the most appropriate and tested technology for focused actions to enhance the output of agriculture while preserving the environment. Lack of study and application access to new and cutting-edge technology, as well as research discoveries, is regarded as one of the sector's issues are primarily caused by inefficient land utilisation, degradation of the environment, excessive costs, and poor beneficiary response.
Successful research thrust on sustainable land use planning should include the following actions:

- Data base improvement
- Adaptive research
- Institutional strengthening
- Socio-economic analysis
- Environmental protection and conservation
- Technology transfer and infrastructure

Strategic Action Programme

The above-described themes and principles strike at the root of the major problems encountered in the land use planning process. To be effective, they have to be translated into actions through the formulation of programs which have to take into account the actual conditions of the environment where they are expected to be implemented. These programs have to include:

• The adoption of a thorough strategy that integrates environmental management, land use and water use

• The encouragement of regional collaboration to make sure that all parties' concerns are taken into consideration when making decisions

• An understanding of the connections between various land uses

• Promoting engagement from a wide range of groups, including governments, academic and research institutions, and non-governmental organisations

• The national and local levels of government endorsing an action plan in phases

The body of a Strategic Action Program is made up of and delineated by this regional strategy is a crucial step in putting prioritised initiatives into practise at the local and national levels.

Conclusions

- Sustainable land use planning is a process that aims to integrate ecological with socio-economic, and political with ethical principles in the management of land, for productive and other functions, to achieve intra and intergenerational equity.
- For formulating and implementing policies and strategies for land use planning, it is essential to collect, process and disseminate timely and reliable information and utilise modern land assessment and evaluation technologies to create sound scientific knowledge for proper decision support.
- The creation of a successful networking system can significantly boost and accelerate information gathering, selection and exchange to avoid overlapping and duplication.
- No comprehensive strategy for sustainable land use can be created for an area as a whole. At most, a regional strategy can provide a rough overview of what has to be accomplished at the national level. Therefore, each nation will need to customise its sustainable development in light of its unique issues, limitations, and comparative advantages.
- Regional plans must establish priorities, pinpoint pertinent initiatives, evaluate the environmental effects of legislation, look into resource mobilisation methods, and improve and promote the involvement of all parties involved
- Projects for land use planning will not be promoted or carried out without cost. Therefore, a lot of attention should be given to finding new sources of funding for the national financial allotment with additional funding. Measures are the most important

of these methods that aim to raise money locally, especially using the "user pays" basis

- The lessons discovered demonstrate the need for a clear rupture with the past policies to adopt a new, holistic method of managing and planning land use, that is comprehensive, participatory, and sustainable in terms of the environment.
- There is an immediate need for individuals with the necessary training to work in the integrated management of natural resources in a multi-sectoral environment.
- Finally, in order to realise sustainable land use planning development, aims and objectives, regulations, and rules should be based on local customs, traditions, and environmental strategies for managing resources.

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MONKEYPOX: AN EMERGING ZOONOTIC DISEASE

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Monkeypox is a viral infectious disease, having zoonotic significance. The disease is caused by monkey pox virus, a double standard DNA virus, belonging to genus *Orthopox virus*, family *poxviridae*, and is closely related to the Variola (VARV), Cowpox (CPX), and Vaccinia (VACV) viruses. It is 200–250 nm brick-shaped or oval enveloped virus with characteristic surface tubules with dumbbell-shaped core component and the viral genome is of 190 kb (Figure 1). The prevalence of the disease is mostly observed in the tropical rainforests of West and Central Africa. The first outbreak was recorded in a monkey during 1958 as a small pox-like disease having fever, chills and rashes like symptoms. The first human case was reported in a 9-month-old child in the Democratic Republic of the Congo on September 1 1970 (Okyay *et al*., 2022). Recently In May 2022, the monkeypox disease outbreak was noticed in non-endemic countries and by June 15, 2022, the disease was reported in around 36 non-endemic countries. A total of 16,016 laboratory confirmed cases of MPXV infection and five deaths reported in 75 countries across all six WHO Regions as of July 22 2022. On 23rdJuly 2022, WHO declared it as public health emergency of international concern (PHEIC). In India outbreak was first reported on 14thJuly 2022 in Kerala.

Epidemiology

The virus is found naturally in West and Central Africa near tropical jungles. In Africa, the case fatality rate ranges from 1 to 10%, with young children dying at a higher rate. However, the case-fatality rate in non-immunized children who are against smallpox ranges from 1% to 14%. Till date, the disease has been endemic in nearly 11 countries of the Central

and Western African regions with thousands of case reports annually. In 2003, there was first-ever MPXV outbreak in nonendemic countries, like USA. World Health Organization classified the MPXV genome, into Congo Basin (Central African) clade designated as Clade one (I) and West African clade as Clade two (II) with two sub-clades IIa and IIb. Currently, the biggest outbreak came across 75 countries, for which the West African clade was mainly responsible. A total of 7892 no of cases were confirmed between January 1 to July 7 2022, which included three deaths, from 63 Member States in five World Health Organization (WHO) Regions (Lahariya *et al*., 2022).Most of the cases have been reported from WHO European region, however, some cases have also been reported from Eastern Mediterranean, Western Pacific Region and Americas region of WHO. In endemic counties like Nigeria the outbreak is underway since 2017. In India, two Monkeypox cases were confirmed through clinical-epidemiological history and laboratory investigation.

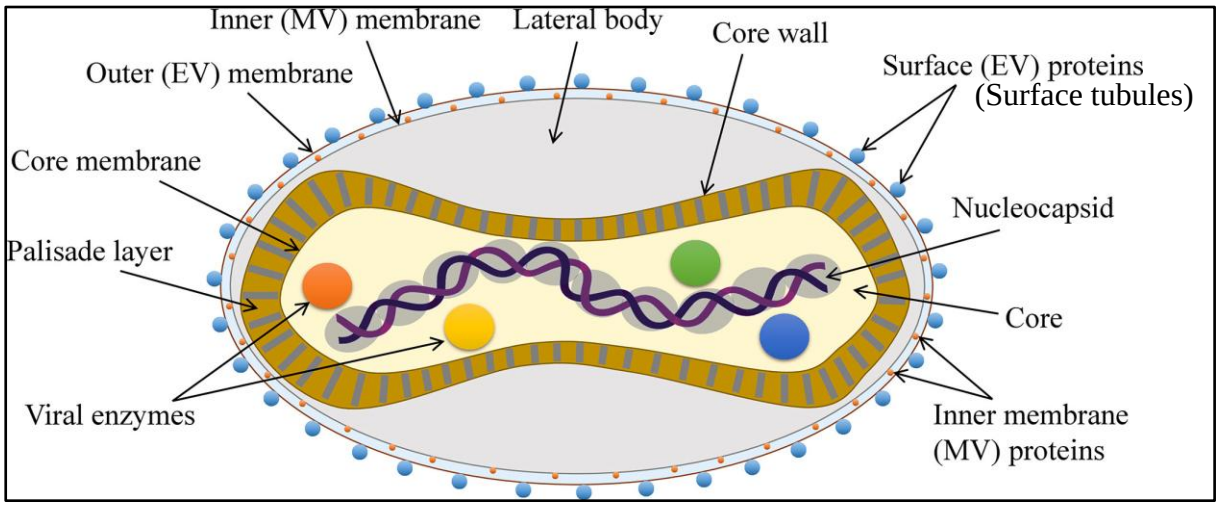

Figure 1. Structure of Monkey Pox Virus (MPXV)

Transmission

Monkeypox virus spread through direct contact with monkeypox lesions i.e., rash and scabs of clinically affected persons, often skin-to-skin contact, as well as contact with their saliva, upper respiratory secretions, and mucous membrane of the anus, rectum, or vagina. Congenital transmission can also occur through the placenta from mother to foetus. While close physical contact is a well-known risk factor for transmission (Ranjan *et al*., 2022) in endemic areas. Animal-to-human transmission occurs by bite or direct contact with the infected animal's blood, body fluids, or lesions. However, in non-endemic areas, transmission can occur by transferring infected animals from endemic to non-endemic areas (Figure 2).

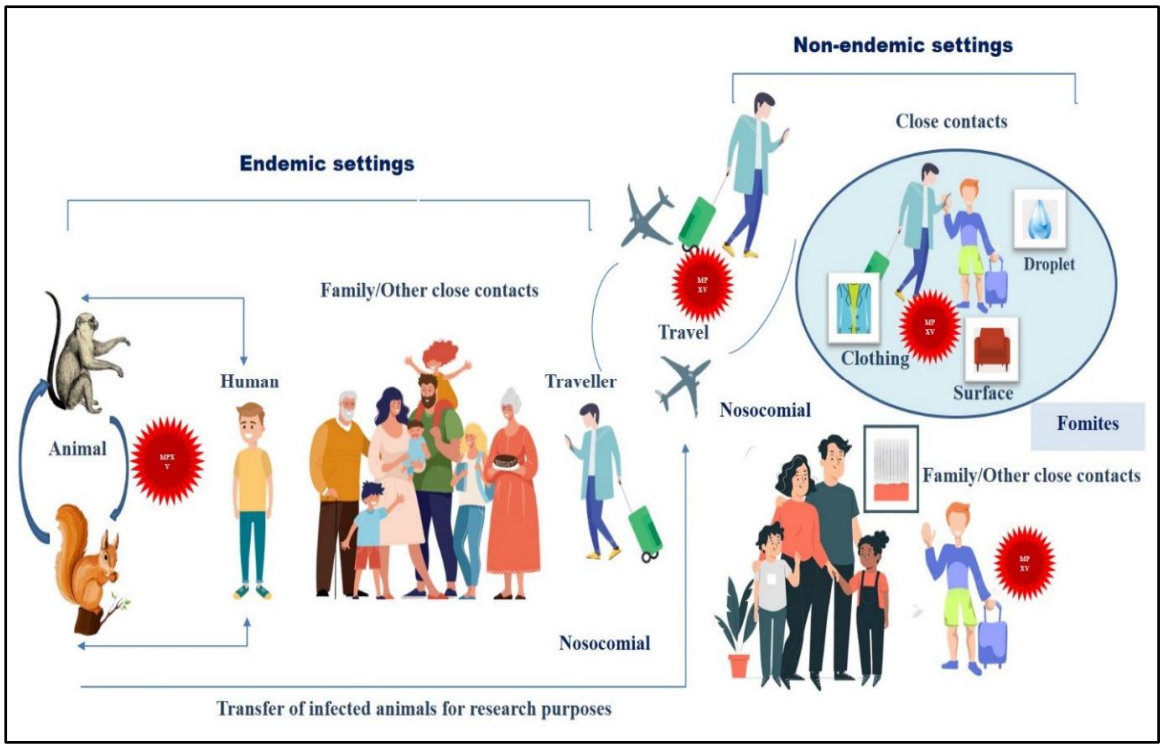

Figure 2. Transmission of MPXV
(adopted from Ranjan *et al.*, 2022)

Pathogenesis

MPXV transmission is similar as that of smallpox virus, that infiltrates the host system. Virus replicates atthe inoculation site, mostly respiratory or pharyngeal mucosa. After replication virus enters into blood stream resulting in primary viraemia (Figure 3). The virus spreads to the local lymph node via monocytic cells and replicates further. Following replication, the virus enters the bloodstream, causing secondary viraemia, and the virus spreads to other organs, such as the skin, lungs, and gastrointestinal tract, where clinical signs and symptoms of the disease manifest (Ranjan *et al.*, 2022).

Clinical Manifestation

The incubation period of the virus is usually from 6 to 13 days. The disease has two phases, first is invasion phase that is characterized by fever, headache, myalgia, weakness and lymphadenopathy, a characteristic feature of monkeypox infection that distinguishes it from chickenpox or smallpox infection. Second one is skin eruption phase, which usually starts within 1-3days of the appearance of fever. The skin lesions are mostly appeared on the face (95%) and extremities like palm and feet. Other than these areas, oral mucous membranes, genitalia and conjunctivae as well as corneais also affected. In the early stages,

the lesion shows central epidermis necrosis and may extend to the superficial layer of dermis in humans. Later on, a necrotic area surrounded by edema and clefts develops in the interstitial space of cells, and cellular debris and fluid are deposited in this space. The rash first appear as macules, sequentially progress towards papules, vesicles and pustules, and then forms crusts which dry up and fall off. It is usually a self-limited disease with the symptoms lasting from 2 to 4 weeks. However, in some cases bronchopneumonia has been reported in humans (Okyay *et al.*, 2022).

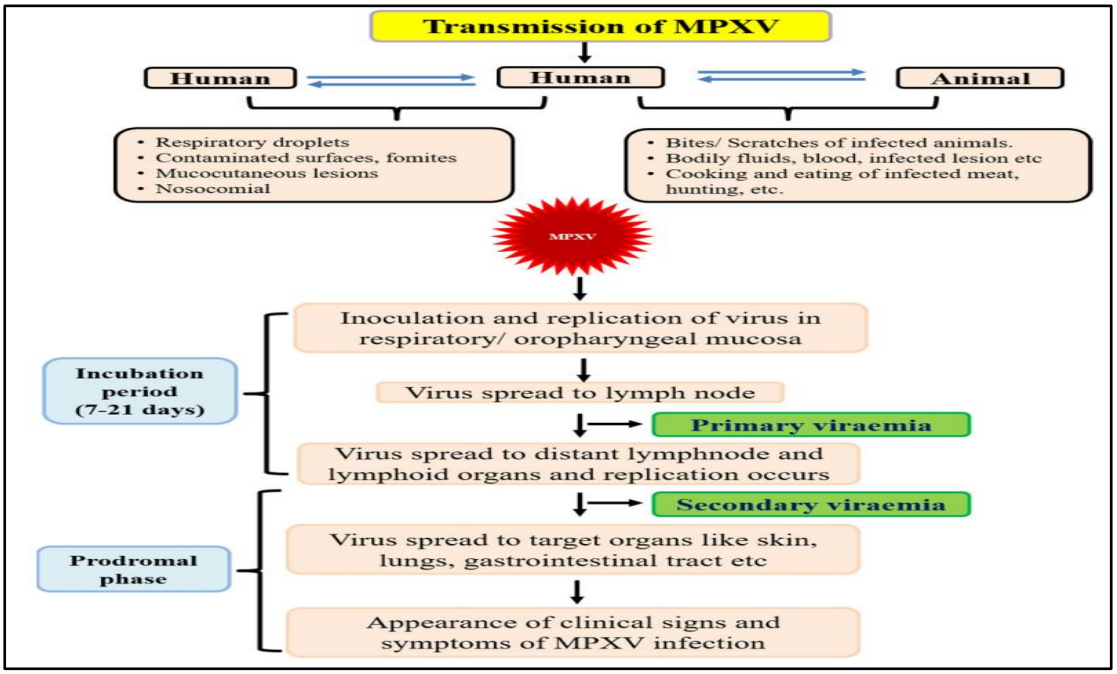

Figure 3.Pathogenesis of MPXV infection
(adopted from Ranjan *et al.*, 2022)

Diagnosis

Diagnosis is done through clinical signs and molecular assays like PCR is the gold standard for laboratory diagnosis. A generic PCR test for *Orthopox* virus is carried, especially from the blister fluid of the vesicular lesions in 97% cases. In addition to that, haemagglutination inhibition assays, electron microscopy, ELISA, Western blotting, or immunohistochemistry are also used for confirmation.

Therapeutics and Prophylactics

Drugs like tecovirimat (TPOXX, ST-246), Cidofovir and Brincidofovir have been used (Choudhary *et al.*, 2022). Tecovirimat was FDA approved for treatment of small pox but can be administered under “Expanded Access Investigational New Drug” (EA-IND) protocol.

Though Cidofovir and Brincidofovir are not FDA approved for monkey pox, but are used for treatment. Vaccination against monkeypox with vaccinia virus (a live attenuated vaccine against the smallpox virus) is about 85 % effective. JYNNEOS™ (also known as Imvamune or Imvanex) is a live vaccine approved by FDA, produced from the strain Modified non-replicating Vaccinia Ankara-Bavarian Nordic (MVA-BN). ACAM2000 also is a live vaccinia virus available under EA-IND for monkey pox.

Conclusion

Every country requires proper preparedness and quick response to handle such outbreaks. The outbreak readiness measureslikevirus isolation facilities, equipment's and reagents for laboratory diagnosis and, dedicated beds, training of group of health care workers as members of rapid response team (RRT) in standard elements of care should be emphasized. Implementation of strict surveillance system, especially for travellers coming from different countries as well as the building of containment zones for the identified suspected cases should also be prioritized. The scientist needs to understand the epidemiology, mutations, or changes that is occurring in virus as well as to focus on the development of vaccines and drugs against the re-emerging virus.

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HYDROGEL – AN UPCOMING STORYLINE OF AGRICULTURE

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Worldly agriculture always requires large amount of water, so it generate a few provocations to restrict water usage. Natural polymers have been used in agriculture because they are high-quality and environment friendly. Based on their structure, natural polymers can be classified into 3 major classes 1) Polyesters, 2) Proteins, 3) Polysaccharides. Derivatives of polysaccharides with combination of other synthetic polymer get together to produce agricultural polysaccharide hydrogel. This hydrogel is basically used in arid and semiarid regions under rainfed condition. Hydrogel is water absorbing and cross linked to absorb aqueous solutions by joining the water molecules. Actually, it's the new proposal of water management under aridity condition to secure the soil water in mobile rooting zone, decreasing the water losses of the crop due to evaporation, percolation and runoff losses. When agricultural hydrogels come in contact with water it swells for some period and it's a water conserving powder which have ability to suck up the large amount of water under plentiful rainfall and water availability period. It's freeing the water to the soil for alleviating crop water requirement under lack of water condition. It has remarkable property like biophysical, hydro-physical and soil physical properties. Contemporary decrease the water supply frequency and increases the water use efficiency, nutrient use efficiency and also gives huge amount of quality produce from the plants, ornamentals and vegetable crops. These granules don't cause any hazards to the environment, plant and soil system.

Water scarcity is seen globally in arid and semiarid climates, and irregular rainfall threatens agricultural sustainability. There is also competition for water in various sectors such as agriculture, industry, and the urban sector. Under moisture stress conditions, various physiological changes have been noted, including decrease in water potential, stomatal closure, decrease in photosynthetic rate, decrease in

morphological rate, and a reduction in decile yield and quality of the plant by restricting overall plant growth. The modern method of water-saving, deficit irrigation technologies is regarded as a crucial element in conditions of restricted water availability to provide favorable soil moisture balance in the root zone with higher water use efficiency without compromising crop yield and quality. At this time, the development of contemporary micro-irrigation technologies, such as low-pressure micro-sprinkler and drip irrigation systems with ideal irrigation scheduling combined with plastic mulching, can solve the problems by drastically reducing the consumption of irrigation water and improving water use efficiency. Recent years have been seen a significant increase in the usage of hydrogel polymer technology in agriculture as a soil conditioner due to its multifunctional capabilities in superior water absorption and water retention. By preventing evaporation loss, deep water percolation, and nutrient leaching in arid and semiarid areas around the world, the polymers maintain a very high water swelling and moisture-releasing capacity under water deficit situations, enhancing plant growth and crop productivity.

Amorphous quasi solid-phase substance hydrogel is often referred to as "root watering crystal," "water retention granules," or "raindrops." With precisely engineered absorbency and biodegradability, it has three-dimensional networks of loosely held cross-linked flexible hydrophilic macromolecules joined by covalent bonds or physical interactions. When in contact with freely available water, these organic polymers have the unusual capacity to absorb a significant amount of moisture in their extremely absorbent structure in a short length of time. When the soil dries up, these materials uniformly release the trapped moisture to the surrounding soil and rhizosphere zones over time. When there is a moisture shortage, having more water available in the soil helps to prevent water stress. Hydrogels is the main component in urban farming for plant growth medium. Hydrogels are used in agriculture for increase water use efficiency, water holding capacity, nutrient mobilizer when it's used. Hydrogel has been applied different type of soil in different dosages. Its ability to absorb water 400 times of their dry weight. it has three dimensional networks interconnected by covalent bonds. These are the polymers which absorb the large amount of water in their super absorbent structure within short period of time when it contacts with freely available water. These materials vanish the stored water to the surrounding soil on rhizosphere zone during the soil drying process uniform manner over a extend period. This type of hydrogels can be classified on several polymeric composition, material origin source, configuration, cross linking type.

Hydrogel

Hydrogel is a soft, fashionable, water loving substance with three-dimensional nature. It has an ability to sup a considerable amount of water or any liquid substance without liquefying its own structure. Hydrogel is quirky and mainly formed from polymers. It can be

classified as natural and artificial. There are some polymers which leads to form hydrogels and these natural hydrogel forming polymers encompasses proteins like collagen and gelatin. Again, they contain polysaccharides like alginate and agarose. Chemical polymerization methods are followed for preparation of artificial hydrogel. Hydro means water and gel is the state of matter which is not fully solid or fully liquid. As hydrogel lies between two different states of matter such as solid and liquid stage it shows some peculiar characters such as drastic volume change with respect to foreign stimuli like temperature, electrical conductivity and pH *etc*. Agricultural hydrogels are mainly synthetically prepared from petroleum products. Main feature of hydrogel is the potential to hold liquid substance such as water and water-soluble nutrients hence can be broadly used in agriculture for mitigating the water stress.

Characteristics of Hydrogel

- It can absorb water 400 times more than its original volume hence it has maximum absorption capacity so called as Super Absorbent Polymer (SAP).
- For a long period of time *i.e.* at least 1 year it can be there in the field without degradation as it has strong stability.
- It acts as a miniature water reservoir in the soil hence provide water to the root zone.
- Hydrogel can be used in saline soils as it is least affected by salty condition.
- It is neutral in pH.
- Hydrogel directly enhances the physical properties of soil such as bulk density, particle density, porosity *etc.*
- It is not too much costly for the beginners.

Role of Hydrogel in Agriculture Sector

- Hydrogel helps in reducing water stress of plant at drought condition.
- Enhances the nutrient use efficiency as well as water use efficiency.
- Plays a vital role in agricultural land conservation.

Advantages of Hydrogel

- As hydrogel is neutral in nature and helps in increasing the physical properties of soil hence seed germination, seedling establishment, root growth, flowering, fruiting of a plant is enhanced.

- Water absorption power of hydrogel is high hence it is used in arid and semiarid as well as in dry spell conditions for diminishing water stress in plants.
- It also releases water and dissolve nutrient in a controlled manner gradually so helps the crop to extract nutrient through out the crop growth period.
- Reduces surface runoff, which leads to decrease in soil as well as water erosion.
- Hydrogel helps in increasing aeration so that enhances microbial activity of that particular region.

Disadvantages of Hydrogel

- Preparation of hydrogel always needs a good mechanical strength but unfortunately somewhat world is lacking this mechanical strength.
- Handling of hydrogel is difficult.
- Mostly synthetic hydrogels are nonbiodegradable in nature hence may be toxic.

Future Prospective of Hydrogel

- Hydrogel can be used for pest management if it will be loaded with different liquid pesticides.
- It can be used for seed coating to shield the seed from pathogens, salinity, acidity, alkalinity and drought *etc.*

Conclusion

Population pressure as well as urbanization is increasing in a rocketing rate in the same manner water usage is also shooting up to meet the demand of population. But as water is incredible for crop-growth we need to save water and we have to adopt the technologies which will enable to produce more production per unit of water use. For fulfilling this dream hydrogel is the premier way.

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ACHIEVING CARBON NEUTRALITY IN THE CONTEXT OF AGRICULTURE: A WAY OF MITIGATING CLIMATE CHANGE

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Achieving carbon neutrality in the agriculture sector is an essential objective for nations worldwide. Particularly through the production of methane and nitrous oxide by animals and the use of synthetic fertilizers, agriculture is a significant contributor to greenhouse gas emissions. Several strategies, including reducing methane emissions from livestock, reducing nitrous oxide emissions from synthetic fertilizers, practising conservation agriculture, promoting the use of renewable energy, and planting trees and other vegetation, can be implemented to achieve carbon neutrality in the agriculture sector. Governments and other stakeholders can also contribute to reaching carbon neutrality in agriculture by establishing carbon taxes, cap-and-trade systems, subsidies for renewable energy and low-carbon farming methods, and regulations and standards. Together, it is possible to minimize the agriculture industry's carbon footprint and contribute to a more sustainable future.

Carbon neutrality, often known as net zero carbon, is the balance between the quantity of carbon dioxide and other greenhouse gases generated into the atmosphere and the amount removed through carbon sinks or offset programmes. In other words, it indicates that there was no overall emission of CO_2 into the atmosphere. The accumulation of greenhouse gases, such as carbon dioxide, in the atmosphere causes climate change by trapping heat and contributing to rising temperatures and other negative environmental effects. Carbon neutrality can be accomplished by engaging in activities like reforestation and carbon sequestration, as well as reducing the amount of carbon that is emitted into the atmosphere and increasing the amount of carbon that is removed from the atmosphere. The objective of

carbon neutrality is to minimize or eliminate the net emission of greenhouse gases into the atmosphere in order to alleviate the adverse effects of climate change. In recent years, the concept of "carbon neutrality" or "net-zero carbon" has attracted increased attention as a means to combat climate change. In the late 1980s, researchers at the University of California, Davis were the first to adopt the term "carbon neutrality" to express the concept of offsetting carbon dioxide emissions with an equal quantity of carbon dioxide removal from the atmosphere. Since then, the term has grown and is now extensively employed in conversations about climate change and measures to cut carbon emissions. The Paris Agreement, which was endorsed by the United Nations Framework Convention on Climate Change in 2015, established the objective of limiting global warming to far below 2 degrees Celsius and pursuing efforts to restrict it to 1.5 degrees Celsius. Many nations and businesses have pledged to reduce their carbon footprint to zero, for achieving this objective.

A large portion of the greenhouse gas emissions that affect our planet come from the agricultural sector, which yet has a vital place in the world economy. Methane production is one of the most significant means through which agriculture emits carbon. Methane is a powerful greenhouse gas. Over a period of one hundred years, the potential for methane to contribute to global warming is twenty-eight times more than that of carbon dioxide. The digestive activities of cows and other ruminant animals, such as sheep and goats, as well as the decomposition of organic materials in landfills and rice fields, both contribute to the emission of this gas into the atmosphere. Nitrous oxide is an additional greenhouse gas created by the use of synthetic fertilizers and animal manure. On a 100-year timescale, its global warming potential is 298 times larger than carbon dioxide's. Methane and nitrous oxide emissions aren't the only ways agriculture adds to global warming; vehicles running on fossil fuels like gasoline and diesel also do their part. Producing synthetic fertilizers and insecticides, as well as transporting them, are both activities that also contribute to carbon emissions. In order to reach carbon neutrality, these emissions will need to be cut down significantly, and any leftover emissions will need to be neutralized through the purchase of carbon credits or participation in other offset schemes.

Achieving carbon neutrality in the agricultural sector is a significant goal that can promote the transition toward a food system that is more sustainable and resilient while also curbing the adverse effects of climate change. Increase in food production with the agriculture must be linked with efforts on reducing greenhouse gas emission and restoring forests (Searchinger *et al.*, 2021). Agro-forestry shall help in improvement of livelihood

opportunity of poor people through economic and environmental security (Basu, 2014). Although there are obstacles that need to be overcome in order to achieve carbon neutrality in agriculture, such as the requirement to measure and verify emissions and ensure that offset programmes are accurate, there is also significant potential to make significant progress in this area through the adoption of sustainable agriculture practises and the development of effective carbon offset projects. Most commonly, sustainable intensification of agricultural production is viewed as a crucial step in this direction (Aubert *et al.*, 2019). Agriculture that is more climate-resilient can improve both food and nutritional security (Ghosh, 2019).

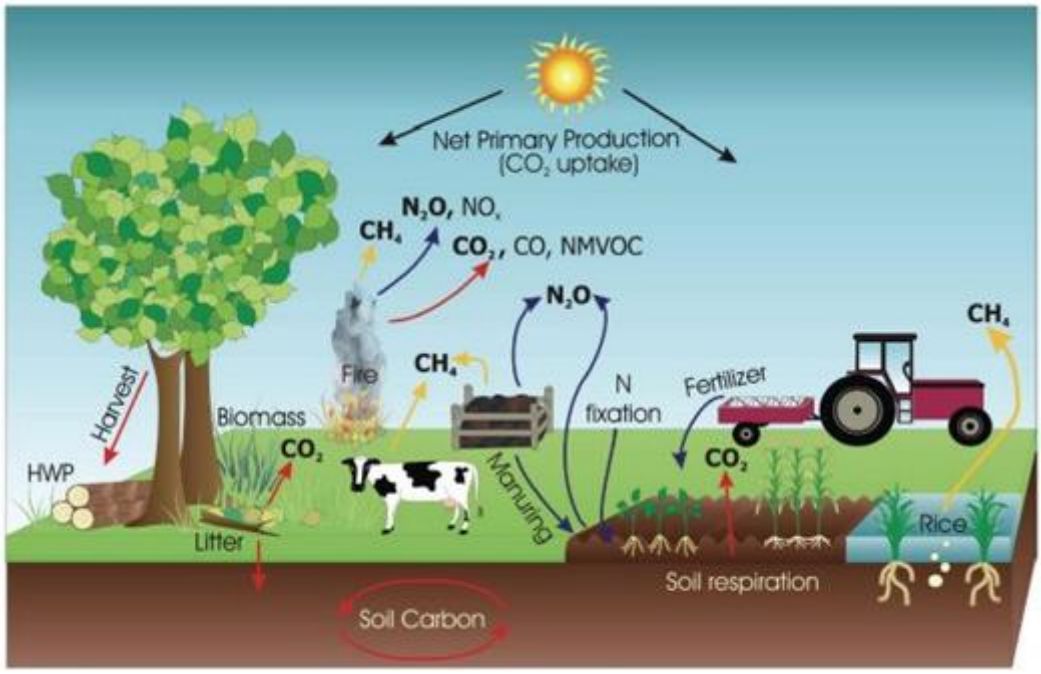

Fig. 1: Carbon emission from agricultural sector; Source: Carbon Neutrality - Farming the Way Out (tracextech.com)

How to Achieve Carbon Neutrality in Agriculture?

A significant goal that can assist to alleviate the negative impacts of climate change and support the transition to a more sustainable and resilient food system is achieving carbon neutrality in the agriculture sector. This can be accomplished by reducing emissions of greenhouse gases. It is possible to achieve carbon neutrality in agriculture through the implementation of a number of different strategies, such as lowering greenhouse gas emissions through the implementation of sustainable agricultural practises and offsetting any remaining emissions through the utilization of carbon credits or other offset programmes. Table 1 provides brief explanations on techniques to achieve carbon neutrality in agriculture.

Table 1: Techniques to achieve carbon neutrality in agriculture

Technique	Description
Reducing methane emissions from livestock	Improving the feed and management of livestock. Methane emissions can be reduced by feeding animals a high-fibre, low-protein diet. Providing animals with enough space and sociability can also minimize methane emissions. Capturing and using methane from manure for energy. Livestock manure contains methane that can be utilized as energy. Anaerobic digestion systems can break down manure's organic materials to produce methane for energy or heat. Approaches to limit methane emission can greatly reduce the agricultural carbon footprint (Sah & Devakumar, 2018).
Reducing nitrous oxide emissions from synthetic fertilizers	Improving soil health to decrease synthetic fertilizers and nitrous oxide emissions. This can be accomplished via techniques like as cover cropping, composting, and mulching, which enhance the soil's structure and fertility. Using more efficient fertilizers: Slow-release synthetic fertilizers lessen nitrous oxide emissions. Using fertilizers suited to soil and plant nutrient needs can also reduce fertilizer use and nitrous oxide emissions. Use of alternative sources of nutrients such as compost and animal manure. These fertilizer sources can improve soil health, provide plants with nutrients, and reduce nitrous oxide emissions.
Conservation agriculture	Practices such as no-till farming and cover cropping that help to improve soil health and reduce carbon dioxide emissions. Water conservation and pest/weed management will help achieve carbon neutrality.
Renewable energy	Providing electricity to irrigation pumps and other machinery through the utilization of renewable energy sources such as solar and wind power.
Planting trees and other	Detoxifying the air by using photosynthesis to remove carbon

vegetation	dioxide.
Carbon sequestration	Carbon sequestration strategies, which include reforestation and afforestation, help plants take up and store carbon dioxide.
Carbon capture and storage	Keeping carbon dioxide from being released into the environment by capturing and storing emissions from agricultural sources underground.
Carbon pricing	Carbon pricing aims to reduce greenhouse gas emissions by pricing carbon dioxide emissions. By pricing carbon, emitting greenhouse gases will become more expensive, creating an economic incentive to limit emissions.
Carbon offsetting	Offsetting carbon emissions by reducing or eliminating an equal amount of carbon dioxide from the atmosphere.

Examples of Carbon Neutral Agriculture Initiatives across the Globe

Several organizations and programmes strive to create carbon neutrality in the agriculture industry. These efforts have the potential to offer other nations and organizations who are interested in reaching carbon neutrality in agriculture significant examples and lessons.

The Carbon Neutral Farms programme in New Zealand, launched in 2015 by the Ministry of Primary Industries and the Ministry of the Environment, is one example. Farmers in New Zealand are offered assistance through this initiative, which is supported by the government of New Zealand. The programme encourages farmers and ranchers to embrace sustainable agricultural techniques and build carbon offset projects. The initiative provides a certification mechanism for farmers who may verify that their businesses have achieved carbon neutrality. Another example is the Natural Resources Conservation Service's administration of the Carbon Farm Plan in the United States (NRCS). Farmers who are interested in implementing sustainable agriculture techniques and constructing carbon offset projects on their operations receive technical and financial assistance through this programme. The programme emphasizes a variety of measures, including conservation agriculture, precision farming, and manure management, in addition to carbon offset programmes such as reforestation and afforestation, methane capture and destruction, and renewable energy projects. A third example is the Carbon Neutrality Coalition in Europe, an effort of the European Commission that intends to facilitate the transition to a carbon-neutral

economy in Europe. The coalition is interested in many different areas, such as agriculture, and wants to speed up the use of clean technologies and the creation of carbon offset projects. It is backed by a network of partners, which includes governments, businesses, and research institutions. It gives farmers money, technical help, and other support to help them switch to sustainable farming practises and start carbon-offsetting projects. These initiatives and programs provide valuable examples of how carbon neutrality can be achieved in the agriculture sector through the adoption of sustainable agriculture practices and the development of carbon offset projects

Initiatives to Bring Carbon Neutrality in Agriculture in India

India is a prominent player in the global agriculture industry and is also promoting carbon neutrality in this area. Agricultural development in India is good for mitigation of carbon in the long run (Zafar *et al.*, 2022). Numerous initiatives and activities in India are geared toward achieving carbon neutrality in agriculture, including the following:

The National Action Plan on Climate Change: This plan, which was established by the Government of India in 2008, lays out a variety of policies and activities for tackling climate change, including those that pertain to the agricultural industry. As part of the strategy, there will be an emphasis placed on environmentally friendly agricultural methods including precision farming and conservation agriculture, and there will also be help provided for the creation of carbon offsetting enterprises.

The National Mission on Sustainable Agriculture: This mission, which was initiated by the Government of India in 2010, is geared toward the reduction of greenhouse gas emissions from the agricultural sector as well as the promotion of sustainable agricultural practises within India. The objective encompasses a wide range of operations, including the development of carbon offset projects, training programmes for farmers and extension services, research and development, and more.

The National Initiative on Climate Resilient Agriculture: This programme, which was started by the government of India in 2011, is geared on assisting farmers in adjusting to the effects of climate change as well as lowering the amount of greenhouse gas emissions they produce. The strategy encompasses a variety of activities, including training programmes, extension services, and the creation of carbon offset projects.

The National Adaptation Fund for Climate Change: The Government of India established this fund in 2015 to provide financial and technical support to state and municipal governments for the development and implementation of adaptation projects, especially those in the agriculture sector. The fund supports a variety of initiatives, including the development of drought-resistant crops and the implementation of sustainable agricultural techniques.

These initiatives and activities illustrate the Government of India's dedication to fostering carbon neutrality in the agriculture sector and facilitating the transition to a more sustainable and resilient food system and greenhouse gas emission from agriculture can be reduced significantly in the country with adoption of various mitigation practices (Sapkota *et al.*, 2019).

Challenges to Achieving Carbon Neutrality in Agriculture

Achieving carbon neutrality in the agriculture sector is a crucial objective that can help alleviate the negative effects of climate change and facilitate the transition to a more sustainable and resilient food system. However, in order to attain carbon neutrality in agriculture, a number of obstacles must be surmounted. Some of the primary obstacles include:

Measuring and verifying greenhouse gas emissions and reductions: Due to the complexity of the agriculture industry as well as the diversity of the sources of greenhouse gas emissions, it can be difficult to accurately measure and verify both the sector's greenhouse gas emissions and the reductions in those emissions. Developing reliable and precise methods for monitoring emissions and reductions is a crucial step toward attaining carbon neutrality, since it enables farmers to track their progress and verify that their actions are having an effect.

Ensuring that offset programs accurately reflect emissions reductions: Carbon offset programmes, which enable companies to offset their emissions by funding initiatives that reduce or remove greenhouse gases from the atmosphere, can be a valuable tool for reaching carbon neutrality in agriculture. To provide a trustworthy and transparent method of offsetting remaining emissions, it is essential, however, that these programmes accurately and effectively reflect emissions reductions.

Providing support and incentives to farmers and ranchers to adopt sustainable agriculture practices: Adopting sustainable agriculture methods can contribute to the

reduction of greenhouse gas emissions and facilitate the transition to a more sustainable and resilient food system. However, it can be difficult to give farmers with the required support and incentives to implement these methods, particularly in underdeveloped nations where resources and capability may be limited. Providing support and incentives, such as training, technical assistance, and financial aid, can be an effective method to encourage farmers and ranchers to adopt sustainable agricultural practises and reach carbon neutrality.

In spite of the difficulties involved, reaching the aim of carbon neutrality in the agricultural industry is a significant objective that can contribute to the reduction of the harmful effects of climate change and support the transition to a food system that is more sustainable and resilient.

Conclusion

In conclusion, carbon neutrality in the agriculture sector is an important objective that can mitigate the negative effects of climate change and facilitate the transition to a more sustainable and resilient food system. Carbon neutrality in agriculture necessitates a combination of techniques, including the reduction of greenhouse gas emissions through sustainable agriculture practises and the offsetting of remaining emissions through carbon credits or other offset schemes. There are a number of initiatives and programs that are working to promote carbon neutrality in the agriculture sector, in both developed and developing countries. These initiatives provide valuable examples of how carbon neutrality can be achieved in the agriculture sector and can serve as models for other countries and organizations.

However, achieving carbon neutrality in agriculture involves obstacles, such as the requirement to quantify and verify greenhouse gas emissions and reductions, ensure the accuracy of offset programmes, and provide assistance and incentives for farmers to adopt sustainable agriculture methods. To address these difficulties, governments, industry, and other stakeholders will need to do continuing research and development and collaborate.

Significant potential exists for carbon neutrality in the agriculture sector, and reducing emissions from this sector will be an integral aspect of global efforts to combat climate change. By supporting sustainable agriculture practises and implementing efficient carbon offset programmes, we can support the transition to a more sustainable and resilient food system and reduce greenhouse gas emissions.

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CARBON BUDGETING IN FORAGE CROP PRODUCTION: AN OVERVIEW

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Carbon budgeting is a crucial tool for addressing one of the most pressing challenges of our time: climate change. At its most basic, carbon budgeting involves measuring and managing the carbon emissions and sequestration associated with a particular activity or system (Lahn, 2020). In the context of agriculture, carbon budgeting involves quantifying the greenhouse gases (GHGs) produced and absorbed through various farming practices and determining ways to optimize the balance between these emissions and sequestrations (Smith *et al.*, 2020).

The importance of carbon budgeting in agriculture cannot be overstated. Agriculture is a major contributor to GHG emissions, accounting for approximately 10-14% of global GHG emissions (Shakoor *et al.*, 2021). This includes emissions from enteric fermentation in livestock, manure management, synthetic fertilizer application, and energy use on farms. At the same time, agriculture also has the potential to sequester carbon through practices such as cover cropping, reduced tillage, and the use of perennial crops (Bell et al., 2020; Gonzalez-Sanchez et al., 2019; Tiefenbacher *et al.*, 2021). By implementing carbon budgeting practices, farmers and ranchers can not only reduce their own GHG emissions but also play a critical role in mitigating climate change at a global scale.

Forage crops, which include grasses and legumes used for livestock feed, are an important component of carbon budgeting in agriculture. These crops are known to sequester carbon in the soil through their root systems and can also reduce GHG emissions through their ability to replace fossil fuel-intensive feed sources. However, carbon sequestration and emissions in forage crop production and utilization can be affected by a variety of factors,

including soil type and quality, fertilization and nutrient management, irrigation and water management, and grazing management (Madigan et al., 2022; Tessema et al., 2020). By understanding and optimizing these factors, it is possible to maximize the carbon sequestration potential of forage crops and reduce their carbon footprint.

Carbon Emissions in Forage Crop Production

Sources of carbon emissions in forage crop production

One of the main sources of carbon emissions in forage crop production is the use of synthetic fertilizers (Menegat *et al.*, 2022). Synthetic fertilizers are made from fossil fuels, and their production and transportation contribute to GHG emissions (Walling & Vaneeckhaute, 2020). In addition, the application of synthetic fertilizers can lead to the release of nitrous oxide, a potent GHG, through the process of nitrification (Schils *et al.*, 2013). Nitrous oxide is approximately 300 times more potent than carbon dioxide as a GHG, and agriculture is a major source of nitrous oxide emissions globally.

Another source of carbon emissions in forage crop production is the use of fossil fuels for machinery and irrigation (McCarthy *et al.*, 2020). For example, tractors and other farm equipment require fuel to operate, and irrigation pumps and other machinery may also use electricity generated from fossil fuels. The transportation of forage crops and livestock can also contribute to GHG emissions, depending on the distance and mode of transportation.

Strategies for reducing carbon emissions in forage crop production

There are several strategies that farmers and ranchers can adopt to reduce carbon emissions in forage crop production. One approach is to use precision agriculture techniques, such as GPS-guided machinery and variable rate technology, to optimize fertilizer application and reduce the number of synthetic fertilizers used (Balafoutis *et al.*, 2017). Cover cropping, which involves planting a cover crop between forage crop rotations, can also help to reduce GHG emissions by improving soil health and reducing erosion (Abdalla *et al.*, 2014). Cover crops can increase soil organic matter and enhance the soil's ability to sequester carbon.

Other strategies for reducing carbon emissions in forage crop production include using low-carbon or renewable energy sources for irrigation and farm machinery, and adopting conservation tillage practices to reduce the use of fossil fuels and the release of GHGs from the soil (Kumara *et al.*, 2020). Another option is to plant forage crops that are

more efficient at sequestering carbon, such as grasses and legumes (Boddey *et al*., 2020), and to implement grazing management practices that promote the health and productivity of these crops (Dowhower *et al*., 2020; Franzluebbers, 2020; Wang *et al.*, 2020).

Finally, farmers and ranchers can also consider participating in carbon offset programs, which allow them to offset their GHG emissions by funding projects that reduce or remove GHGs from the atmosphere (Paustian *et al.*, 2019). Carbon offset programs may be voluntary or mandatory, depending on the jurisdiction, and they can provide a financial incentive for farmers and ranchers to adopt carbon-friendly practices (Kesternich *et al.*, 2019).

Carbon Sequestration in Forage Crops

The role of forage crops in sequestering carbon

Forage crops, which include grasses and legumes used for pasture and hay, can play a significant role in sequestering carbon from the atmosphere. Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide (CO2) in long-term sinks, such as soil and vegetation. When forage crops photosynthesize, they absorb CO2 from the atmosphere and convert it into plant biomass, which can be stored in the form of roots, stems, and leaves. Over time, as the plant material decomposes, the carbon is released back into the atmosphere. However, if the plant material is managed properly, some of the carbon can be sequestered in the soil, where it can be stored for longer periods of time.

Factors that influence the carbon sequestration potential of forage crops

There are several factors that influence the carbon sequestration potential of forage crops. One important factor is the type of forage crop being grown. Grasses and legumes are generally more efficient at sequestering carbon than other types of forage crops, due to their deep root systems and ability to fix nitrogen from the atmosphere (He *et al.*, 2021). Legumes, in particular, are able to form symbiotic relationships with nitrogen-fixing bacteria, which allows them to convert atmospheric nitrogen into a form that can be used by the plant. This process, known as nitrogen fixation, not only helps to enrich the soil but also sequesters atmospheric carbon in the process.

In addition to the type of forage crop, management practices can also play a role in the carbon sequestration potential of forage systems. For example, grazing management

practices that promote the health and productivity of forage crops can increase the amount of carbon sequestered in the soil. Practices such as rotational grazing, which involves moving livestock to different pasture areas on a regular basis, can help to prevent overgrazing and maintain the integrity of the forage plant root systems. This can enhance the carbon sequestration potential of the forage system, as well as improve the overall health and productivity of the pasture. Other management practices that can promote carbon sequestration in forage systems include reducing tillage, adding organic matter to the soil, and using cover crops.

Utilization of Forage Crops for Carbon Offset Credits

Overview of carbon offset markets

Carbon offset credits are a way for individuals and businesses to offset their GHG emissions by funding projects that reduce or remove GHGs from the atmosphere. Carbon offset programs can be voluntary or mandatory, depending on the jurisdiction, and they can provide a financial incentive for farmers and ranchers to adopt carbon-friendly practices (Van Wyngaarden, 2022). In the context of forage crop production, farmers and ranchers may be able to generate carbon offset credits by sequestering carbon in their forage systems and selling the credits on the carbon offset market.

Requirements for forage crops to qualify for carbon offset credits

To qualify for carbon offset credits, forage crop producers must be able to demonstrate that their practices are sequestering carbon in a measurable and verifiable way. This typically involves developing a carbon budget for the farm or ranch, which quantifies the number of GHGs emitted and sequestered by the operation. The carbon budget must be based on sound scientific principles and must be independently verified to ensure the accuracy and reliability of the data.

There are several types of carbon offset programs that forage crop producers may be able to participate in, depending on their location and the specific requirements of the program. One example is the Clean Development Mechanism (CDM), which is a program established under the United Nations Framework Convention on Climate Change (UNFCCC) (Subbarao & Lloyd, 2011). The CDM allows developed countries to offset their GHG emissions by funding projects that reduce GHGs in developing countries. Forage crop

producers in developing countries may be able to participate in the CDM by demonstrating that their practices are sequestering carbon in a measurable and verifiable way.

Another example of a carbon offset program is the Carbon Farming Initiative (CFI), which is a voluntary program established by the Australian government. The CFI allows farmers and ranchers in Australia to generate carbon offset credits by adopting carbon-friendly practices, such as planting trees, improving pasture management, and reducing GHG emissions from livestock. Forage crop producers may be able to participate in the CFI by demonstrating that their practices are sequestering carbon in a measurable and verifiable way (Kragt *et al.*, 2017).

Case studies of forage crop producers participating in carbon offset markets

There are several case studies of forage crop producers who have successfully participated in carbon offset markets and generated carbon offset credits. One example is a ranch in California, USA, which implemented a variety of carbon-friendly practices, including precision irrigation, cover cropping, and rotational grazing. By adopting these practices, the ranch was able to reduce its GHG emissions and sequester additional carbon in the soil. As a result, the ranch was able to generate over 200,000 carbon offset credits, which it sold on the carbon offset market (Niles *et al.*, 2002).

Another example is a dairy farm in New Zealand, which implemented a variety of carbon-friendly practices, including reducing its GHG emissions from livestock, improving pasture management, and planting trees. By adopting these practices, the dairy farm was able to reduce its GHG emissions and sequester additional carbon in the soil and vegetation. As a result, the dairy farm was able to generate over 100,000 carbon offset credits, which it sold on the carbon offset market (Beukes *et al.*, 2010).

There are many other examples of forage crop producers who have successfully participated in carbon offset markets and generated carbon offset credits. By adopting carbon-friendly practices and participating in carbon offset programs, forage crop producers can not only reduce their environmental footprint, but also potentially benefit from financial incentives and other benefits.

Challenges and Considerations in Carbon Budgeting For Forage Crop Production

Challenges in measuring and verifying carbon emissions and sequestration in forage crop systems

There are several challenges and considerations that farmers and ranchers should be aware of when it comes to carbon budgeting for forage crop production. One challenge is the difficulty of measuring and verifying carbon emissions and sequestration in forage systems. While there are well-established methods for measuring GHG emissions from livestock and fertilizer use, it can be more challenging to quantify the carbon sequestration potential of forage systems. This is because the carbon sequestration potential of forage systems depends on a variety of factors, including the type of forage crops being grown, the management practices being used, and the soil and climatic conditions. In addition, carbon sequestration can be affected by other GHG emissions, such as methane emissions from livestock.

Another challenge is the cost and time required to develop a carbon budget and participate in carbon offset programs. Carbon budgeting can be a complex and time-consuming process, and it requires specialized knowledge and expertise. In addition, participating in carbon offset programs may require additional resources and infrastructure, such as monitoring and reporting systems, and may incur additional costs.

Economic considerations of carbon budgeting in forage crop production

In addition to the logistical challenges of carbon budgeting, there are also economic considerations that farmers and ranchers should be aware of. For example, adopting carbon-friendly practices may involve upfront costs, such as the purchase of new equipment or the implementation of new management practices. In some cases, these costs may be offset by the financial benefits of carbon offset credits and other financial incentives, such as grants and subsidies. However, it is important for farmers and ranchers to carefully consider the economic implications of carbon budgeting, and to ensure that the benefits outweigh the costs.

Another economic consideration is the potential risk of carbon offset prices fluctuating. Carbon offset prices can vary significantly depending on supply and demand, and there is no guarantee that carbon offset credits will retain their value over time. This can be a concern for farmers and ranchers who are relying on carbon offset credits as a source of income. It is important for farmers and ranchers to carefully evaluate the risks and rewards of

participating in carbon offset programs, and to consider the long-term economic viability of their operations.

Conclusion and Future Outlook

In conclusion, carbon budgeting is an important tool for mitigating the environmental impacts of agriculture and promoting more sustainable farming practices. By quantifying and managing the carbon emissions and sequestration associated with their operations, farmers and ranchers can reduce their environmental footprint and potentially benefit from carbon offset credits and other financial incentives. However, there are challenges and considerations that farmers and ranchers should be aware of when it comes to carbon budgeting for forage crop production, including the difficulty of measuring and verifying carbon emissions and sequestration, the cost and time required to participate in carbon offset programs, and the potential economic risks and rewards.

As concerns about climate change continue to grow, there is likely to be increasing demand for carbon offset credits and other mechanisms for reducing GHG emissions. This presents an opportunity for farmers and ranchers to adopt carbon-friendly practices and generate carbon offset credits by sequestering carbon in their forage systems. However, it is important for farmers and ranchers to carefully evaluate the feasibility and sustainability of participating in carbon offset programs, and to consider the long-term economic viability of their operations.

There is also likely to be ongoing research and development in the area of carbon budgeting for forage crop production, with a focus on developing more accurate and reliable methods for measuring and verifying carbon emissions and sequestration. This could help to improve the accuracy of carbon budgets and increase the credibility of carbon offset programs. In addition, there may be additional policy and regulatory developments related to carbon budgeting in the agriculture sector, as governments and other stakeholders seek to address the environmental impacts of agriculture and promote more sustainable farming practices.

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PRIVATIZATION OF AGRICULTURE EXTENSION

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In developing countries achieving progress in agriculture from subsistence farming to more commercialized and specialized farming demands a technically sound and client accountable extension service. In most of the developing countries, the performance of the public extension system is not up to expectation and is generally disappointing moreover in the recent past . public extension system around the world is witnessing a severe finance crisis, the ideology of globilizarion and liberalization has thrown many challenges and opportunities to developing countries, particularly in the agriculture sector to meet the challenges of the global free market economy this situation demands structural and functional adjustments in the extension system. In this existing climate privatization of the agricultural extension service might be an inviting proposition in the years to come many developing countries around the world are likely to try experimentation or implementation of privatization.

Concept

Privatization of agriculture extension service may be defined as the services rendered in the area of agriculture and allied sectors by extension personal working in private agencies or organization for which farmers are expected to pay a free and it can be viewed as supplementary and complimentary to public extension services

These Concepts about the Privatization

1. It involves extension personnel from private agency/ organization
2. Clients are expected to pay the service fee.
3. Act as supplementary or alternative to public extension service

Privatization Agriculture Extension Because of the Following Reasons

1. Decline trend in government expenditure in public extension due to heavy rainfall burden.
2. Perception of public extension service as less effective in meeting the current needs of the. farmers .
3. A shift in agriculture from subsistence level to commercialized agribusiness.
4. To meet the challenges of globalization and liberalization of the farm sector.
5. And demand of the farmers for specialized knowledge, information and assistance.

Characteristics of Private Extension System

Objectives- Private extension system mainly concern with maximum possible profit to the clients through advisory services.

Target group – Private extension mostly concentrates on big farmers

Clients – In private extension system clients are more committed and careful about extension services because they are paying for the services.

Offerings – Profit-oriented services include not only technology transfer but also supply of critical inputs.

Technologies – Private extension agencies transfer the locations specific and demand- driven technologies, technologies are specialized and costly

Organizations – Private extension personnel becomes more accountable to clients and highly motivated because they are getting remuneration from their clients.

Funding – Private extension services gets funds from farmers contribution and developments agencies.

Extension services – Advisory nature of service extension becomes purchased input and it generates new income to farmers.

Methods – Private consultancy mostly adopt contact methods as group approach will reduce their chance of getting consultancy fee.

Strategies for Privatization Extension

- **Commercialization of extension service** – complex demand- driven technologies in the public extension system should be provided for particular cost.
- **Introducing contract extension system** – public extension system can make contract with registered private agriculture consultancy agencies to transfer the agriculture technology.
- **Introducing sharecropping system** – private and public extension agents are provided with remuneration in the form of share crop, it will increase the extension personals accountability and commitment to the service
- **Giving partnership rights and more responsibility to private sector and NGOs** – private sector and NGOs are entering in a big way in recent years to provide agriculture consultancy. They may be given more responsibility in agriculture technology transfer.
- **Gradual withdrawal of public extension system** – gradual withdrawal can be done in two ways area- wise or commodity wise; extension service responsibility in areas having favorable environment like high soil fertility, high irrigation potential, satisfactory infrastructure facilities, commercial farming and commodities which provide high profit to farmers, can be given to the private sector.
- **Creating and strengthening farmers' groups and cooperatives** – through farmers group and cooperatives, extension agents are appointed and the members will share the cost for this purpose, existing village cooperatives, clubs, mahila mandals and water managements committees are used. private organizations such as agricultural consultancy, commercial firms, agro- based industries, input agencies organization etc. will enter the area of extension service.

Conclusion

The work of agricultural extension gives the farmers the right information related to farming, new information and methods of modern farming, but the government agencies of the government are proving to be inactive in doing this. Farmers get the right information at the right time which will increase their production; all these things can be done easily after the privatization of the extension, how to apply it along with the transfer of private agencies technology under agriculture privatization. Government agencies also give information, there

is a huge shortage of resources, infrastructure etc. in sufficient quantity, that is why private agencies work to give correct information to the farmers by taking a fair price from them.

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CO-OPERATIVE MOVEMENT IN INDIA

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In India has been acclaimed as an agency for economic and social development and an important sector of national economy. It is a unique feature of the Indian Co-operative Movement that, besides being a voluntary democratic people's movement, it enjoys the active partnership of the state in terms of policy, financial and management support. Through the co-operative system, it is our aim to take democracy to the people and facilitate social justice. We look at co-operation as an effective instrument by the people involved in these areas, and as a countervailing force against the exploitative propensities that develop in the economy. Protecting and promoting the interest of the weaker section through co-operatives is one of our basic aims.

Co-operative Movements

Introduced as an agency for providing relief from the exploitation of the money lander to the agriculturists in the country, co-operation in India has emerged as an economic force providing variety of services to the masses undertaking agriculture and industrial production. Our Co-operative Movement has emerged as one of the largest in the world. Its contribution to economic growth is evident from the fact that about 55% of institutional credit, 45% of fertilizer distribution and 60% of sugar production is accounted for by co-operatives. The working capital of co-operatives which was a mere Rs 276 crores in 1950-51 increased to Rs 35,000 crores in 1984-85. During this period, agricultural credit provided by co-operatives increased from Rs 23.38 crores to Rs 3250 crores; marketing of agricultural produce from Rs 47 crores to over Rs 3,000 crores. Co-operatives have indeed helped the economic growth of the agricultural sector in our country in a very significant manner.

I find that an overwhelming majority of the delegates present here are basically farmers. Through them, I would like to compliment the farming community for achieving record foodgrains production in the country. Co-operatives have greatly helped in this achievement. Nearly two-thirds of co-operatives in the country are in rural areas and support agricultural and allied activities like dairying, fishery etc. Co-operatives constitute the principal institutional framework for the provision of farm credit and other inputs like fertilizers, seeds, implements, pesticides, etc, An important element in our agricultural strategy for increasing production and productivity is to provide remunerative prices to farmers. In the implementation of the schemes relating to price support and market intervention, co-operatives have been assigned the role of a nodal agency in respect of commodities like oilseeds, coarse grains, potatoes and onions. The protection to growers provided through co-operatives in the situation of gluts in the market and fall in prices during the recent time has been commendable.

In developing economic programmers in rural areas through co-operatives, the National Co-operative Development Corporation has been playing a significant role as a promotional, financial and consultative agency in the co-operative sector. Up to March, 1985, NCDC has provided a total financial assistance of Rs. 844.21 crores in economic development programmes through co-operatives. Co-operative agro-processing industries in the field of fertilizer production, dairying, oilseeds processing, sugar and spinning have attained excellence and have acted as pace-setters for rural industrialization in the country.

Co-operation is recognized as a shield for the poor. Support to weaker sections and tribal population, thus, constitute the sheet anchor of co-operative development efforts. Through measures relating to concessional rate of interest, liberal pattern of assistance and specialized technical and managerial assistance, co-operatives of such people are being encouraged as a matter of policy. They are making significant contribution to their economic and social upliftment.

Equity and justice in the provision of services and sharing of surplus are the guiding principles in co-operatives. Membership in co-operatives is open to all those who can use its services without any social, political, racial or religious discrimination. Observance of these tenets and their guiding principles promote national integration. In the course of the working of the movement for over eight decades, hardly any incident, which has resulted in promoting devisive forces, threatened unity and integrity of the nation and shaken the base of equity and

universality of the people has come to light. This is a great redeeming feature for which I would like to express our gratitude to the ingenuity of the co-operators.

For the healthy and balanced growth of a unified co-operative movement in the country, we have to be conscious of the prevailing weaknesses in the movement and strive for removing the same at the earliest. The weaknesses which are upper-most in my mind, relate to regional disparity, growing apathy of members, management deficiencies, inadequate technology orientation, the politicization of co-operatives and want of democratic content. These pose a threat and challenge to the management and leadership in movement. We would welcome suggestion regarding corrective measures which should receive the attention of both the movement and the Government.

The objectives, plans and programmes of co-operative development have been adequately reflected in the Seventh Five-Year Plan. The Plan, however, should not be taken as that of the Government alone. It is a plan for the co-operatives and the movement is responsible partner in the whole concept, thinking and operation. While we should be happy on our achievements, there should be on room for complacency. The nation, under the dynamic leadership or our youthful Prime Minister, Shri Rajiv Gandhi, is poised to enter the next century with determination and optimism. Co-operation, as a people's socio-economic and democratic movement, would have to expand and diversify its economic activates to raise the level of productivity, employment and income, provide better service to masses at economic cost, modernize the management of co-operative enterprises, and make its policies and programmers forward-looking.

Conclusion

In its deliberation, I have no doubt that this Co-operative Congress would give a comprehensive thought to the present status of the Indian Co-operative Movement and the challenges of the 21st century, and evolve guidelines on immediate as well as long-term objectives and strategies as enunciated in the Seventh Five-Year Plan. As I visualize, our immediate goal should be: (i) reaching every farmer through co-operative agricultural credit, marketing and processing programmers; (ii) enabling the co-operative sector to emerge as the major agency in the service of the common man; and (iii) intensifying human resource development efforts particularly relating to orienting every youth in co-operation.

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SCIENTIFIC BREEDING MANAGEMENT OF DAIRY ANIMAL vis-à-vis ARTIFICIAL INSEMINATION FOR COMMERCIAL DAIRY FARMING

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By rearing dairy animals, farmers not only generate enough income to sustain their farm operations profitably, but dairy farming also ensures efficient input management in the whole farming system. The bi-product of crop farming can act as inputs in dairy farming, on the other side, the bi-product of dairy farming like cow dung, and urine act as essential inputs for crop farming in the form of manure. Increased milk production from dairy breeds would be realized if appropriate genotypes are used alongside optimum management and other husbandry practices (Murage & Ilatsia, 2011). Excessive rainfall, drought, or other climatic aberrations affect negatively the agricultural farming system as a whole and the crop farming system in particular. Dairy farming acts as a cushion to compensate for the losses due to extreme weather events. Dairy cattle farming are in constant development worldwide to improve dairy production and welfare which is done through the advanced management strategies that permitted the introduction of many technologies in cattle breeding (Meskini *et al.*, 2021). For successful and economically sustainable dairy farming, breeding management of dairy animals is a very important aspect. Poor conception rates in highly productive lactating cattle are especially prevalent in large, intensively-managed commercial herds (Larson *et al.*, 2007) . Artificial insemination (AI) has remained the main vehicle for the rapid dispersal of valuable genes and it has been the method of choice for dairy farmers around the world to improve the genetic quality of their stock (Vishwanath, 2003). The selection of proper breeds and management of reproduction is of utmost importance for dairy farming.

Different Breeds of Cattle

Different breeds of cattle are reared in different agro-climatic regions of the country. Broadly, cattle breeds can be classified into two categories; Indigenous breeds and exotic

breeds. The indigenous breeds are also reared for different reasons; they are described in the following points:

A. Breeds reared for milk: These types of indigenous breeds are reared specially for milk production purposes. Some examples of this type of breed are Sindhi, Sahiwal, Gir, Tharparkar, etc.

B. Breeds reared for draught purpose: These types of cattle are reared for mainly draught purposes. Their service is utilized in tilling the land or pulling weights. Milk production from these breeds is very low. Some examples of this type of cattle breed are Amritmahal, Nagouri, Hallikar, Malvi, Khillari, Dangi, etc.

C. Dual purpose breeds: These types of cattle breeds are reared for both milk production and draught purpose. Milk production from these breeds is satisfactory, as well as the male animals are capable of drawing weights. Some important breeds of this category are Hariana, Ongole, Tharparkar, Krishnavalley, Rathi, etc.

Some examples of good quality exotic breeds which are reared in India for milk purposes are Brown Swiss, Jersey, Holstein Friesian, etc. Apart from pure breeds crossbred of these cattle breeds with local breeds are preferred due to their high milk yield potentiality and more adaptability in Indian conditions than the pure exotic breeds.

Artificial Insemination (A.I.) of Dairy Animals

Artificial Insemination or A.I. is the procedure through which semen from male animals is collected and deposited in the female reproductive tract at the right time. Through this method, rearing of male cattle is not required, which substantially reduces the cost of dairy farming. Crossbreeding can lead to a combination of favorable characteristics from the breeds involved, based on breed-additive genetic effects (Freyer *et al.*, 2008). Moreover, the chances of disease contamination (which is more in natural service) can be reduced significantly. A.I. is generally performed by qualified veterinary doctors or trained animal husbandry technical manpower.

Advantages of Artificial Insemination in Dairy Animals

There are several benefits or advantages of scientific animal husbandry, which are enlisted as follows:

- Female dairy animals can be inseminated by good quality semen from cattle
- There is no need to rear male animals to inseminate female animals which substantially reduces the cost of dairy farming
- Several reproductive diseases can be controlled through Artificial Insemination
- Through Artificial Insemination, female animals can be inseminated in the remotest part of the country with high-quality bull semen
- Artificial Insemination helps in maintaining proper records of a dairy farm and reduces the cost of farming operations, thereby increasing the operating profit margins
- The success rate of insemination in female dairy animals can be increased if the A.I. is performed by qualified manpower

Identification of Heat in Dairy Animals for Successful Insemination

Dairy animals show several signs of heat and those signs should be taken into account for the proper time of Artificial Insemination. Right detection of heat in dairy animals can ensure timely insemination which increases the success rate of A.I. The signs of heat in dairy animals are as follows:

- Female animals make themselves separate from the herd while in heat
- Reduces food intake
- Licks the body of other animals
- Vaginas of dairy animals swelled
- Frequent urination can be observed
- Clear discharge from the vagina of dairy animals can be seen
- The animal in heat tries to mount on the other animals or allows other animals to mount on it

Scientific Breeding Management of Dairy Animals

Identification of heat and insemination of dairy animals at right time are major breeding strategies for successful dairy farming. Selection of the right breed for the right environment can ensure high productivity from dairy animals. Dairy farmers must be vigilant to check the status of heat in dairy animals and in case of heat; the animals must be inseminated between 12 to 18 hours. Case of discharge along with puss from the vagina of dairy animals indicates infection in the reproductive tract. In that case, the immediate veterinary doctor should be consulted. If the duration of heat is more than 24 hours, then it

also indicates a problem in the reproductive organ, and doctors should be consulted. If the dairy animal does not come to heat then also doctors may be consulted. Healthy dairy animals should be inseminated after 2 to 3 months of parturition.

Conclusion

Dairy farming is an effective enterprise with a high benefit-to-cost ratio. This enterprise can safeguard the farmers from crop loss or low prices of products. Farmers can get income from dairy farming throughout the year from livestock rearing if proper care on breeding is taken. Identification of heat in female animals, the right time of insemination, insemination by qualified manpower, and inseminating animals with high-quality semen can ensure better profitability in dairy farming. In a nutshell, it can be said that proper breeding management along with suitable breed selection can enhance farm profitability.

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PROTRAY RAISING OF VEGETABLE NURSERY SEEDLINGS

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Vegetable crops are mostly propagated through the seeds and raising seedling nursery for vegetable crops is very difficult if the protocol is unknown. Raising of vegetable seedlings in protray is gaining importance day by day due to the establishment of robust seedlings in the main field. Healthy seeds and seedlings are the first and most important elements for every vegetable crop to reach its maximum yield potential. Quality seeds or seedlings have become increasingly important to vegetable farmers in recent years(Bharathi *et al.*, 2014). A large amount of the land under vegetable agriculture in India is now seeded with hybrid seeds, which are more expensive but provide greater yields and higher quality products. Because seeds are expensive, several vegetable crops such as tomato, brinjal, capsicum, and cucurbits are transplanted after growing in a nursery under protected circumstances to obtain maximum germination count and good plant establishment. One such method that meets the aforesaid need is seedling growth in protrays or plugtrays. Because of the apparent benefits to both the nursery growers and the farmers, this technique is quickly growing as an agro-industry in India (Pandiyaraj *et al.*, 2017).

Methodology

Selection of portrays

Selection of portrays and the number of cells depends upon the requirement of the land and demand of the seedlings. Generally, the number of cells ranges from 72 to 800 in a standard tray (53.7 X 27.5 cm). The size of the cell is significant since it determines the quantity of media needed as well as the ability to store water. Seedlings grown in bigger cells

grow taller and weigh more than those grown in smaller cells. Use protrays with blocks of 1.5-2.0 m^2 for tomato, brinjal, and all sorts of vine vegetables, and protrays with blocks of 1.0-1.5 m^2 for capsicum, chilli, and cauliflower crops (Reddy, 2019).

Preparation and sterilization of media

Media selection is an important aspect for nursery raising and it should be selected based on the type of seedlings to be raised. Physical and chemical properties of the media affect the germination and establishment of the seedlings. The important physical media components are water, air and nutrient retaining capacity of the media for optimum root growth. pH of the medium also affects the germination (Pandiyaraj *et al.*, 2017). The media selection should be done in a such a way that it should retain optimum moisture neither more nor less moisture. Generally used media for production of seedlings in nursery are cocopeat, vermiculite, sphagnum peat, etc. The selected media should be prepared in these combinations of cocopeat, vermiculite and perlite in 3:1:1 ratio. The prepared media should be sterilized before filling in protrays.

Sowing of seeds

One seed should be sown per cell. Before sowing the seeds, they should be treated with recommended biofertilizers, biopesticides, insecticides or fungicides to avoid pests and diseases. The recommended order for the treatment of these chemicals are: insecticides-fungicides-biofertilizers.

Irrigation

Light irrigation should be given with rose can or overhead irrigation can be given with fine nozzles as mist or a spray after sowing of the seeds and care should be taken to maintain the proper moisture in the portrays by spraying of water at regular intervals. Excess watering should be avoided as it favours foliar and root rot diseases.

Light

Light is an essential environmental component that influences germination and development of the seedling. Optimum lighting should be provided. Avoid the direct exposure of seedlings to sun as it leads to scorching of seedlings. Light may also be used to prepare seedlings before transplanting them into more adverse surroundings.

Germination

Cover the seedling tray with black polythene sheet immediately after sowing and watering to provide optimum humidity and warmer temperature in the protray for the germination of seeds. After the seedling emergence remove the polythene sheet. The optimum temperature in the root zone is essential for various vegetable seeds to germinate. For Tomatoes and Brinjal: 21°C – 24°C; chillies and capsicum: 28°C – 32°C. During the first four weeks of seedling growth, the optimum root zone temperature is 26 ^{0}C to 29^{0}C and 20 ^{0}C to 26 ^{0}C during the fifth and sixth weeks(Reddy, 2019).

Spraying of fertilizers

Nutrition is an important aspect for the healthy establishment of the seedlings. All of the essential elements required for optimal growth and development of nursery plants are supplied by nutrition in the form of organic and inorganic sources. Artificial application of nutrients through foliar spray should be provided even though some amount of nutrients will be present in the media and in seed treatment with biofertilizers. Spraying 0.3 percent (3g/litre) water soluble fertilizer with poly feed (19 all with trace elements) twice (12 and 20 days after sowing) to promote seedling development. Phosphorus with minimal nitrogen is essential for improved root development. On the 12th day following germination, apply a root drenching @ 12:61:00. 15 days before transplanting, a micronutrient mixture can be sprayed. Any nutritional deficiency can cause poor and stunted plant development, resulting in poor performance(Reddy, 2019).

Hardening

It is the gradual exposure of the seedlings from the protected condition to normal environmental conditions. Seedlings should be hardened before transplanting into the main field to avoid transplanting shock and to reduce the stresses for the further checking of seedling growth in the main field. Hardening can be done by two methods. The first method is spraying of the seedlings with little amount of salt as it prevents more water and nutrient uptake and the second methos is the seedlings should be exposed to sun for a brief period of time during the morning hours and the exposure and light intensity should be increased gradually (Pandiyaraj *et al.*, 2017). Some other methods are holding irrigation and nutrients application.

Transplanting

Seedlings will be ready for transplanting when they are in 2 to 4 leaf stage or 21 to 30 days old depending upon the crop. When the seedlings were taken out from the protray, a fine mesh of roots can be seen holding around the media. Transplanting can be done in morning or evening hours on normal sunny days. When the temperature is very high, it can be done during evening hours.

Advantages

1. Excessive loss of seeds should be avoided and there is less wastage of seeds which are commercially very high.
2. Nursery raising will ensures time for the main field preparation
3. There is a less chance of occurrence of pests and diseases.
4. Soil borne diseases could be prevented due to the use of sterilized media in the portray preparation and treating the seeds with recommended fungicides.
5. Minimum seedling mortality.
6. Uniform establishment of seedlings.
7. Damage to the roots can be prevented as in nursery beds.
8. Irrigation and fertilizer use efficiency is more.
9. Costly hybrid seedlings can be raised in this method.

Limitations

1. Trained and skilled labours are needed.
2. Certain amount of pre-knowledge is required.
3. Care should be taken during from selection of protrays to hardening.
4. Pests and disease incidence.

Conclusion

Vegetable seedling production has become a widely commercialised sector, with the majority of farmers purchasing seedlings from professional producers and protray raising getting popularised now a days due to the production of healthy plants free from pests and diseases. Many variables contribute to the production of high-quality seedlings this include using high-quality seeds, growth medium with appropriate drainage and water retention capacity, and ensuring ideal fertility rates (Pandiyaraj *et al.*, 2017). Vegetable nursery raising

provides an ample amount of jobs to unemployed people and it will become a hobby to the uneducated rural women, if they are trained well. There is a great scope for this market and many more commercial crops, particularly those with high economic value and potentially high seed cost, may be cultivated as seedling transplants in the future.

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ALTERNATE WETTING AND DRYING IN RICE: AN OVERVIEW

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Almost half of the world population depends on rice as it is a staple food and it is critically important for global food security. Approximately 90% of worldwide rice is grown as well as produced and consumed in India. In India rice is 1st most important and extensively grown is under irrigated. As we know that the water requirement of rice is more than other cereals and it consumes 2\3 of total irrigation water used in agriculture. Generally, 3000 to 5000 litres of water is required to produce 1 kg of rice. Throughout the world, Water is a fast becoming a valuable commodity as an increasing population and it widely use it for the household, industrial and agricultural purposes. By 2025, 15 to 25 Mha of irrigated rice fields suffers from water scarcity. The share of water for agriculture is likely to go down from 80% to 60%. The plenty of water used in rice is lost as percolation and surface runoff which includes in water requirements. The project demand of rice in India by 2050 is estimated to be 197.40 MT for increasing population (ICAR – NRRI). However, climate change induced rainfall variability which results in decreasing groundwater levels. To overcome from water scarcity and to meet the project demand production of rice, scientists of IRRI have developed water-saving technologies. One of these technologies is AWD (Alternate Wetting and Drying) is a water saving technology for lowland irrigated rice.

Alternate Wetting and Drying

Alternate wetting and Drying is an irrigation management practiced in rice for irrigated lowland rice. It was first developed by IRRI and first begun in China and India in 1980 and 1990 (Mushtaq *et al.*, 2006). Soil moisture is maintained at 0-40 kPa by applying irrigation, this is known as AWD. The AWD practice involves intermittent flooding (Alternate cycles of drying and re-flooding) and controlled irrigation. In AWD the rice field is allowed to dry for a period of certain days before being flooded again. Hence the field is

alternately flooded and left dry. Implementation of AWD irrigation management involves by monitoring the depth of water in the field using field water tube. This AWD is followed 10 days after transplanting in case of puddled rice (which helps plants to recovery from transplantation shock) where as in case of direct seeded rice the AWD is followed when the plant height attains 10 cm tall until first heading (when many weeds are present at early crop stage of growth). After irrigation the rice field should be allowed to dry until the ponded water level in the field water tube reaches 10 cm below the soil surface, Then the field is flooded again to a depth of 5cm before allowing water level to drop again upto 10 cm below the soil surface in the field water tube. When the flooded water has dropped to 15 cm below the surface of the soil, Irrigation should be applied to reflood field with 5cm of flooded water, this practice is known as safe AWD. Safe AWD is stopped form 2-3 weeks until the weeds have been suppressed by the flooded water. Some studies reveal that 15 cm threshold limit will not cause any yield declinations.

These cycles of wetting and drying varies from 1 to 7 days depend on the soil texture, irrigation capacity, rainfall, soil moisture, rice crop growth stage, weather and field conditions. The peak period of water requirement in rice is falls between tillering to grain filling, so the field should not be left fully dried at this stage, water stress at this stage which could be results in potentially severe yield loss. After flowering before grain filling safe AWD should be applied. Particularly at panicle initiation and grain filling full flood is maintained.

AWD associated with SRI (System of Rice Intensification) results in greater yields and efficient use of water. One of the most promising factors for decreasing water requirement and methane emission and protecting soil structure is cultivation of aerobic rice with AWD management practices. Aerobic rice is developed by crossing low yielding upland rice varieties and high yielding lowland rice varieties. It is the direct seeding of rice in non-puddled, non-flooded and non-saturated conditions. In ARS (Aerobic Rice System) rice is directly seeded on a dry bed and irrigation is applied at an interval to maintaining the soil moisture.

As the field is alternately wetted and dried, there is a chance of increase in weed growth, Weeds are the major problem in AWD. The critical period for weed competition on transplanted rice is 30-45 days after transplanting. Ponding in the fields about 2weeks after transplanting shows lesser weed growth (Richards and Sander, 2014). Weed infestation was

more in AWD fields compared to the flooded plots, As weed infestation is more in AWD plots, the farmers harvest fewer yields when compared to non-AWD plots (Neogi *et al.*, 2018). Timely application of herbicides and weed management practice in AWD fields favours good yields.

The nitrogen requirement is high in rice and most of the applied nitrogen in the form of urea is lost through surface runoff, leaching in flooded conditions. Application of nitrogen fertilizers just before flooding is beneficial.

Suitable Field Conditions for Implementing AWD

1. Selected field should be free from weed pressure at crop growth stages.
2. Generally practiced in lowland rice growing areas where field should be drained within 5 days.
3. Followed in low rainfall areas, were high amount of rainfall delays AWD management, if rainfall exceeds evapo-transpiration, the field will be flooded and unable to dry during growing period.
4. Light texture and sandy loam soils are not suitable, as they drain quickly.
5. Heavy clay texture soils are suitable as they have high water holding capacity.
6. Selected field should be fewer incidences towards pests and diseases.
7. Land should be properly levelled, and improper levelling leads to uneven distribution of water, fertilizers and extra weed growth.
8. Salt affected soils are not suitable.

Practical Indicator of Implementing of AWD: Field Water Tube

A practical way for implementing Alternate wetting and drying (AWD) is by observing the depth of water by using field water tube or perforated tube or pani pipe. This tube helps the farmers to monitor the water present below the soil surface.

The field water tube is made up of plastic pipe or bamboo, for better observations plastic pipe is preferred. Take a plastic pipe of height 30 cm in length and with diameter of 15cm. The bottom of the tube (20) cm length drilled with holes on each and every side, and that holes should having diameter of 0.5mm with a distance of 2cm away from one another.

After, the tube can place in the field, close to the bund not less than 1m away from the bund. If we placed the tube nearer to the field, farmers can easily take observations.

Bury the field water tube vertically up to 20cm and remaining 10cm protrudes above the soil surface, after dipping remove the soil / mud present in the tube for visible of bottom of the tube. When water level falls below 15cm then the field is reflooded up to 5cm. The threshold limit of 15 cm will not cause any yield declines. Roots of the rice plant will be able to take up water from saturated soil and perched water level in the soil surface (IRRI).

Advantages of AWD

1. Continuous flooding results in increase of pests, disease of rice which cause yield reduction. AWD control incidence of pest and disease infestation when compared to continuous flooding. Alternate wetting and drying (AWD) is practiced to manage the brown plant hopper which transmits "Rice grassy stunt virus" in rice which is characterized by narrow, erect, yellowish green leaves. A study reported less insect infestation from stem borer in AWD method than over flooded method of rice cultivation (Hasan *et al.*, 2016).
2. It increases water use efficiency by decreasing water requirement, AWD saves water 35 to 70%, without any significance yield loss when compared to conventional system of cultivation of rice (Singh *et al.*, 1996). AWD saves up to 660 litres of water per kg of paddy.
3. Safe AWD doesn't decrease the yield. It decreases the pumping costs, fuel costs for irrigation which enhances returns.
4. Globally 13 to 15% Anthropogenic GHG emissions came from agriculture sector. Cultivation of rice under fully flooded conditions emits nearly 20 to 40 Mt of methane every year. AWD is the most promising factor that mitigates methane emission by 50% when compared to flooded rice.
5. AWD alters availability of macro and micro nutrients; it also increases the availability of phosphorous, AWD promotes higher zinc availability compared to conventional method of cultivation of rice.
6. Decreases arsenic uptake by paddy fields.
7. Decreases nitrogen leaching.
8. AWD reduces lodging of plants in paddy fields.

Disadvantages

1. Delay in AWD management practices during grain filling, flowering, tillering results in greater reduction of yields.

2. Denitrification is more in AWD fields because when drying more nitrate is formed, which is lost during flooding.
3. Weed population is more in AWD fields than flooded fields.
4. AWD may increase salinity in the fields.

Conclusion

Growing more rice with less water is important for global food security for increasing population. AWD may help the farmers to grow rice with less water. This management also helps the farmers to bring more area under cultivation of rice which ensures increase in rice production. Implementation of this practice in fields that promotes sustainability in the field of agriculture.

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MARKETING OF HORTICULTURAL CROPS: FRUITS AND VEGETABLES

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The marketing of horticultural crops is complicated because of perishability, seasonality, and bulkiness. In recent years, there has been much concern about the efficiency with which fruits and vegetables are marketed in India. Poor marketing channel efficiency and inadequate marketing infrastructure are thought to be the causes of high and volatile consumer pricing, with little of the consumer rupee reaching the farmer. (Kaul 1997, Ashturker and Deole 1985). In the marketing of fruits and vegetables, Indian farmers often rely significantly on middlemen. Producers and consumers frequently get a bad deal, and middlemen control the market while adding little value. There is also huge waste, the decline in quality, and a frequent mismatch between demand and supply, both spatially and over time.(Subbanarasiah 1991,Singh *et.al.*1985).

Fruits and vegetables are traditionally a vital element of the daily diet in India, and they are in high demand throughout the year from most segments of the population. The commercial worth of fruits and vegetables in terms of direct consumption, processing, and commerce has increased significantly in recent years. Their economic significance has grown, and the high labor intensity of most fruits and vegetables production makes them vital from an employment standpoint as well (Sharma 1991).

Overview of the Fruit and Vegetable Economy of India

India produced 107.10 million metric tonnes of fruits and 204.61 million metric tonnes of vegetables between 2021 and 2022. In 2021–2022, there were 7.09 million hectares of land under cultivation for fruits, compared to 11.28 million hectares for vegetables. Along

with banana, papaya, mango, and guava, India also tops the globe in the production of ginger and okra (IBEF.2022).

Fruits and Vegetables Production in India

India was the world's second-largest producer of fruits and vegetables, according to the Food and Agriculture Organization (FAO) of the United Nations. The largest states for fruit production in India are Andhra Pradesh, Maharashtra, Madhya Pradesh, Uttar Pradesh, Tamil Nadu, Karnataka, and Gujarat. States that produce the most vegetables include Uttar Pradesh, Madhya Pradesh, West Bengal, Bihar, Gujarat, Odisha, and Maharashtra. 97.97 million tonnes of fruit were produced in India in 2018–19, and 107.10 million tonnes were produced in 2021–22, representing a 3.0% CAGR (Compound annual growth rate). The production of vegetables increased by 3.8% CAGR to 204.61 million tonnes over this time, as well. (IBEF.2022).

Fruit and Vegetable Marketing

Due to the bulkiness, seasonal production, and perishable character of horticulture products, marketing them is quite risky and complex. Due to their high perishability, fruit and vegetables can have very poor or even negative returns if they are not sold quickly after harvest. Therefore, it is important to plan ahead for the selling of fruits and vegetables before the produce is harvested. A quality product must be produced in order to successfully market horticultural produce. Post-harvest treatment must also be carefully attended to in order to preserve quality, nutritional value, economic value, and food safety.

Currently, the majority of the fruit and vegetable trade is unorganized and is conducted through commission agents of wholesale markets under state government regulation. Growers willingly consign their goods to commission agents who auction it off on their behalf while only keeping the legally required commission. The majority of regulated markets have designated specific hues for farmers. Additionally, Apni Mandies have been set up in a few towns that are close to the areas of production, allowing farmers to bring their own food and sell it directly to customers. In our country, the transition from unstructured to organized fruit and vegetable marketing is still in its infancy. In this situation, farmers can sell their goods directly to customers through a variety of NGO's and public limited businesses, such as Mother Dairy etc.

Why Marketing is Important?

Post-harvest losses in fruits and vegetables are currently estimated to be approximately 30%, which can be due to inadequate post-harvest and marketing procedures. These techniques include sorting, grading, packaging, delivery, and so on, as well as multi-stage marketing, which causes delays in getting fruits and vegetables to the end user. This delay reduces the value even further. Efficient and effective post-harvest handling and well-planned marketing of fresh fruits and vegetables have a direct favorable impact on fruit and vegetable ultimate realization (IGNOU. Govt. of India).

Different Marketing Channels

It is the route that things take to get from the producer to the consumer. The following types of marketing channels are available:

1. Producer-trader-wholesaler-retailer-consumer.
2. Producer-trader-retailer-consumer.
3. Producer-trader-consumer.
4. Producer-consumer.

An Efficient Marketing System Can

1. Lower post-harvest losses.
2. Increase farmers' awareness.
3. Lower consumer prices.
4. Promote food safety and grading practices.
5. Implement demand-driven production.
6. Allow for greater value addition
7. Export should be made easier.

Conclusion

Horticulture crops are particularly significant in the global economy for the high nutritional value supply of human life. It plays a unique function in the Indian economy by increasing rural income. These crops need a lot of labour to cultivate, thus they provide a lot of job opportunities for the rural population. Fruits and vegetables are normally an important part of the daily diet in India, and they are in high demand throughout the year from various segments of the population. In recent years, the commercial value of fruits and vegetables has

increased significantly in terms of direct consumption, processing, and trade. Due to poverty, a large portion of rural residents are unable to consume fruits and vegetables. The emphasis on high-quality goods must be combined with effective post-harvest crop management for the horticulture industry to flourish holistically. To strengthen the physical infrastructure, information sharing, and services needed for supply chain quality improvement, the government and private operators must work together.

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