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Times of Agriculture

A Resonance in Agriculture

Monthly Agriculture E-Magazine

July-2023

The Rise of HYDROPONICS Farming

FROM THE EDITOR'S DESK

Greetings to all. The importance of the cover story being presented to you is even more significant in today's changing environment. We are discussing the **hydroponics system,** also known as water-based farming. The July issue of **Times of Agriculture magazine** is dedicated to the fascinating world of hydroponics farming.

The significance of this farming method increases because India has become the most populous country in the world, and arable land per person is decreasing day by day. This poses challenges in feeding the growing population and maintaining farmers' income. Considering these factors, the hydroponics system can prove to be highly beneficial.

The hydroponics method produces agriculture products of **good quality and ensures rapid growth**. With this farming technique, farmers can have better control over the environment, enabling them to cultivate vegetables out of season and earn profits.

Comprehensive information about **hydroponics** is presented in this edition of the **Times of Agriculture magazine**. We believe that, like previous issues, you will all enjoy this edition and find it helpful in expanding your knowledge. Thank you for joining us on this enlightening journey.

Enjoy Reading.

Thank you!

Dr. Devraj Singh
Editor-In-Chief

Times of Agriculture

A Resonance in Agriculture

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Monthly Agriculture e-Magazine

About us

"Times of Agriculture" is a monthly agriculture e-Magazine initiated for the purpose of providing information about recent innovations and technologies in agriculture and allied sectors. This e-Magazine gives a platform to dignitaries like scientists, researchers, scholars, students and innovative farmers to share their views and vivid ideas about agriculture. The main objective of this e-Magazine is to provide an open access platform for authors to get on the soapbox and spread awareness regarding the technologies and awareness in agriculture sector by e-publishing articles addressing the upcoming needs in the field agriculture.

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MILLETS 2023

Cover Story

The rise of hydroponics farming

AGRICULTURE UPDATES

Shri Parshottam Rupala launched "Report Fish Disease" app

Shri Parshottam Rupala launched an android-based mobile app **"Report Fish Disease"**. The 'Report Fish Disease' has been developed by ICAR-National Bureau of Fish Genetic Resources (NBFGR).

The app designed for the aquaculture sector enables quick reporting of disease cases and also provides timely advice to farmers associated with aquaculture. With the help of this app, the farmers will be able to connect directly to district fisheries officers and scientists.

PM Kisan Mobile App

Central Agriculture Minister, Narendra Singh Tomar, has unveiled the **PM Kisan Mobile App** with an innovative **Face Authentication Feature.**

The Face Authentication Feature incorporated in the app allows farmers to complete their electronic **Know Your Customer (e-KYC)** process conveniently from their homes.

This ground breaking technology has already facilitated the e-KYC process for 100 farmers.

Gabon's first Agri- SEZ project

Union Minister of Education and Skill Development and Entrepreneurship Shri Dharmendra Pradhan flagged off **Gabon's first Agri- SEZ project** from New Delhi.

In the first phase of the program, **30 farmers and 20 B.Sc./M.Sc. Agri and B.Tech/M.Tech** Engineering students from Gajapati district, which is an Aspirational district of Odisha, will be travelling together as agri-technical and technical consultants for the agriculture SEZ which is being developed under this project.

India Approve Wheat And Broken Rice Exports

India has decided to approve **wheat and broken rice exports** to few selected countries following their requests to allow the shipments of the grains.

Following requests of South Asian country , India would allow broken rice exports to **Indonesia, Senegal and Gambia** in 2023-24 financial year.

New Delhi also approved request from Nepal and allowed wheat exports in the current financial year.

GOI Has Approved The Fair And Remunerative Price For Sugarcane

The government has approved the fair and remunerative price of **Rs.315 per quintal** for sugarcane farmers for the season 2023-24.

The government has also decided to bring the **National Research Foundation (NRF) Bill, 2023** to strengthen the research ecosystem in the country. The Bill approved by the Union Cabinet will pave the way to establish NRF to seed, grow and promote research and development and innovation throughout India's universities, colleges and research institutions.

GOI Decided To Introduce Sulphur Coated Urea (Urea Gold) In The Country

The Indian government has decided to introduce **Sulphur coated Urea** (Urea Gold) for the first time in the country. This was announced by the Cabinet Committee on Economic Affairs (CCEA).

Sulphur-coated urea will be more economical and efficient than the currently used Neem-coated urea. The new sulphur coated urea will address Sulphur deficiency in the Indian soil.

Central Government Reduced Import Duty on Refined Sunflower and Soyabean Oil

The Central government has reduced the import duty on refined sunflower oil and refined soyabean oil from **17.5% to 12.5%.**

B. V. Mehta, Executive Director of Solvent Extractor's Association of India, said now all crude edible oils, crude palm oil, crude sunflower oil and crude soyabean oil attract **import duty of 5%.**

The refined oils attract import duty of **12.5% plus cess at 10% on import duty**.

Uttar Pradesh Government Plans to Invest Rs. 3,800 Crore in Agricultural

In a bid to strengthen the agricultural sector and enhance the state's agricultural value, the Uttar Pradesh government has announced plans to invest approximately **Rs. 3,800 crore** in agricultural start-ups during the financial year 2023-24.

The initiative aims to support various ventures focusing on seeds, fertilizers, warehousing, soil nutrients, harvest/post-harvest crop management, and food processing units.

IFFCO Export Nano Liquid Urea to The US

Indian Farmers Fertiliser Cooperative Ltd. (IFFCO) has signed an agreement with **California-based Kapoor Enterprises Inc** for export of nano liquid urea to the US.

IFFCO now started exporting world's 1st Nano Urea invented & manufactured indigenously in India by IFFCO to USA. An agreement in regard of exporting IFFCO Nano Urea to USA is signed between IFFCO & Kapoor Enterprises Inc, California the cooperative.

IFFCO Procure 2,500 Agri Drones For Spraying Solutions of Nano Urea and Nano DAP

Indian Farmers Fertiliser Cooperative (IFFCO) will procure **2,500 drones** under **'IFFCO Kisan Drones'** as spray solutions for spraying its products nano urea and nano DAP (Diammonium Phosphate). This will lead to the development of 5,000 rural entrepreneurs who are identified by IFFCO to be trained for spraying drones.

The Rise of HYDROPONICS FARMING

About the Author

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World population is projected to reach **9.7 billion by 2050. At the same time, it has been estimated that 50% of the arable land** around the world will be unusable for farming. **Consequently, the food production will need to be increased by 110% to meet the high demand.** As the world population grows, the demand and need for different products, especially food products, grows as well. Because of this growing demand, a food crisis is expected in the coming years. To prevent such crisis from happening, farming methods must be improved, and sources of food must be used efficiently.

What is hydroponics?

Hydroponics is the art and science of growing crops in a soil-less manner. In hydroponics, plants are grown without soil by providing them with nutrient-rich solutions in water solvent, which the plants conventionally obtain from the soil in traditional farming. The main objective of hydroponics is to supply the ideal nutritional environment for optimum plant performance, further optimized by controlling the climate.

Advantages of Hydroponics

Water Efficiency

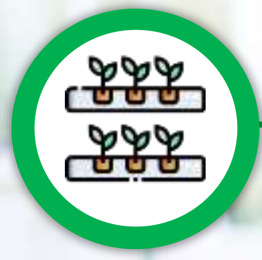
It use up to 90% less water than traditional soil-based agriculture. The water in hydroponic setups is continuously recirculated and reused, reducing water wastage and making it a more environmentally friendly option, especially in regions with water scarcity.

Optimal Nutrient Control

In hydroponics, nutrient solutions can be precisely tailored to meet the specific needs of different plants. This allows for better nutrient uptake, leading to healthier plants and higher yields.

Faster Growth and Higher Yields

By providing plants with a direct and readily available supply of nutrients, hydroponics promotes faster growth rates and increased crop yields compared to conventional farming methods.



Space Efficiency

Hydroponic systems can be designed to maximize space utilization. Vertical hydroponic setups, in particular, allow for stacking multiple layers of plants, effectively increasing the growing area without expanding horizontally.

Year-Round Cultivation

Hydroponics allows for year-round cultivation regardless of the external climate conditions. By creating a controlled environment indoors or in a greenhouse, growers can provide the necessary light, temperature, and other environmental factors needed for plant growth.

Reduced Pest and Disease Risks

Growing plants hydroponically can significantly reduce the risk of pests, weeds, and soil-borne diseases that commonly affect soil-based crops. Since hydroponics eliminates the use of soil, many pests and diseases that thrive in soil are not present, reducing the need for chemical pesticides and herbicides.

Controlled Environment

Hydroponic systems allow for precise control over environmental factors like temperature, humidity, and light. This level of control optimizes plant growth and helps to create an ideal environment for various crops.

Flexibility and Mobility

Hydroponic setups can be easily relocated, making them suitable for temporary or mobile agricultural operations. This mobility is especially useful for research, experimental farms, or disaster relief efforts.

Various Techniques For Hydroponics

There are different methods of cultivation in hydroponics. The difference in each method is based on the structure set up. Below are some of the systems, which are being used by hydroponic farms around the world.

Nutrient Film Technique (NFT) Systems

In NFT system, the plants are grown in channels known as gullies where the nutrient solution is pumped throughout the reservoir. The plant roots are kept moist by the thin film of nutrient solution. Ideally, the bottom of the roots is exposed to the nutrient solution. It is like a stream that feeds the line with dissolved nutrients. This system delivers a constant flow of nutrients to the plants with a pump, so no timer is required. The nutrient film technique was developed during the late **1960s by Dr. Allan Cooper** at the Glasshouse Crops Research Institute in Littlehampton, England.

NFT is suitable for **lettuce, tomatoes, leafy crops, herbs, onions, and more of short-term crops.**

Deep Water Culture (DWC)

DWC is a hydroponic system where plants are suspended in a nutrient-rich water solution with their roots fully submerged. Oxygen is supplied to the roots through the use of air pumps or air stones. The continuous immersion in oxygenated water allows for rapid and efficient nutrient absorption, promoting robust plant growth. **DWC systems are relatively simple to set up and maintain, making them popular among both commercial growers and hobbyists.** The method's simplicity, combined with its ability to deliver optimal nutrient uptake and support high yields, has made **DWC a favored choice for cultivating a variety of plants, including leafy greens, herbs, and some fruiting crops.**

Ebb & Flow/Flood & Drain Systems

In the Ebb and Flow (also known as flood, and drain) process of hydroponics, a growing area is **filled with flow of nutrients for 5 to 10 minutes and then the solution is drained away.** The nutrient mixture is stored in a reservoir. In this system, the plant roots are usually grown in a medium of perlite, rockwool, or enlarged clay pebbles.

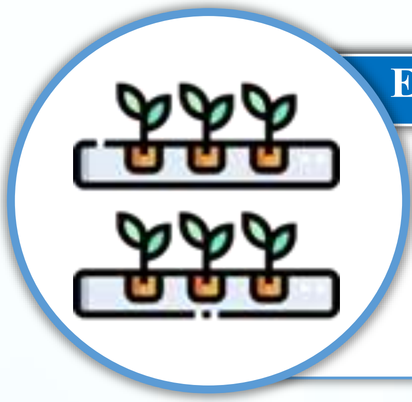
Aeroponics

Aeroponics is a highly efficient and innovative form of hydroponics that involves growing plants in an air or mist environment without the use of soil or a solid growing medium. In aeroponic systems, plant roots are suspended in air and regularly misted with a nutrient-rich solution, providing them with an oxygen-rich and moisture-laden environment. This method allows for **maximum nutrient absorption and rapid growth, as the fine mist promotes excellent root aeration and facilitates nutrient uptake**. Aeroponics offers several advantages, including faster growth rates, higher yields, water efficiency, reduced disease risk, and the ability to grow plants in a compact vertical space. It is particularly suitable for growing delicate plants, like lettuce, herbs, and certain orchids.

Aeroponic techniques have been given special attention from NASA since a mist is easier to handle than a liquid in a zero-gravity environment. **The first commercially available aeroponic apparatus was manufactured and marketed by GTI in 1983.**

Nutrient Solutions in Hydroponics

In hydroponics, nutrient solutions play a crucial role in providing essential elements for plant growth and development. These solutions are carefully formulated to contain a balanced mixture of nutrients that are readily available for plant uptake. Here are some key aspects of nutrient solutions in hydroponics:



Essential Nutrients

Nutrient solutions for hydroponics typically contain macronutrients, such as nitrogen, phosphorus, and potassium, as well as micronutrients. These nutrients are essential for various physiological processes, including photosynthesis, root development, and overall plant growth.

Nutrient Balance

The nutrient solution is carefully balanced to provide the right proportions of each nutrient. Imbalances can lead to deficiencies or toxicities, affecting plant health and productivity. The ideal nutrient balance varies depending on the crop being grown, its growth stage, and environmental conditions.

pH Adjustment

The pH of the nutrient solution is also crucial, as it affects nutrient availability and uptake. Most plants prefer a slightly acidic pH range between 5.5 - 6.5. PH levels outside this range can lead to nutrient deficiencies or toxicities. pH adjusters, such as pH-up or pH-down, are used to maintain the desired pH.

Nutrient Formulations

Nutrient solutions can be purchased pre-formulated or prepared from individual nutrient salts. These salts are typically water-soluble and come in the form of powders or concentrated liquids..

Electrical Conductivity

EC measures the concentration of dissolved salts in the nutrient solution and indicates its strength. It is measured in terms of EC and is commonly expressed in units of millisiemens per centimeter. Maintaining an appropriate EC level ensures that plants receive adequate nutrients without overloading them.

Recycling and Replenishing

Nutrient solutions are often recirculated to minimize waste. However, over time, nutrient levels may deplete, necessitating replenishment or complete replacement of the solution. This allows for precise control over nutrient composition and ensures plants receive a consistent supply of essential elements.

Future prospect of hydroponics in India

Nowadays, the traditional farming system does not meet the current and maybe will not meet the future demands of food. Therefore, there is a real need for adapting new farming system that stimulates plants to grow faster. Also due to overuse of pesticides and insecticides the land is getting infertile which diverts the practice toward soilless farming.

The water which is being used for agriculture mainly comes from river but with the progress of industrialization, toxic waste is dumped in these rivers. This makes them polluted with heavy metals and other toxins due to which water availability for conventional farming will not be available. **Thus, one will have to shift toward hydroponics where 80-90% less water is used.**

Conclusion

Hydroponics is an age old method which is getting lime-light again as it is a promising technological solution to the problems faced by current agricultural system. Hydroponics may be used in underdeveloped countries for food production in limited space. It is even feasible to grow hydroponically in areas of poor soil conditions such as deserts. It has many pros but major drawback is its high capital investment and needs clear knowledge as it is a perfect combination of biology, chemistry, physics and mathematics. With the help of this technique, the demand and supply gap can be filled providing fresh and better quality also consistency can be maintained.

SMART AGRICULTURE
USING IoT-BASED EAgriS SYSTEM

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TIH Foundation for IoT and IoE at IIT Bombay (TIH-IoT)

TIH Foundation for IoT and IoE at IIT Bombay (TIH-IoT) have collaborated with the ICAR-Directorate of Onion and Garlic Research (DOGR) to provide guidance and action plans to onion producers in Ahmednagar and Pune district by leveraging advanced technologies such as Internet of Things (IoT), drones, and mobile applications with the aim to combat insect attacks and control diseases. The farmers will benefit from Internet of Things (IoT) and Artificial Intelligence (AI) and technologies involving drones and robotics. These innovations will offer farmers continuous advice, guidelines, and vigilance, as per the revised recommendations by ICAR-DOGR.

To facilitate the implementation of this technology, the TIH Foundation for IoT at IIT Bombay has developed the 'IoT-based Smart Agri Station (EAgriS).' Recently, during 30 May to 1 June 2023, a successful installation of an EAgriS station was carried out at four locations -Panoli (Parner), Ambijalgaon (Karjat), Halgaon (Jamkhed) in Ahmednagar district and Jalgaonsupe (Baramati) in Pune districts by Harsh Sawardekar, Kaushik Landge, and Nikhil Mhadaye from TIH-IoT, IIT Bombay and scientists of ICAR-DOGR namely Dr. Suresh Gawande, Dr. Rajiv Kale, Shivam Gaikwad. From Agricultural Development Trust - Baramati Mr. Rajendra Pawar (CEO), Prof. Nilesh Nalavde, Dr. Dheeraj Shinde and Soil Scientist Dr. Vivek Bhoite have facilitated the installation. Further, team of Baramati Agrostar FPO (Farmer Producer Organization) Mr. Yogesh Khomne, Sunil Jagtap, Anand Khomne and Ankush Bhapkar have supported the installation.

The EAgriS station records a wide range of vital data, such as Soil parameters (moisture, temperature, pH, fertilizer content), weather parameters (ambient temperature, humidity, rainfall, wind speed, solar radiation), and crop parameters (leaf moisture, temperature). These measurements aid in predicting climate change, pest infestations, diseases, and irrigation management. The EAgriS will collect the farm-related data in real-time and share with ICAR-DOGR scientists through web application, the scientist can access the live data from farms with a single click and can share more precise and specific guidelines immediately. These guidelines can be disseminated more effectively to a larger number of farmers through mobile application.

The EAgriS technology holds immense potential for farmers as it helps to reduce production costs, improve yields, and minimize unnecessary pesticide and water usage.

USEFULNESS OF NANOTECHNOLOGY IN PRECISION FARMING

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According to the current data of the United Nations, by the year 2050, the total population of the world will increase to 9.1 billion (about 900 crores). The expected increase in total population will be more in developing countries than in developed countries. As a result of which the availability of land, food, fodder, fiber and fuel will double at the world level. At present, the world's average per capita crop land availability has come down to about 0.27 hectares. According to the Food and Agriculture Organisation, expanding agricultural land is not only possible but impossible. Without the inclusion of advanced technology and resources, it is impossible to feed the growing population. India represents 17.84 percent of the world population. At present, the total population of India is around 1.30 billion, but the way the population continues to grow, by 2025, the total population of India will reach 1.5 billion. At present the per capita availability of land within India is 0.10 hectare which is very less as compared to developed countries. Due to the increase in population, where today the requirement of food grains is 330 million tonnes, by the coming year 2050, the demand of food grains will reach around 500 million tonnes. As a result of increasing population, competition for land and water on the one hand, and on the other hand limited land and migration of people from villages to cities and due to increase in cost of farming, food crisis may deepen in future due to migration from agriculture and climate crisis. Recently, in the index presented by the Global Hunger Index (Global Hunger Index-2022), India has reached the 107th position with a score of 29.1 points, in such a situation; these figures are showing that there is a serious situation of hunger in India too. Due to such situations, if new technology is not incorporated, assimilated and used in agriculture in time, then in the coming future India may go through a deep food crisis. Today, Indian agriculture is focused on solving environmental challenges i.e. sustainability, development of improved plant varieties, improvement, increase in productivity and natural resources (land, water, vegetation).

But necessity is the mother of invention, that is, from time to time, change is considered necessary according to needs and demands. Growing population, climate crisis, low productivity, high cost in farming is a major problem for farming today. To deal with such serious challenges, a need was felt for an effective system in agriculture, which, keeping the cost in mind, using natural resources in appropriate quantity, combining it with innovative technology, produces a quality product, as well as environmental protection. The harmful effects of imbalance can also be minimized in farming. At present, the system on which more emphasis is being given today, that system is being given the noun of precision farming or precision farming.

Concept of precision farming:

Reducing the cost of production by using the inputs of production (fertilizers, pesticides, weedicides, water management etc.) in the right quantity, right time, right method, and right place according to the demand of the crop, and maximize production. Its ultimate aim is to achieve. Precision farming works on the principle of 4-R's. Computers, Global Satellite Positioning System (GPS), Geological Information System (GIS), and Remote Sensing (RS) equipment are used under precision

farming. The local environmental and soil conditions are assessed and measured using these instruments. Apart from this, it is determined that by accurately identifying the fertility variation of the land, the efficiency of the crops can be increased by using the inputs at the right time, thereby keeping the environmental pollution, soil pollution at a low level. Today scientists and governments are recommending the use of nanotechnology in agriculture as a component of precision farming for the farmers.

Application of nanotechnology in agriculture and related sciences:

The use of nanotechnology in agriculture is still in its initial stage, but with its proper use, crop cost can be kept low along with increasing the productivity. With respect to modern discoveries, it has been found that nanotechnology will also prove successful in gathering information for plant breeding and genetic improvement. Nanotechnology was invented in 1974 by a scientist named "Norio Taniguchi". Later, a scientist named "Erik Drexler" propounded it independently. IIT Bombay in India is the leading institute in the country which is working on nanotechnology. In nanotechnology, the size of nano particles is small, usually 1-100 nanometers. Nanotechnology is used in agriculture in food technology, crop improvement (genetically modified crops), seed technology, precision farming, nano fertilizers for balanced crop nutrition, disease diagnosis of crops, weed management, pest management, and biosensors.

Various products derived from nanotechnology:

Nanofertilizers: The invention of nanofertilizers has been developed by a scientist named **Dr. Jagdish Chandra**. In nano fertilizers, mainly nano urea, nano phosphorus, nano zinc, etc. are freely available in the market, but it is being used in agriculture in limited quantity by the farmers of India because Indian farmers are still not aware of this technology.

Nano Urea: The ever-increasing consumption of chemical fertilizers has a direct impact on the subsidy, which in turn has a direct impact on the government's expenditure. According to statistics, in the year 2020-2021, a subsidy of Rs. 80,000 crore was given to the farmers. Due to increasing subsidy expenditure and unbalanced use of chemical fertilizers, soil productivity gradually declined and the land was on the verge of becoming barren. The size of particles in nano urea is usually 20-50 nano meters. Its surface area and volume are approximately 10,000 times greater than that of ordinary urea. Nano Urea manufactured by IFFCO is available in 500 ml bottle which works equivalent to 50 kg of urea. The price of 500 ml Nano Urea is Rs 240, while the price of one sack of urea is Rs. 350 in the market.

Nano DAP: Nano DAP has recently been invented by IFFCO, which has been approved by the Ministry of Agriculture and the Fertilizer Control Board for its use. This fertilizer is available in the market in 500 ml bottle which works equivalent to 50 kg sack of DAP. Today, where the cost of one bottle of Nano DAP is Rs. 600, the cost of one sack of DAP is Rs. 1350. Nano sensor: Health, diseases, pests of crops can be easily monitored through nano sensors, so that they can be easily

managed successfully in time. Nano Chip-Lab: This technology is being used in crop research, (genetically modified crops), crop improvement technology in developed countries.

Methods of using nanoparticles:

Spraying on the leaves:

There are stomata on the upper surface of the leaves of the plant, with the help of which the plants also get nutrition. For this, mixing 2-4 ml of nano fertilizers like nano urea in per liter of water (250 ml / acre 125 liters of water) and spraying on the standing crop reaches the useful parts from the source along with photosynthesis. Soil application: Nano zinc mixture can be used by soil application at the time of last ploughing. From which plants get nutrition by absorbing it from their roots.

Seed treatment:

A mixture is prepared by dissolving a certain quantity of nano particles in water. Then the seeds should be kept in that prepared solution for 24-48 hours, so that the nano particles in the dissolved state can reach the depth of the seeds and work to provide nutrition at the time of formation of new plants.

Significance:

Nanotechnology is working like a revolution in agriculture. With the use of this technique, along with increasing the production of the crop, the amount of cost can be worked out. With the use of nanoparticles, the response to the crop is quick and permanent, so that maximum production per unit of land can be obtained. The use of nano particles does not cause problems like soil, air and water pollution.

■■■

ROBOTICS IN VITICULTURE

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JSA CAT

Robotics is the intersection of science, engineering and technology that produces machines, called robots. It substitutes for human actions. Robotics involves the design, construction, operation, and use of robots. Robotics is a combined field of mechanical engineering, electrical engineering, information engineering, mechatronics, electronics, bioengineering, computer engineering, control engineering, software engineering, mathematics, etc. As the technologies continue to develop and improve, many agricultural industries are appraise innovations that can be integrated into their operations to provide management support.

Grapes growers in many parts of the world face disruptive challenges caused by climate change and variable weather patterns, compressed seasons, drought, heat, shortages of labour and higher production costs. There is an increasing need to continuously monitor biophysical characteristics and grapevine performance in order to assess vineyard management practices. A suite of technologies which included a suite of tools like remote and proximal sensing technologies, GPS, GIS, geostatistics, AI, and DSS is now available which allows grape growers and wine producers to obtain and use detailed data and information about their vineyards as a basis for making the correct decisions related to remaining productive as well as environmentally and financially sustainable.

Non-invasive sensing technologies such as spectroscopy, MSI, HSI, Chl fluorescence, thermography, ER, LiDAR and CV can be applied in wine grape production systems to recover key information about the vineyard and the grapes growing within it. They can be used as portable sensors that can be mounted to or embedded in ground-based platforms such piloted vehicles, autonomous robotic systems and machinery, or aerial platforms such as satellites, light aircraft and UAVs or drones.

Soil testing

Due to continuous growing of crops, there is a shortage of nutrients in the soil and so to meet the nutrients, the farmer applies different types of fertilizers in the fields. However, nutrient levels in the field may vary from place to place and this affects the germination and growth of seeds, resulting in variation in production in different parts of the same field. Hence farmers have to keep on testing the soil of their fields continuously to know status and level of nutrients present in it. An automatic soil penetrometer that combined with mobile robots takes field measurements in manual and automatic mode. The European Union Vine Robot project, which includes eight partner groups from wine-producing countries such as France, Italy, Germany, and Spain, has created an autonomous robot that will measure vineyard parameters (vegetative growth, grape yield, grape composition, and soil moisture) on-the-go in a non-invasive way to aid winemaking decisions.

Weed management by using robots

Weeding is one of the most repetitive, tedious and time-consuming activities within the crop production cycle. Especially for those developing countries and smallholder farms, weed management accounts for more than 40% of the labor effort.

Weed control in vineyards will enhance the establishment of newly planted vines and improves the growth and yield of the vines. Growers have many weed management tools available to achieve their goal, but the method in which these tools are utilized vary from year to year and from vineyard to vineyard.

As the technology has continued to grow in endless form, the farms can be maintained free of weed using the robots. Robots can be used for spraying both mechanical and weedicides. The mechanical robot picks up the weeds from the field selectively whereas robots can spray the weedicides with accuracy. Mechanical robots works at very slow speed. The robot needs energy to work continuously hence solar energy can be used so that it can work

continuously. Like soil testing and plantation robot, these robots also use RTK GPS to move. Simultaneously, these robots use vision-based technology i.e: camera is used to make a three-dimensional map and this technology is used to identify plants and their rows. Automation allows for the identification and differentiation of crops from weeds, as well as the removal of weeds using a carefully controlled device.

Pruning of vineyard

Pruning is necessary to develop the plant and to maintain it on the support provided. Regular, purposeful pruning is essential for controlling the number, position and vigor of fruiting canes and the yield and quality of the fruit. Unpruned table grapevines soon become unproductive and overgrown since basically it is a creeper. Pruning is the removal of vegetative portions of the vine, including leaves, shoots and canes. If the vines are too vegetative, the crop will be short. Hence pruning in grapes is important.

Robotic Vineyard Pruner are stereoscopic scanning cameras which can 15 frames per second, scanning the entire vine field and working on a full vine length ahead of the pruning shears. The 'vision' is the key sense for the machine’s needs; otherwise it can't understand the vine and prune intelligently. An onboard computer is been used so that the multiple overlapping photos are taken to build a three-dimensional model of the vine, then it applies "pruning rules" that were programmed into the software. The pruning rules guide and tell robotic arms with hydraulic pruning shears which canes to cut and which to leave, and where to make the cuts for the desired lengths and desired density of buds/vine.

Harvesting

Fruit growing in agriculture is more important in accordance with its economic, nutritional as well as its health values. Fruits and vegetables are perishable goods. Time of harvesting is more important. A fruit's biological properties are influenced by its location, growing environment, geometric form, size, colour, and hardness, among other variables. Multi arm robots are used to harvest vineyards.

Conclusion

We need to improve resource use efficiency in all agricultural production systems in order to meet current and future challenges associated with climate change, the environment and waste, shortages of labour and elevating production costs. The goal of using robotics in viticulture is to supply accurate data, imagery and maps in real time to grape growers and wine producers to help manage their vineyards both efficiently and sustainably. Agricultural robots are being used the most for weeding, hoeing and harvesting of fruits and are proving to be more effcient than humans. Robotic sector in agriculture is an emerging market in which there is immense potential for jobs and employment, as well as robots will definitely prove helpful in attracting the younger generation to agriculture and increasing agricultural production.

ORGANIC NUTRIENT SYSTEM
DYNAMICS AND STRATEGIES

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Soil is the ultimate source of nutrition to the plants as described by many edaphologists and pedologists. The two main soil nutrient systems through which it is supplied to the plants are namely organic and inorganic nutrient pool. Organic nutrients are the complex vital structures which are synthesized in the living system and only a small amount is taken up by the plants as such from the soil. Inorganic nutrients are the mineral forms present in the soil which is easily taken up by the plants for the synthesis of complex organic forms.

Components of organic nutrient system

- **Plant residues and roots:** comprises of the fresh leaves and litter, dried leaves, debris, stubbles, roots of the plants.
- **Animal wastes:** all the organic material of animal origin like excreta, dead cells, etc.
- **Soil microbes:** all the soil microbiota are the key components in the organic nutrient system as they help in the major processes of decomposition of the organic material in the soil and making the nutrients available to the plants.
- **Stable humus:** the seat of all the energy and nutrients comes from the humus portion of the soil which determine the nutrient supply and buffering capacity of the soil and hence the availability of nutrients to the plants.

Sources of organic nutrients

The term "bulky organic manure" is used collectively for cattle dung, FYM, composts, etc. because of their large bulk in relation to the nutrients contained in them. Concentrated organic manures, such as oilcakes, bone/blood meal; bio fertilizers, slaughterhouse wastes, fishmeal and guano are comparatively richer in NPK.

Fate of organic nutrient sources in the soil

All the organic material that has been added in the soil system later turned into soil organic matter which is a resistant and stable complex. Out of this stable material, one or the most active and mobile material that plays a key role in providing energy and nutrients in the soil is Dissolved Organic Matter. Major processes involve in this when organic nutrient sources are either applied or fall into the soil are oxidation, decomposition, mineralization/ immobilization, leaching, adsorption/desorption and uptake by plants.

Soil dynamics and organic nutrient sources

Organic nutrients sources have a great impact on the soil properties enhancing the overall conditions of the soil and suitability to the plants and soil biota. Physical, chemical and biological all the dynamics are greatly influenced by it.

Organic nutrient management and strategies

The resource components available for organic nutrient management are:

- Biofertilizers like Azolla, *Azospirillum, Azotobacter, Rhizobium* culture, PSB, etc. can be used.
- Various sprays like vermiwash, liquid manure, etc. can be used in crops for nourishing the soil and plant.
- Partially decomposed FYM has to be applied 3–4 weeks before sowing, while well-decomposed FYM should be applied immediately before sowing.
- Manuring with different short-duration legumes is suitable for maintenance of soil quality in terms of adding nitrogen to soil.
- In case of soil application, desired strain of bio-fertilizer is normally

mixed with 20 times well-decomposed FYM to maintain uniformity of mixture and applied in furrows. However, for seedling treatments, bio-fertilizer slurry is made (1:10 ratio) in water, and roots are emerged in suspension for about 30 minutes.

Future prospects

- Efficiency of the organic nutrient depends on the right amount right time right method and right application of the inputs into the soil.
- More utilization of the crop residues and their proper application in the field to prevent the losses of nutrients occur in the residue burning within the system.
- Efficient utilization of the bio fertilizers and liquid manures in the fields.
- Need to focus on the research on the soil organic chemistry apart from the farming systems and management systems.
- Need to focus on the organic pool of the soil nutrient system for conserving long term fertility and sustaining the agricultural ecosystem.

Conclusion

The purpose is therefore to large extent driven by increased use of chemical fertilizers, that scrutinize some of the evidence suggesting that plants is acquire significant amounts of nutrients through uptake of organic forms. It is of the dependence of modern agriculture on the production and is also our purpose to identify the major knowledge gaps and use of inorganic N fertilizers in crop production. The type of studies required to fill these gaps. In this context, new approaches that can be taken to further of the basic mechanisms through which plants acquire organic nutrients is a fundamental requirement.

HARNESSING THE POWER OF ARTIFICIAL INTELLIGENCE (AI) IN AGRICULTURE

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Artificial Intelligence (AI) has emerged as a game-changer in various industries, and agriculture is no exception. The integration of AI in agriculture is revolutionizing the way farmers approach crop management, resource utilization, and decision-making processes. With its ability to analyse vast amounts of data, provide predictive insights, and automate tasks, AI is unlocking new levels of efficiency, sustainability, and productivity in the agricultural sector.

Enhancing crop monitoring and predictive analytics

AI-powered systems are transforming crop monitoring by leveraging satellite imagery, drones, and ground-based sensors. These technologies enable farmers to gather high-resolution data on crop health, soil moisture, and nutrient levels. AI algorithms can analyze this data in real-time, identifying early signs of diseases, nutrient deficiencies, or pest infestations. By detecting these issues early, farmers can take proactive measures to mitigate risks, optimize resource allocation, and ensure healthy crop growth.

Optimizing resource utilization

One of the key challenges in agriculture is efficient resource management. AI-driven precision agriculture techniques offer a solution by precisely tailoring inputs such as water, fertilizers, and pesticides to match the specific needs of each crop. By analyzing data from multiple sources like weather patterns, soil conditions, and historical yields, AI algorithms can generate optimal recommendations for resource application. This targeted approach not only reduces waste and environmental impact but also enhances crop quality and yields.

Automation and robotics

AI-powered robotics and automation are transforming labour-intensive tasks in agriculture. Robotic systems equipped with computer vision and machine learning algorithms can perform activities such as planting, harvesting, and weeding with precision and efficiency. These technologies reduce labour costs, increase operational speed, and minimize human errors. Furthermore, autonomous machinery can work around the clock, optimizing productivity and allowing farmers to focus on higher-level decision-making.

Predictive yield analysis

Accurate yield prediction is vital for farmers to plan harvest logistics, manage supply chains, and make informed business decisions. AI models trained on historical data, combined with real-time inputs, can provide predictive insights into crop yields. By considering factors such as weather patterns, crop health indicators, and historical yield patterns, AI algorithms can generate accurate yield forecasts. This empowers farmers to optimize storage, transportation, and market planning, leading to better profitability and reduced waste.

Decision support systems

AI-based decision support systems are empowering farmers with valuable insights and recommendations. By integrating data from various sources such as weather forecasts, market trends, and soil conditions, AI algorithms can assist farmers in making informed decisions. Whether it's selecting the most suitable crop varieties, determining optimal planting times, or managing disease outbreaks, AI-based decision support systems provide real-time guidance that enhances productivity and profitability.

Conclusion

Artificial Intelligence (AI) is revolutionizing agriculture by offering innovative solutions to age-old challenges. From crop monitoring and predictive analytics to automation and decision support systems, AI is transforming the way farmers operate. By harnessing the power of AI, farmers can achieve higher yields, optimize resource utilization, and make data-driven decisions for sustainable and efficient agricultural practices. As AI continues to advance, its role in agriculture will only grow, paving the way for a more productive and sustainable future in the field.

EFFECT OF SUMMER PLOUGHING IN AGRICULTURE

BOON TO MICRO-ORGANISM AND SOIL HEALTH

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Summer ploughing, also known as summer fallow or summer tillage, is an agricultural practice that involves tilling or ploughing the soil during the summer months when the land is not actively cultivated with crops. This practice can have several effects on microorganisms and soil health, which are generally considered beneficial. In this article, we will explore the various ways in which summer ploughing can be a boon to microorganisms and soil health.

One of the primary benefits of summer ploughing is the increased soil aeration. By ploughing the soil, it is loosened and turned over, improving its structure and allowing for better penetration of oxygen. This increased aeration creates a more favorable environment for beneficial soil microorganisms. These micro-organisms, including bacteria, fungi, and other decomposers, play crucial roles in soil health. They break down organic matter, release nutrients, and enhance nutrient cycling. Adequate oxygen levels in the soil promote their activity and ensure the proper functioning of these essential soil organisms.

Furthermore improved soil aeration resulting from summer ploughing also benefits plant growth. With better oxygen availability, plant roots can respire more effectively, leading to improved root development. Healthy and well-developed roots are essential for efficient nutrient uptake, which contributes to overall plant health and productivity. By enhancing plant growth, summer ploughing indirectly supports soil health by increasing the amount of organic matter and root exudates available for microbial activity.

Weed control

Weed control is another advantage associated with summer ploughing. When the soil is ploughed, weed seeds are uprooted or buried, disrupting their growth cycles. This reduces weed competition with crops, leading to improved crop yields. Additionally, by turning over the soil, summer ploughing brings buried weed seeds closer to the surface, where they are more likely to be exposed to unfavorable conditions, such as sunlight and temperature fluctuations. These factors can inhibit weed germination and reduce the weed seed bank in the soil, further aiding in weed control. Minimizing weed competition not only benefits crop growth but also reduces the reliance on chemical weed control methods, promoting more sustainable and environmentally friendly agricultural practices.

Incorporation of organic matter

The incorporation of organic matter is a critical aspect of summer ploughing. Ploughing facilitates the mixing of organic residues, such as crop stubble or green manure, into the soil. Organic matter serves as a valuable food source for soil microorganisms, stimulating their growth and activity. As microorganisms decompose organic matter, they release nutrients trapped within it, making them available to plants. This process, known as mineralization, replenishes nutrient stocks in the soil, promoting soil fertility. Additionally, the breakdown of organic matter by microorganisms contributes to the formation of stable soil aggregates, improving soil structure and water-holding capacity. Adequate levels of organic matter are essential for sustaining soil health and fertility, and summer ploughing aids in its incorporation and decomposition.

Pest and disease management

Pest and disease management can also be positively influenced by summer ploughing. When the soil is ploughed, pests and pathogens that reside in the soil are exposed to environmental factors like sunlight, temperature fluctuations, and desiccation. These conditions can be detrimental to their survival and reproduction, effectively reducing their populations. By disrupting their life cycles and providing unfavorable conditions, summer ploughing can help control certain soil-borne pests and diseases. However, it is important to note that the effectiveness of this practice can vary depending on the specific pests and diseases present and the local environmental conditions. Integrated pest management strategies that combine summer ploughing with other pest control methods can provide more comprehensive and sustainable pest management solutions.

Another significant benefit of summer ploughing is the promotion of nutrient cycling. As mentioned earlier, ploughing incorporates organic matter into the soil, leading to increased microbial activity and decomposition. This decomposition process breaks down complex organic compounds into simpler forms, releasing nutrients that were previously locked in organic matter. These nutrients, including nitrogen, phosphorus, and potassium, become available for plant uptake, contributing to improved nutrient cycling in the agricultural system. Nutrient cycling is vital for maintaining soil fertility, reducing nutrient losses, and minimizing the need for external inputs, such as synthetic fertilizers. By promoting nutrient cycling, summer ploughing supports sustainable agricultural practices and reduces the environmental impacts associated with excessive fertilizer use.

It is essential to recognize that the effects of summer ploughing on microorganisms and soil health can be influenced by various factors, including soil type, climate, crop rotation, and management practices. For example, in sandy soils, ploughing may lead to increased erosion and nutrient leaching if not carefully managed. Therefore, adopting a holistic approach to soil management is crucial. Farmers and agricultural practitioners should consider site-specific conditions and implement appropriate soil conservation practices alongside summer ploughing. These practices may include conservation tillage, cover cropping, and the use of organic amendments to maintain soil structure, prevent erosion, and preserve soil organic matter content.

Conclusion

Summer ploughing can have several positive effects on microorganisms and soil health in agriculture. It improves soil aeration, benefiting beneficial soil microorganisms and enhancing plant growth. The practice aids in weed control, reducing competition with crops and minimizing reliance on chemical weed control methods. Summer ploughing promotes the incorporation of organic matter, stimulating microbial activity and nutrient cycling. It can also contribute to pest and disease management by disrupting their life cycles and providing unfavorable conditions. Additionally, nutrient cycling is improved through the breakdown of organic matter, releasing nutrients for plant uptake. However, it is crucial to implement summer ploughing alongside appropriate soil conservation practices to mitigate potential negative impacts. By considering site-specific conditions and adopting a holistic approach to soil management, farmers can harness the benefits of summer ploughing, enhancing microorganisms' activity and soil health in their agricultural systems.

SOIL MICROBIOME
AND ITS DIVERSITY ASSESSMENT

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Soil is the most varied and intricate ecosystem, comprising millions of fungus, billions of bacteria, and other enormous creatures living in it. Soil microorganisms perform critical roles in nutrient cycling and protecting plants from the detrimental impacts of abiotic and biotic stresses. Intensive agriculture practices improve crop output while having a negative impact on the biological and physical qualities of soils. Agricultural practices modify the variety and composition of soil microbial communities, and these altered communities have an influence on the functioning of agricultural ecosystems, which is still unknown.

Introduction

The soil microbiome is defined as "a set of genes found in association with organisms that establish colonies a specific environment." The' soil microbiome' is an interacting community of bacteria, archaea, viruses, fungi, and protozoa found in soil. The term "microbiome" refers to a native microbial community. The soil microbiome is vital in the global nutrient cycle and plant nutrition, as well as in a variety of ecological activities that vary depending on the environment. The soil microbiome is made up of a diverse range of microorganisms that contribute to key ecosystem functions such as nutrient recycling, soil structure protection, and disease control has the potential for both beneficial and harmful effects on plant growth and crop yield.

Short study of Soil microbiome diversity assessment

Estimate biodiversity of soil microbiome by Shannon index in different edaphotopes of primeval forest ecosystems.

Procedure:

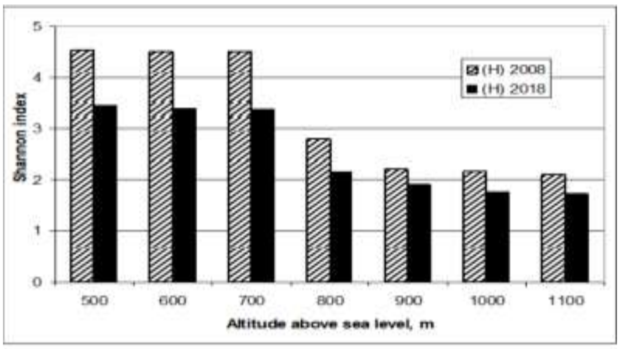
1. Materials of research were soil samples, which had been collected from natural ecosystems
2. The soils are very stony, mostly mid-loamy with good water and air penetration ability. Climate conditions change from mild-warm to cold. The massif belongs to three different climatic zones with annual average temperatures ranging from 0 to +7 °C and annual average precipitation varying between 1,000 mm and 1,500 mm. The temperature in July changes from +17 °C to +12 °C, and in January from -3 °C to -10 °C. The sum of active temperatures changes with the altitude from 2,300 °C to 800 °C. Researches were conducted from 2008 to 2018 years.
3. Microbiological study of soil was performed in sterile conditions. The method of serial dilution was used to obtain the suspension where microorganisms titre were 10^{-3} CFU/ml. - 10^{-5} CFU/ml. 100 µl (CFU-Colony Forming Units) of the soil suspension was evenly distributed on the surface of the medium with a sterile spatula.
4. For the study we used the following media: Endos agar, Meat peptone agar, Strepto agar and Entero agar, Agar-Agar, Eshbi agar, Soil agar, Chapek agar, Starch agar, Fedorova Agar, Vinogradsky Agar, Ashbys agar in 4 repetitions. Petri dishes with study material were incubated in the thermostat at 37ºC for 48 hours in aerobic and anaerobic (Wilson-Blair Agar, Vinogradsky Agar) conditions. Petri dishes with Czapek agar were incubated in the thermostat at 28ºC for 96 hours.

Analysis

Biodiversity of soil microbiome was calculated according to the Shannon index (Magurran, 1988). Shannon's diversity index (H): $H = -\sum Pi \ln (Pi)/$ pi − is the proportion of individuals belonging to species i. The results of the experimental studies were statistically analyzed using the Microsoft Excel program package. Results were expressed as means (±) standard deviation (SD) and (SSD05) smallest significant differences of experiments conducted in quadruplicating. The level of significance selected for the study was $P < 0.05$.

Results

Long-term investigations showed significant changes in the structure of soil microbiome, increased in twice the quantity of oligotrophic and pedotrophic bacteria, micromycetes and actinomyces. Number of ammonifierswas not changed significantly, the quantity of aerobic nitrogen-fixing bacteria decreased by 17%-22%. Changes in the structure of soil microbiome can be caused by two reasons: the influence of external factors and the availability of resources. Resource availability is also likely to be a fundamental driver of microbial succession, but the limiting resources and environmental factors regulating succession will be more complex given the far greater physiological diversity contained within microbial communities and the breadth of environments in which succession can occur. In autotrophic succession, nutrients and light (or the availability of inorganic electron donors) are likely to be the primary resources limiting biomass accumulation. However, in the earliest stages of autotrophic succession, heterotrophs may also be in relatively high abundance, utilizing trace levels of available carbon. During endogenous heterotrophic succession, labile substrates will be consumed first, supporting copiotrophic microbial taxa that are later replaced by more oligotrophic taxa that metabolize the remaining, more recalcitrant, organic C pools in the later stages of succession. Endogenous heterotrophic succession cause increasing biomass of oligotrophic bacteria and decreasing phylogenetic diversity (Figure 1). Diversity is indicate, how changed microbial communities during succession. After 10 years, fluctuation of microbial diversity at different altitudes was the same. But it should be noted that in 2008 the Shannon index fluctuated within (4.54-2.10), after 10 years the values of this index decreased by an average of 15% and ranged from 3.45 (at altitude 500 m.a.s.l) to 1.72 (at altitude 1100 m.a.s.l)



Note: The data are statistically significant, P < 0.05, x ± SD, n = 4

Figure 1. Diversity of soil microbial community

Conclusion

Soil microbial community diversity changed along successional time, but it showed significant difference at altitude 700-800 meters above sea level, which indicate hot spots in edophotopes at this altitude. Soil Microbiome promises to be a sustainable and eco-friendly approach for effect and affects to soil microbiota. Our analysis was confirmed by the quantity of soil microorganism and they functional activity. Endogenous heterotrophic succession caused increasing biomass of oligotrophic and pedotrophic bacteria and decreasing microbial diversity. Diversity indicates, how changed microbial communities during succession. After 10 years, fluctuations of microbial diversity at different altitudes were the same. Multiparametric indices are recommended for environmental impact assessment of soils and monitoring study: microbiological and biochemical. Long term monitoring allowed determining hot spots in structural and functional successions of soil microbiome.

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BIOCHAR

A BLACK FUTURE FOR PLANT PATHOGENS

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Crop growth and productivity are fiercely influenced by manifold biotic and abiotic stresses such as pests, drought, salinity, extreme temperature, etc. and notably soil quality. The exaggerated use of chemical fertilizers has led to the worsening of the environment inciting infinite worries. Not only does it reduce the nutrient composition of plants, but it also degrades soil fertility in the long run and affects soil microbiota. Biofertilizers, on the other hand, can revitalize soils by improving soil fertility and thus can be used as an effective tool for sustainable agriculture to reduce stress in agroecosystems.

Soil amendments should have properties such as high binding capacity and environmental compatibility, and should not adversely affect soil structure, soil fertility, or the ecosystem as a whole. Besides being a nutritional source, organic amendments have been proposed to reduce plant disease incidence caused by soil-borne pathogens. The use of pioneering amendment biochar has been approved as a sustainable practice and is a promising way to ameliorate plant health by nurturing soil quality in view of nutrition and by combating soil-borne pathogens.

Biochar: black gold of agriculture

The word "biochar" can be divided into two parts bio (biological in origin) and char (charcoal) which means biochar is a charcoal-like carbon-rich material that is derived from an array of organic materials that are biological in origin. Biochar is basically distinguished from charcoal by its final end use *i.e.*, biochar is used for agriculture and environmental management whereas charcoal is used as fuel and energy.

Properties of biochar

- Biochar is black finely grained charcoal-like
- Highly porous with a large surface area
- Neutral to high pH
- High carbon content
- Inclusive of elements *viz.*, carbon, hydrogen, oxygen nitrogen and

sulfur as well as minerals in the ash fraction

The importance of biochar in agriculture is explained in Fig-1.

Biochar as a disease-suppressing agent

Biochar typifies as an innovative and promising approach to control a myriad of plant diseases caused by both soilborne and airborne plant pathogens. When applied to the soil, biochar may awfully influence the multiplex rhizosphere-root-soil-pathogen system in the wake of physicochemical properties *viz.*, nutrient content, redox activity, water holding capacity, pH, adsorption ability and level of toxic and hormone-like compounds, consecutively affect the factors of disease triangle either directly or indirectly.

Mechanisms of disease suppression

Biochar combats plant pathogens by following five distinct mechanisms:

a. Biochar-mediated chemicals act as elicitors that induce systemic resistance in the host plants and also indirectly induce the accumulation of ROS and phenolic compounds.
b. Because of its large surface area and high porosity, biochar can provide shelter and nutrition for many beneficial microorganisms that in turn enhance induced systemic resistance (ISR) within the host plants.
c. Revamping of soil quality with respect to nutrient availability and abiotic conditions that aid the plant vigor, morphological, histological and functional properties of plant tissues and also maintain an elevated level of inhibitory compounds in tissues or enable quicker plant responses to pathogen attack.
d. During pyrolysis, an array of organic compounds are produced which are potentially fungitoxic, have a direct effect on fungal growth.
e. The ability of sorption of phytotoxic and allelopathic compounds, could reduce their contact with root cell walls, thus protecting the plant to some extent.

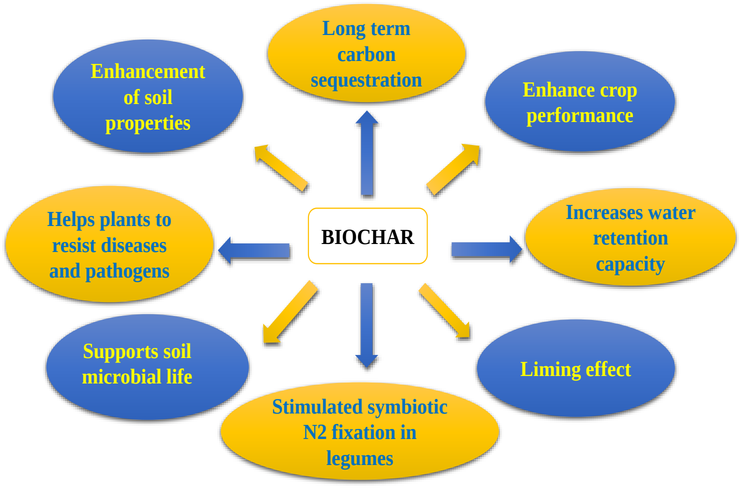

Fig-1 Significant role of biochar in agriculture

Conclusion

Biochar is a wonderful organic soil amendment compared to all other amendments, which has proven its ability to enhance soil physicochemical and biological properties and improve soil health in turn plant health. Also makes the plant strengthen to fight against many soil-borne and air-borne pathogens.

Future research studies should address the usage of specific biochar for diseases of representative crops from different plant families, and for several diseases on a specific crop, in an attempt to identify biochar that is effective in a number of pathosystems. The most useful biochar types and concentrations should be tested in scaled-up experiments on various soil types and in different climate zones.

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SOIL ORGANIC CARBON MANAGEMENT

NEED OF THE MODERN AGRICULTURE

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Carbon (C) is one of the most common elements in the universe and found virtually everywhere, in air, oceans, soil and rock on earth. Soils contain carbon in their organic and inorganic (carbonates) forms. Soil organic carbon (SOC) is the central indicator of soil quality and health. Soil management plays a critical role in whether the carbon remains in the soil or is released to the atmosphere and also can impact both the amount and the composition of soil organic carbon. Soil organic matter is primary source of SOC (58% SOC in SOM) which have primary influence on soil's physical, biological and chemical characteristics. It serves as the primary habitat and food source for soil micro-organisms. Soil moisture holding capacity and nutrient supply are regulated in large part by soil organic matter.

What is soil organic carbon?

According to Soil Science Society of America "SOC refers to the organic fraction of the soil exclusive of un-decayed plant and animal residues". Another definition "SOC is the sum of all biologically derived organic materials found in the soil or on soil surface irrespective of its source, living status or stage of decomposition but excluding the aboveground portion of living plant."

Fractions of soil organic carbon

Soil organic matter is a biological system that functions as whole. But there are components of SOM/SOC that are considered as separate pools (Fig. 1). SOM management should focus on strategies that build all three pools.

1. The labile/active pool/particulate organic carbon: Recently added organic residues and soil micro-organisms. Important for nutrient release in available forms.

2. Intermediate pool: Strongly influence soil's physical condition and nutrient buffering capacity. Includes microbially processed organic carbon that is partially stabilized and protected through physical and biochemical processes.

3. Slow pool /inert pool/stable pool: It is old, highly stabilized, highly recalcitrant pool that is resistant to further breakdown, represents the products of the last stage of decomposition that influences the cation exchange capacity of the soil and physics.

Importance of soil organic carbon in agriculture

1. Soil organic carbon as the basis of soil fertility: Soil organic carbon is important for all three aspects of soil fertility e.g. chemical, physical and biological fertility which affects the soil health in following ways.

- Nutrient availability.
- Soil structure and soil physical properties.
- Biological soil health.

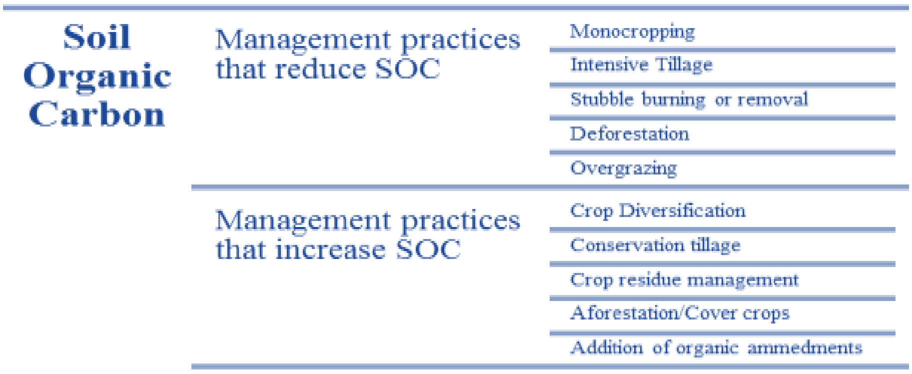
Fig. 1 Turnover periods of different soil organic carbon fractions

2. As a buffer against toxic and harmful substances: Soil organic matter can lessen the effect of harmful substances e.g. toxins, and heavy metals, by sorption of them, and increasing degradation of harmful pesticides.

3. Soil organic carbon as a sink for atmospheric carbon: Soil organic carbon sequestration is the process by which carbon is fixed from the atmosphere via plants and organic residues and stored in the soil.

Managing soil organic carbon

Increasing population putted pressure on earth to produce more in less time in the form of intensive agriculture and agriculture system changed drastically. Depleting soil organic carbon is the one of consequences of these changes. Various agricultural management practices affecting soil organic carbon has been listed below.



Management plans to increase soil organic carbon should include following two approaches.

A. Strategies to increasing carbon input:

1. Recycling residues/waste

a. Crop residues: Incorporation or retention of residue after crop harvest.

b. Animal waste: Organic manures made from animal waste.

c. Industrial biproducts of Agro-industries: By-products like oil cakes, sugarcane bagasse, press mud, fruit and vegetable processing wastes.

2. Growing biomass

a. Cover Crops: The legumes crops grown in spring or in between a widely spaced crop.

b. Crops with more root biomass: Growing crops like legumes, grasses.

c. Agroforestry/Biomass Plantation: Trees can have great potential to add C in the soil.

d. Green manures: Incorporation of green biomass add soil nutrients and soil organic C.

B. Strategies to decrease carbon losses:

1. Reducing soil erosion

a. Conservation tillage: Cultivation is either reduced (minimum tillage) or completely eliminated (zero tillage) and stubble/residue is retained on soil surface.

b. Cropping systems: Adoption of appropriate cropping system.

c. Engineering practice: Many land shaping techniques reduce erosion so finally reducing carbon and other nutrient loss from the soil.

2. Minimizing decomposition

a. Managing soil surface cover: Cover crops, grasses can help in managing to soil covered to reduce the loss of organic carbon.

b. Reducing tillage: Reduced tillage reduces carbon losses from both reduced cultivation and reduced fossil fuel usage, both of these lead to organic carbon increases.

Conclusion:

In ancient times the agriculture system was self-sustainable but due to intensive farming for huge demand of increased population, agriculture self-sustainability system destroyed and agriculture production adversely affected. Soil organic carbon affects crop production and productivity in various ways hence acquire important place in agricultural system management. To maintain the crop production and productivity a strong support system in needed to improve soil health. Integrated approach of fertilizer management, conservation agriculture, diversified farming and many other approaches may help to soil to regain its viability and sustainability.

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TREND ANALYSIS OF FERTILIZER PRODUCTION AND CONSUMPTION IN INDIA

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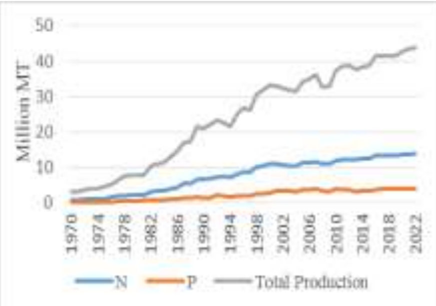
The agriculture sector is an important aspect of the country's economy, and fertilizers have played an important role in its expansion. It is sufficient to mention that the country has attained and maintained historically unparalleled output growth over the last 50 years. India made a great production of food grains with the help of a new strategy in the period of the green revolution which was introduced in the mid-sixties. The strategy was the combination of high-yield varieties, fertilizers, machines, and pesticides. Among these, Fertilizers are prominent in boosting production and productivity. After this, fertilizer consumption in India has been steadily increasing to attain the food demand of the country's growing population. At present, India is the second largest producer and consumer of fertilizers in the world. The major fertilizers are categorized as Nitrogen, Phosphorus, and potassium fertilizer. To understand the production and consumption of fertilizer, this article calculates and explains the growth rate of production and consumption.

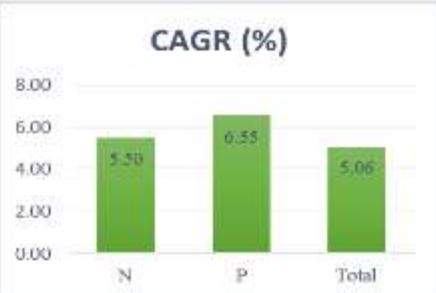
Fertilizer production

The total production of fertilizer at 43.74 million MT during 2021-2022 had a positive growth rate of 5.06% over the period 1970-71. In long-term analysis, the production of N and P_2O_5 fertilizer at 13.87 million MT and 3.85 million MT increased by 5.50% and 6.55% respectively during 2021-22. In short-term analysis, phosphate at 3.85 million MT during 2021-22 witnessed a marginal decline of 2.4% over 2020-21. Another side, the 100% usage of potassium fertilizer depends on imports. Because the resources of commercially usable potash or potassium compound are unavailable in our country.

Fertilizer consumption

Since the green revolution, the consumption of fertilizer has been increasing year by year. The total consumption of fertilizer was 2.26 million MT in the base year 1970-71 and it increased to 29.80 million MT in 2021-22 with an annual growth rate of 5.01 percent. In total consumption, Nitrogen, phosphorus, and potassium fertilizers share 65 %, 26%, and 9% respectively. The consumption of N, P_2O_5, and K_2O at 19.44 million MT, 7828 MT, and 2.53 million MT during 2021-2022 increased by 4.86%, 5.56%, and 4.70% respectively over 1970-71. The maximum growth of consumption



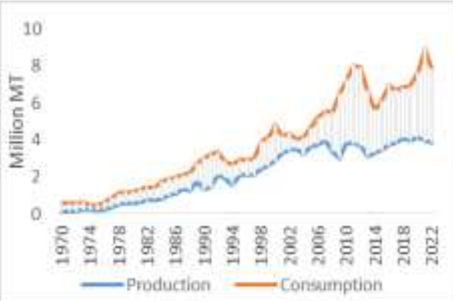


observed in potassic fertilizer. The highest consumption of fertilizer was recorded in 2020-21 at 32535 MT. According to the annual review, the All India NPK use ratio changed from 6.5:2.8:1 in the previous year to 7.7:3.1:1 during 2021-2022. From the figure, total fertilizer consumption started to decline at 8.4% in the period 2021-2022 compared to the previous year.

Gap analysis

The production and consumption of nitrogen fertilizer showed a positive trend. Even though, the gap between production and consumption is still present. From the below figure, it depicted that there is a positive trend in the gap between production and consumption. In 2000 and 2002, production was able to meet our consumption. The reason for this unbalance was the slow growth rate of production compared to the growth rate of consumption. The difference between the production and consumption of phosphatic fertilizers also expressed a similar pattern in nitrogen fertilizer. The

Gap analysis of N fertilizer



Gap analysis of P_2O_5 fertilizer

unbalance showed an increasing trend. Therefore, the self-sufficient production of fertilizer is not yet attained. The gap between the production and consumption of fertilizer is filled by imports from China, Russia, United Arab Emirates, and Saudi Arabia. So, India became the third largest importer of fertilizer in the world.

Conclusion

In India, the production and consumption of fertilizer had a positive growth rate without attaining the self-sufficiency of our country's needs. But India has the potential to produce nitrogen and phosphorus fertilizers for domestic consumption. Therefore, policies have to create an encouraging environment for domestic industries and existing industries have to increase their efficiency. Instead of domestic production, Increasing the imports will become a burden for the government due to increasing international prices of fertilizers. Another side, the subsidies played a significant role to increase fertilizer consumption. Same time it leads to an imbalance in the use of fertilizers. Therefore, Experts recommended that India needs to move towards balanced fertilizer consumption with an increased focus on micronutrients and organic fertilizer.

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RADAR APPLICATION IN AGRICULTURE

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RADAR, as indicated by the name, it is based on the use of radio waves, belongs to the group of active sensors for remote sensing. Radar works in microwave range of EM spectrum, mostly in frequency range of 0.05-40GHz. The specific frequency range of the radio waves used in radar can vary depending on the application and requirements of the system. Radars emits electromagnetic waves similar to wireless computers and cell phones. The signals are sent out as short waves which may be reflected by objects in their path, in part reflecting back to the radar. When these short waves come in contact with precipitation, part of the energy is scattered back to the radar. This concept is similar to hearing an echo.

Components of RADAR

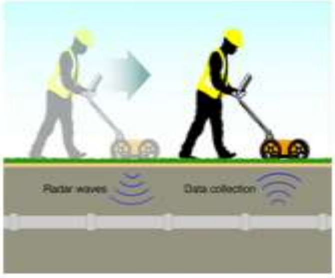
A radar system consists of several key components that work together to facilitate the detection, ranging, and tracking of objects. Transmitter, Antenna, Receiver, Duplexer and Display System are the main components of a radar system:

Working principle of radar

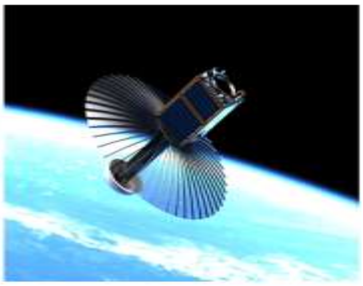
The transmitter generates the radio frequency (RF) signals or microwaves that are emitted into space. It produces high-power electromagnetic waves that are directed towards the target area. The antenna is responsible for transmitting the RF signals into space and receiving the reflected signals (echoes) from objects. It plays a crucial role in determining the radar's coverage and beam shape. Antennas can be designed as a dish, horn, phased array, or other configurations depending on the specific application. The receiver captures and amplifies the weak echo signals received by the antenna. It extracts the desired information from the received signals

Dopper weather RADAR

Defense RADAR



Ground Penetrating RADAR



Synthetic Aperture RADAR

and prepares them for further processing. The duplexer is a device that allows the radar system to alternate between transmitting and receiving. It ensures that the high-power transmitter does not damage the sensitive receiver by separating the outgoing and incoming signals. The display system presents the information obtained from the signal processor in a human-readable format. It can be a visual display, such as a radar screen or monitor, or an auditory display, such as a sonar-like ping.

Wavebands used for detection of different parameters

Radar systems operate in various frequency bands, each with its own characteristics and applications. The choice of frequency band depends on factors such as the desired range, resolution, target size, atmospheric conditions, and regulatory constraints.

Cyclone detection: S-Band radar is typically used for the detection of cyclone and have a wavelength range of approximately 7.5-15 cms. 10 cm waveband is used for the cyclone detection.

Thunderstorm detection: S-Band or C-Band radar is used for the detection of thunderstorm and lightening. The wavelength range for C-Band radar is around 3.75 centimeters to 7.5 cms.

Rainfall detection: Radar systems used for rainfall detection typically operate within the S-Band, C-Band, or X-Band. The wavelengths for X-Band radar is approximately 2.5 centimeters to 3.75 centimeters.

Types of RADAR

There are various types of radar systems, each designed for specific purposes. These include weather radar, surveillance radar, synthetic aperture radar (SAR), ground-penetrating radar (GPR), air defense radar, and more. Different radar systems use different frequencies, antenna configurations, and signal processing techniques depending on their intended application.

Applications of RADAR in agriculture

Soil moisture monitoring: Ground-penetrating radar (GPR) can assess soil moisture content by measuring the dielectric properties of the soil. This information helps farmers optimize irrigation practices, conserve water, and improve crop productivity.

Crop growth monitoring: Radar-based remote sensing can provide valuable information about crop growth and development. Synthetic Aperture Radar (SAR) systems mounted on satellites or aircraft can detect changes in crop structure, biomass, and health, enabling farmers to identify areas requiring attention and take appropriate actions.

Crop mapping and yield estimation: Radar-based imaging can create detailed maps of agricultural fields, allowing farmers to identify variations in crop health, growth, and yield potential. This information helps in optimizing resource allocation, such as adjusting fertilizer application rates and irrigation schedules.

Pest and disease detection: Radar technology can aid in the early detection of pests and diseases affecting crops. By analyzing radar images, farmers can identify abnormal plant responses, such as changes in canopy structure or moisture content, enabling timely intervention and targeted pest management strategies.

Weather monitoring: Radar systems are essential for monitoring weather patterns, including rainfall intensity, storm tracking, and severe weather events. This information is crucial for farmers to make timely decisions related to planting, harvesting, and other farm operations, minimizing weather-related risks.

Precision agriculture: Radar technology, when combined with other data sources like GPS and geographic information systems (GIS), enables precision agriculture techniques. It helps farmers create accurate field maps, target specific areas for input application (e.g., fertilizers, pesticides), and optimize resource utilization, leading to improved efficiency and environmental sustainability.

These applications demonstrate how radar technology contributes to enhancing agricultural practices, enabling farmers to make data-driven decisions and achieve higher yields while minimizing inputs and environmental impact.

■■■

IMPORTANCE OF WEATHER MONITORING
FROM AN AGRICULTURE PERSPECTIVE

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Weather refers to the atmospheric conditions in a specific location at a particular time. It includes temperature, humidity, precipitation, wind speed, wind direction, atmospheric pressure, sunshine hours, cloud cover, etc. The study of weather is known as meteorology, and it involves observing, measuring, and analysing weather patterns to make predictions about future weather conditions. The weather impacts people's everyday lives, including transportation, agriculture, outdoor recreation, and safety.

The most essential weather parameters include the following:

Temperature: The measurement of hotness or coolness is temperature. It can vary significantly from place to place and day to day and usually measures in degrees Celsius (°C) or Fahrenheit (°F). the temperature impacts; how we feel, what we wear and how some materials behave.

Humidity: Humidity refers to the amount of water vapour in the air. It's usually measured as relative humidity, the percentage of water vapour in the air relative to the maximum amount the air can hold at that temperature. How hot or cold we feel and how well our bodies can control our internal temperature can be affected by humidity.

Precipitation: Precipitation refers to any form of water that falls from the atmosphere, including rain, snow, sleet, hail, dew, mist, etc. Many factors influence precipitation, including temperature, humidity, and air pressure. It is critical in many aspects of life, from agriculture to water management.

Wind speed and wind direction: Wind is the movement of air from an area of high pressure to an area of low pressure. Wind speed is measured in kilometres per hour (km/h), while wind direction refers to the direction from which the wind is blowing.

Atmospheric pressure: Atmospheric pressure is the force exerted by the weight of the air in the atmosphere. It's usually measured in units called millibars (mb) or mm of mercury (mmHg). Changes in atmospheric pressure can affect weather patterns and cause storms or changes in wind direction.

Cloud cover: Cloud cover refers to the amount of the sky covered by clouds. It's usually measured as a percentage, with 0% indicating clear skies and 100% indicating complete cloud cover. Clouds can affect the amount of sunlight that reaches the surface and temperature and precipitation patterns.

Weather is influenced by many factors, including the amount of sunlight that reaches the Earth's surface, the Earth's rotation and tilt, the distribution of land and water, and the movements of air masses around the planet. These factors can create complex and ever-changing weather patterns that can be difficult to predict and prepare. Weather monitoring is critical for understanding and preparing for how weather can affect human lives and communities. By collecting and analysing weather data, we can better predict and respond to potential weather-related impacts, helping to ensure the safety, health, and well-being of people and ecosystems worldwide. So, weather monitoring is essential concerning the following aspects:

1.Agriculture: Weather monitoring is extremely important for farmers and other agricultural producers since they need to know when it is the best time to start for sowing, applying irrigation, and harvesting their crops. Farmers may better manage their livestock and prepare for potential losses caused by the weather if they have access to current weather conditions and forecasts.

2.Safety: Weather monitoring can help people prepare for and respond to hazardous weather conditions, such as thunderstorms, hurricanes, tornadoes, and blizzards. Early warning systems can give people time to evacuate, take shelter, or prepare their homes and businesses for potential damage.

3.Public health: Weather conditions can affect public health in many ways, such as air quality, disease transmission, and exposure to extreme temperatures (heat waves). Weather monitoring can help public health officials to prepare for and respond to potential health impacts.

4.Transportation: Weather conditions can have a significant impact on transportation, including roadways, railways, air travel, and shipping. Weather monitoring can help transportation companies to adjust their schedules, reroute shipments, and take other measures to ensure safe and efficient transportation.

5.Energy production: Weather conditions can affect the production and distribution of energy resources, including solar, wind, and hydroelectric power. Weather monitoring can help energy producers optimize their operations and plan for disruptions.

6.Planning and decision-making: Weather monitoring is also essential for many businesses, governments, and other organizations that must make informed decisions based on current and future weather conditions.

Weather monitoring is particularly important for farmers, who rely on weather conditions to plan and manage their agricultural operations. Here are a few ways in which weather monitoring can benefit the farmers:

1.Timing of planting and harvesting: Farmers need to know when to plant their crops and when to harvest them. Weather monitoring can help farmers determine optimal timing for sowing and harvest based on temperature, precipitation, soil moisture, etc.

2.Irrigation management: Almost all crops require regular watering to grow and thrive. Weather monitoring can help farmers to manage irrigation by providing information about rainfall, evaporation rates, and soil moisture levels.

3.Pest and disease management: Weather conditions can significantly impact the spread of pests and diseases that can harm crops. Farmers can take preventive measures to reduce the risk of infestations and outbreaks by monitoring weather patterns.

4.Crop yield predictions: Weather conditions can influence the size and quality of crop yields. Weather monitoring over time allows farmers to develop models to predict crop yields and plan accordingly.

5.Risk management: Weather events such as droughts, floods, and storms can cause significant damage to crops and livestock. By weather monitoring, farmers can minimise risk, diversify their crops, purchase crop insurance, and implement emergency response plans.

By understanding current and future weather patterns, farmers can optimize their production and reduce risk, helping to ensure a stable and sustainable food supply for local and global communities. Meteorologists use various tools and techniques to observe and measure weather parameters, including satellites, radar, weather balloons, and ground-based weather stations. They also use computer models to predict future weather patterns, which can help people prepare for severe weather events and manage resources more effectively.

Automatic Weather Station (AWS)

An automatic Weather Station (AWS) is a system designed to automatically collect weather data from the environment and transmit that data to a central database or server for analysis and processing. AWS typically includes sensors that measure various weather parameters, viz., temperature, humidity, rainfall, wind speed, wind direction, solar radiation, etc. AWS can be an especially valuable tool for farmers in regions with highly variable weather patterns, and conditions can change rapidly. By collecting data over time, farmers can better understand local weather patterns and develop predictive models that can help them anticipate future weather events and make proactive decisions to protect their crops. In addition to benefiting farmers directly, AWS data can be shared with local and regional weather monitoring networks to improve overall weather forecasting and climate modelling. This can help build more resilient agricultural systems and support sustainable farming practices better adapted to changing weather patterns.

Automatic Weather Station can be an essential tool for farmers looking to optimize their crop management strategies, minimize risk, and build more resilient agricultural systems. The main components of AWS are as follows:

1.Sensors: The sensors used in AWS can vary depending on the specific needs of the user but typically include sensors for measuring temperature, humidity, rainfall, air pressure, wind speed, and wind direction. Some AWS also have sensors for measuring solar radiation, soil moisture, and other parameters.

2.Data logger: The data logger is a device used to collect and store sensor data. It is typically equipped with a microprocessor, memory storage, and a communication port for transmitting the data to a central database or server.

3.Power supply: AWS typically requires a reliable power source to operate continuously. This can include a battery, solar panel, or other renewable energy source.

4.Communications: AWS needs a way to transmit the collected data to a central database or server. This can be done using various communication methods, including cellular networks, satellite communications, or radio transmissions.

5.Software: Software is used to manage and analyze the data collected by AWS. This can include software for data processing, visualization, and modelling.

All the components of AWS work together to collect and store accurate and reliable weather data that can be used for decision-making. The ability to monitor and collect real-time weather data to meet specific farm needs and generate reports on weather patterns and trends can help farmers to optimize their crop management strategies and improve farm production. AWS data can be extremely helpful to the farming community in improving their crop production by providing real-time, accurate weather information that can help for decision-making and to optimize crop management strategies.

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ENHANCING CLARITY AND QUALITY

THE APPLICATION OF ENZYMES IN FRUIT JUICE CLARIFICATION

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The production of fruit juices involves a series of processes to extract the natural goodness of fruits and deliver a refreshing, nutrient-packed beverage. One essential step in fruit juice production is clarification, which involves the removal of undesirable particles, cloudiness, and sediment to achieve a clear and visually appealing product. While traditional clarification methods such as filtration and centrifugation have been widely used, the application of enzymes has emerged as an effective and eco-friendly alternative. In this article, we explore the various ways enzymes are utilized in fruit juice clarification, enhancing clarity and quality.

Types of enzymes

Out of 4000 known enzymes, about 200 are used commercially. Only Europe continent contributes around 60% of the world's enzymes. They are used to extract, clarify and modify juices from many fruits, including berries, stone and citrus fruits, grapes, apples, pears and even vegetables. So many enzymes are used to clarify fruit juices, including pectinases, amylases, cellulases, arabanase, fructozyme, dextranase, protease, amyloglucosidase, etc. The available commercial pectinase preparations used in fruit processing generally contain amylases, cellulases and a mixture of pectinesterase, polygalacturonase, and pectinlyase.

Enzymatic clarification process

Enzymes are natural catalysts produced by living organisms, which speed up chemical reactions. In fruit juice clarification, enzymes are used to break down the complex components responsible for cloudiness, such as pectin and proteins. Pectin is a natural polysaccharide found in fruits that contributes to the viscosity and turbidity of the juice. Proteins, on the other hand, can cause haze and sedimentation. By employing specific enzymes, fruit juice producers can effectively target and degrade these substances, leading to improved clarity.

Pectinolytic enzymes

Pectinolytic enzymes, including pectinases and pectin methyl esterases (PME), play a crucial role in fruit juice clarification. Pectinases break down the pectin, which is responsible for the formation of gel-like structures and cloudiness in the juice. These enzymes degrade the pectin molecules, reducing the viscosity and facilitating the separation of solids from the liquid phase. PME enzymes, in turn, hydrolyze the methyl ester groups present in pectin, making it more susceptible to the action of pectinases and further improving the juice's clarity.

Proteolytic enzymes

Proteins present in fruit juices can cause haze and sedimentation, impacting their visual appeal and quality. Proteolytic enzymes, such as bromelain and papain, are employed to degrade these proteins into smaller peptides and amino acids, preventing their aggregation and ensuring a clear and stable juice. The use of proteolytic enzymes not only enhances clarity but also improves the overall sensory characteristics of the juice by reducing bitterness and astringency associated with certain proteins.

Benefits of enzymatic clarification

The application of enzymes in fruit juice clarification offers several advantages over traditional methods:

- Improved Clarity: Enzymes effectively break down complex components responsible for cloudiness, resulting in a visually appealing, clear juice. This enhances the product's marketability and consumer acceptance.
- Enhanced Nutritional Profile: Enzymatic clarification selectively targets unwanted components while preserving the natural nutritional content of the juice, including vitamins, minerals, and antioxidants. This ensures that the clarified juice retains its inherent health benefits.
- Reduced Processing Time: Enzymes act as efficient catalysts, accelerating the clarification process and reducing the time required for traditional clarification methods such as filtration and centrifugation. This increases production efficiency and reduces energy consumption.
- Eco-Friendly Solution: Enzymatic clarification reduces the dependency on chemical additives traditionally used for juice clarification. Enzymes are biodegradable, environmentally friendly, and do not leave harmful

residues in the final product or wastewater.

Conclusion

Enzymatic clarification has revolutionized the fruit juice industry by offering an efficient, eco-friendly, and high-quality alternative to traditional methods. Through the targeted action of pectinolytic and proteolytic enzymes, fruit juice producers can achieve optimal clarity, stability, and sensory attributes while retaining the nutritional value of the juice. The application of enzymes in fruit juice clarification not only benefits the producers but also meets consumer.■

STRAWBERRY

A DELICIOUS AND NUTRITIOUS FRUIT

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Strawberries are a delicious and nutritious fruit that is loved by many people around the world. They are small, red fruits that grow on low-lying plants and are known for their sweet and tangy flavour. Strawberries are a good source of several important nutrients, including vitamin C, fibre, and antioxidants. In this article, we will explore the nutritional benefits of strawberries in more detail.

Nutritional value

Strawberries are packed with several important vitamins and minerals that are essential for good health. One cup of strawberries contains 49 calories, 12 grams of carbohydrates, 1 gram of protein, and 3 grams of fiber. They are also a good source of vitamin C, which is an important antioxidant that helps to protect the body from damage caused by free radicals. In fact, one cup of strawberries contains more than 100% of the daily recommended value of vitamin C.

In addition to vitamin C, strawberries are also a good source of folate, which is important for the development of healthy red blood cells. They also contain potassium, which helps to regulate blood pressure, and manganese, which is important for healthy bone development.

Antioxidants

Strawberries are an excellent source of antioxidants, which are compounds that help to protect the body from damage caused by free radicals. Free radicals are unstable molecules that can damage cells and contribute to the development of chronic diseases, such as cancer, heart disease, and Alzheimer's disease. Antioxidants help to neutralize free radicals and prevent them from causing damage.

In addition to vitamin C, strawberries also contain several other important antioxidants, including anthocyanins, ellagic acid, and quercetin. These antioxidants have been shown to have anti-inflammatory properties and may help to protect against chronic diseases.

Fiber

Strawberries are a good source of fiber, which is important for digestive health. One cup of strawberries contains 3 grams of fiber, which is about 12% of the daily recommended value. Fiber helps to promote regularity, prevent constipation, and may also help to lower cholesterol levels.

Weight management

Strawberries are a great choice for people who are looking to manage their weight. They are low in calories and high in fiber, which helps to promote feelings of fullness and prevent overeating. In addition, the natural sweetness of strawberries can help to satisfy cravings for sugary snacks.

Cancer prevention

Some studies have suggested that the antioxidants found in strawberries may help to prevent the development of certain types of cancer. For example, a study published in the journal Cancer Research found that the ellagic acid found in strawberries may help to prevent the growth of cancer cells in the colon.

Heart health

The antioxidants found in strawberries may also be beneficial for heart health. One study published in the American Journal of Clinical Nutrition found that women who consumed more than three servings of strawberries per week had a lower risk of heart disease compared to those who consumed less than one serving per month.

Conclusion

In conclusion, strawberries are a delicious and nutritious fruit that are packed with several important nutrients, including vitamin C, fiber, and antioxidants. They may also have several health benefits, including cancer prevention, heart health, and weight management. Whether you enjoy them on their own or in a smoothie or salad, strawberries is a great addition to any healthy diet.

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EFFECTS OF GROWTH REGULATORS ON DRAGON FRUIT PRODUCTION

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Dragon fruit belomgs to family (Cactaceae). It is one of the most recent exotic fruit crops to be grown in India. The origins are in Mexico and Central South America's tropical and subtropical forest areas. It is also known by the names Pitaya, Strawberry Pear, Night Blooming Cereus, Queen of Night, Honourable Queen, Cereus triangularis, Jesus in the Cradle, and Belle of the Night. It was originally commonly cultivated as a decorative plant but is now regarded as a fruit crop**.** Plant growth regulators (PGRs) were used in the majority of investigations on the effects of rooting on dragon fruit cuttings, although these concentrations are not recommended for use in greenhouse and field settings. It has several health advantages, particularly its high antioxidant content, is red dragon fruit. Plant cutting propagation is a technique that enthusiasts have long used. Compared to other sexual or asexual plant propagation methods (seeds), it is easier, quicker, and less expensive. Cutting-based breeding should ensure the mother's characteristics and a relatively quick fruiting period. Auxin is a plant hormone that plays a key role in cell division and expansion, therefore plants utilise a variety of cellular mechanisms to control auxin levels and response.Chemicals called "growth regulators" control all aspects of plant development and growth, Increased output, higher crop tolerance to abiotic stress, and improved physiological features of crops are all results of the use of plant growth regulators. The idea of plant hormones serves as the foundation for the concept of growth regulators. Due to their crucial function in plant growth and development, plant growth regulators are mostly used to do this. The hormonal condition of the plant is directly impacted by the "correct" plant growth regulators. Hormone receptor blockers, plant hormones or their synthetic analogues, and inhibitors of hormone production or translocation all serve as examples.

Chemicals known as plant growth regulators control every aspect of a plant's growth and development. It also goes by the titles phytohormones and plant growth hormones.

Based on their actions, plant growth regulators are broadly classified into two major groups:

- Plant growth promoters
- Plant growth inhibitors.

Auxins, Gibberellins, and Cytokinins are grouped into Plant growth promoters while Abscisic acid and Ethylene are grouped into Plant growth inhibitors.

Phases of growth

Meristematic, elongation, and maturation are the three steps that make up the growth period.Let's examine the root tips to better grasp this. The meristematic stage of development is represented by the continuously proliferating cells at the shoot and root apex. The protoplasm in these cells is abundant, and their nuclei are big and noticeable. Their basic cell walls are thin, cellulosic, and have a lot of plasmodesmatal connections. The elongation phase is represented by the cells immediately next to the meristematic zone, distant from the tip. The properties of the cells during this phase include increased vacuolation, cell expansion, and the deposition of new cell walls. The segment of the axis that is going through the maturation phase is located closer to the apex, or more proximal to the phase of elongation. In terms of wall thickening and protoplasmic changes, the cells in this zone grow to their largest size.

Growth rates

Growth rate is defined as the increased growth per unit of time. As a result, the rate of growth may be mathematically represented. There are several ways for an organism or a component of the organism to multiply its cells. The growth rate exhibits an increase that might be either geometrical or arithmetic. There are two techniques to compare the development of biological systems quantitatively:

1) Measurement and the comparison of total growth per unit time is called the absolute growth rate.
2) The growth of the given system per unit time expressed on a common basis, e.g., per unit initial parameter is called the relative growth rate.

Why it so necessary?

In order to grow plants that are true to type, vegetative propagation of dragon fruit is highly desirable. Therefore, vegetative means of propagation, like as stem cuttings, are used since they are quick, easy, economical, and don't need specialized procedures as other ways do. There are few publications on research into the application of growth regulators for enhanced root development and the production of Dragon fruit from cuttings. Consequently, research was done on how to quickly multiply the dragon fruit by employing several growth regulators.

Effect of different plant growth regulators on shooting of stem cuttings in dragon fruit

In contrast to plants produced from seeds, which take three years to develop fruit where the dragon fruit cultivated by stem cuttings begin to bear fruits twelve to eighteen months after planting. Because the stem may be quickly and easily removed after the fruiting season, cutting the stem from the mother plant is practical. However, rooting problems with stem cuttings can also lead to lower output. The experiment is thus carried out to ascertain the impact of growth regulators and their mixtures on the shooting of stem cuttings. Cuttings treated with IBA7000ppm required fewer days for sprout initiation than those treated with IBA 6000ppm and IBA 5000ppm across the various concentrations. Significantly, untreated cuttings required the most days for the first sprouting. Because hydrolytic enzymes are activated, reserve carbohydrates, nitrogen, and other nutrients held in stem cuttings may be used more effectively.

Effects of season and GA_3 concentrations on *Hylocereus undatus* flowering

GA_3 can postpone cropping, hence increasing pitaya yield. Other impacts of gibberellin include its involvement in cell elongation, which results in larger and heavier fruits, as well as an increase in fruit set. Taken together, these actions result in increased fruit output and fruit quality. Accordingly, this study details the impact of gibberellin (GA_3) concentrations and spray application season on *Hylocereus undatus'* blooming and production characteristics.

Effects of plant growth regulators on seed germination and callus induction

Grafting, vegetative propagation, and seed propagation are all methods for growing dragon fruit plants. The three traditional techniques of seed propagation, vegetative means using stem cuttings, and grafting are currently unable to satisfy the demands of the market. Additionally, there is no thorough in vitro propagation procedure for this specific species that would allow for the production of several superior plants with desirable characteristics. The limitations of seed propagation can be circumvented by using vegetative propagation techniques like stem cutting and grafting. However, callus induction is the first step of establishing In vitro cultures to obtain secondary metabolites in various plants. There is currently no widely available information on a systematic set of protocol for the establishment of In vitro and callus induction of this particular species of dragon fruit. Therefore, this study was aimed to establish callus culture of *Hylocereus costaricensis.* To achieve this objective, germinated seeds were grown on medium fortified with various concentrations of PGRs for callus induction.

Effect of different plant growth regulators on micropropagation pitaya varieties

Plant tissue culture in fruit science is one of the key applications of plant biotechnology. Several clonal micropropagation techniques are used in plant tissue culture systems. The list of techniques used in plant tissue culture has been extended to include somatic embryogenesis, organogenesis, haploid plant production, and somatic hybridization. Additionally, it is well recognised that research on plant tissue cultures might result in secondary plant metabolites. The creation of efficient tissue culture procedures is crucial for both quick and widespread reproduction and the preservation of genetic resources. The components of the culture medium, the kind of plant explant, the genotype, and the proper growth conditions are all important for in vitro micropropagation success. Therefore, investigations using plant tissue culture benefit greatly from new and revised techniques. This study seeks to assess the impact of several PGRs on roots and micropropagation in in vitro propagation of various pitaya cultivars. This paper adds to the production of these economically significant pitaya cultivars while introducing new techniques to the literature.

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IMPACT OF MODERN AGRICULTURE ON THE ENVIRONMENT AND HEALTH

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Agriculture is an essential source of income since it involves the process of growing plants and livestock to provide food, feed, fiber, and a variety of other desirable items. Agriculture and the environment have a strong and complex interaction. Agricultural practices that are environmentally conscious improve the environment, yet intense agriculture can have a negative influence on nearby ecosystems and the environment on a broader scale. Agriculture may have a big environmental impact. While the negative effects are severe, including pollution and degradation of soil, water, and air, agriculture can also have a positive impact on the environment, for example, by trapping greenhouse gases within crops and soils or mitigating flood risks through the use of certain farming practices.

Modern agriculture

Modern agriculture is a developing approach to agricultural inventions and farming practices that assist farmers boost efficiency and minimize the quantity of natural resources needed to fulfil the world's food, fuel, and fiber demands, such as water, land, and energy. Modern agriculture is also known as agribusiness, intensive farming, organic farming, and sustainable agriculture.

Impact of modern agriculture

As we all know, modern agriculture has increased food affordability, increased food supply, assured food safety, increased sustainability, and produced more biofuels. However, because it is based on a high input-high output technology that uses hybrid seeds of high-yielding varieties and sufficient irrigation water, fertilizers, and pesticides, it also causes environmental difficulties.

1. Soil erosion

Due to an abundance of water, the top productive soil of the agriculture is removed. This results in the loss of nutrient-rich soil, which reduces production. It also contributes to global warming because silt from bodies of water triggers the release of soil carbon from particulate organic material.

2. Waterlogging and eutrophic-cation

The salinity of the soil is one of the causes of reduced production due to poor farm drainage management. In this condition, the roots of plants do not obtain enough oxygen to breathe, resulting in reduced crop output and mechanical strength. Eutrophication refers to the introduction of manufactured or natural compounds into a freshwater system, such as nitrates and phosphate, via fertilizers or sewage. It causes an increase in the water body's primary production or the 'bloom' of phytoplankton. Excessive usage of nitrogen and phosphate fertilizers causes overnutrition of lakes and water bodies, resulting in the phenomena called eutrophication (*Eu* means more, *trophication* means nutrition).

3. Greenhouse effect

Food production in modern agriculture consumes a lot of energy. One of the negative consequences of modern agriculture is the impact of greenhouse gases on the environment. Agriculture contributes to global warming by emitting significant amounts of methane into the atmosphere as a result of cattle rearing (enteric fermentation), rice cultivation, and the burning of vegetation to create way for new fields. According to a recent assessment from the Centre for Biological Diversity, modern agriculture accounts for up to 25% of global greenhouse gas emissions. Carbon dioxide from soil respiration, nitrous oxide from fertilizers, methane from cattle digestion, and solid waste decomposition are all included in this figure. CO_2 emissions from deforestation are caused by the extension of farming operations into forests or other formerly uncultivated regions.

4. Excessive pesticides use

Many insecticides are used to eliminate pests and increase crop productivity. Arsenic, Sulphur, lead, and mercury were once employed to eliminate pests. Pesticides including DDT were utilized, but regrettably, they also targeted beneficial pests. Most significantly, many pesticides are non-biodegradable and have been connected to food chains that are toxic to humans.

5. Groundwater depletion

Groundwater is one of the most important sources of irrigation water. Nitrogenous fertilizers from agricultural fields leak into the soil and eventually pollute groundwater. When the nitrate level in groundwater surpasses 25 mg/l, it can produce a major health concern known as "Blue Baby Syndrome," which mostly affects babies and can lead to death.

Modern agriculture impacts on health

Modern agriculture has had both positive and negative impacts on human health. Here are some key points to consider:

Positive impacts:

1. **Increased food production:** Modern agricultural practices have significantly increased food production, allowing for a more reliable and abundant food supply. This has helped to alleviate hunger and malnutrition in many parts of the world.
2. **Improved nutrition:** Modern agricultural techniques have allowed for the cultivation of a wide variety of crops, providing a more diverse range of nutrients in the diet. This has helped improve overall nutrition and reduce deficiencies in certain regions.
3. **Disease prevention:** Advances in agricultural technology have enabled the development of more effective pest control measures, reducing the incidence of crop diseases and insect-borne illnesses. This indirectly contributes to better public health by reducing the spread of diseases.

Negative impacts:

1. **Pesticide use:** Modern agriculture relies heavily on pesticides to control pests and diseases. While these chemicals are effective in protecting crops, excessive and improper use can lead to environmental contamination and potential health risks for farm workers and consumers. Prolonged exposure to certain pesticides has been linked to various health issues, including cancer, reproductive disorders, and neurological problems.
2. **Antibiotic resistance:** In intensive livestock farming, antibiotics are often used to promote growth and prevent diseases. The overuse and misuse of antibiotics in agriculture contribute to the development of antibiotic-resistant bacteria, posing a significant threat to human health by reducing the effectiveness of these drugs in treating infections.
3. **Environmental pollution:** Intensive farming practices, such as the use of chemical fertilizers and the release of animal waste, can lead to water and soil pollution. This

pollution can have adverse effects on human health when contaminated water is consumed or when pollutants enter the food chain.

4. **Reduced nutrient content:** While modern agriculture has increased food production, there are concerns about the declining nutrient content of some crops. Factors such as soil degradation, selective breeding for yield and reliance on synthetic fertilizers can result in lower levels of certain vitamins, minerals, and antioxidants in crops, potentially impacting human health.
5. **Genetic modification:** The genetic modification of crops has been a topic of debate. While genetically modified organisms (GMOs) have the potential to increase crop yields and enhance resistance to pests and diseases, concerns exist regarding their long-term impact on human health and the environment. However, extensive research and regulation are in place to ensure the safety of GMOs.

It is important to note that the impact of modern agriculture on health can vary depending on the specific practices employed, the region, and various socioeconomic factors. Efforts are being made to address the negative impacts through sustainable farming practices, organic farming, and the promotion of agroecology, which focuses on ecological principles to support both human and environmental well-being.

Conclusion

Modern agriculture has evolved over the previous century, and its environmental impact is enormous. Industrial farming, which comprises large-scale monoculture, and organic farming, which focuses on small-scale diverse farms, are the two primary types of modern agriculture. Industrial farming is a style of farming in which the goal is to maximize farm size and productivity. It largely relies on technology developments to boost farmer production and profit margins. The primary negative environmental repercussions of contemporary agriculture include soil deterioration, water pollution, and greenhouse emissions.

RISK MANAGEMENT STRATEGIES
FOR CLIMATE CHANGE IN AGRICULTURE

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Climate change poses significant risks to agricultural systems worldwide. Increasing temperatures, changing precipitation patterns, extreme weather events, and rising sea levels are some of the challenges farmers face. To ensure food security and sustainable agricultural practices, it is crucial to adopt effective risk management strategies. This article explores key approaches to managing climate change risks in agriculture.

Crop diversification

One strategy to mitigate climate risks is crop diversification. Planting a variety of crops with different growth requirements and tolerances can help buffer against climate-related shocks. Diversification spreads the risks associated with changing climate conditions, as some crops may perform better under specific circumstances. Farmers can explore resilient and climate-adaptive crops suitable for their region, which can help maintain productivity and economic stability.

Improved water management

Water scarcity and irregular rainfall patterns are common consequences of climate change. Implementing efficient irrigation techniques, such as drip irrigation and precision farming, can optimize water use. Moreover, adopting water harvesting and conservation practices, such as constructing ponds and rainwater harvesting systems, can provide supplementary water during dry spells. Integrating water management strategies into farming practices is essential for climate resilience.

Enhanced soil health

Healthy soils are crucial for climate-resilient agriculture. Conservation practices like cover cropping, crop rotation, and organic matter additions improve soil structure, water-holding capacity, and nutrient cycling. Healthy soils also sequester carbon dioxide, mitigating greenhouse gas emissions. Implementing sustainable soil management practices maintains agricultural productivity, enhances ecosystem services, and strengthens the resilience of farming systems to climate change impacts.

Integrated pest and disease management

Climate change influences pest and disease dynamics, creating new challenges for farmers. Integrated Pest Management (IPM) approaches, focusing on prevention, monitoring, and ecological strategies, can help manage pests and diseases effectively. By promoting biodiversity, using resistant crop varieties, and adopting cultural practices, farmers can reduce reliance on chemical pesticides while maintaining crop health and productivity.

Weather forecasting and early warning systems

Access to accurate weather information is crucial for farmers to make informed decisions and manage climate risks. Establishing weather monitoring stations and disseminating timely weather forecasts can help farmers plan their agricultural activities accordingly. Early warning systems for extreme weather events, such as cyclones or droughts, can enable farmers to take precautionary measures, protect crops, and minimize losses.

Financial risk management

Climate change impacts can lead to significant economic losses for farmers. Therefore, implementing financial risk management strategies is essential. Farmers can explore climate risk insurance, crop insurance and risk-sharing mechanisms to protect their livelihoods. Government support in the form of subsidies, disaster relief funds, and insurance schemes can help farmers recover from climate-related losses and build resilience.

Conclusion

Climate change poses substantial risks to agriculture, threatening food security and rural livelihoods. However, by adopting comprehensive risk management strategies, farmers can enhance their resilience to climate change impacts. Crop diversification, improved water management, sustainable soil practices, integrated pest management, weather forecasting, and financial risk management are key elements of an effective risk management framework. Encouraging farmers' participation, providing necessary support, and integrating these strategies into agricultural policies and programs are crucial steps towards building climate-resilient agricultural systems.

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ADVANCING COTTON BREEDING TECHNIQUES

EXPLORING HYBRIDIZATION AND SELFING FOR CULTIVAR ENHANCEMENT

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Hybridization and selfing are common techniques used in cotton breeding to develop new cultivars with desired traits. Let's discuss each method separately.

Hybridization

Hybridization involves crossing two different cotton plants with desirable traits to produce offspring that combine the best characteristics of both parents. The general steps involved in hybridization are as follows:

Selection of parents: Two cotton plants with complementary traits are chosen as parents. These traits could include disease resistance, high yield, fiber quality, or any other desirable characteristic.

Emasculation: The flower of one parent, known as the female parent, is emasculated (removal of male reproductive organs) to prevent self-pollination. This ensures that the desired pollen from the male parent is used for fertilization.

Pollination: Pollen from the male parent is collected and carefully applied to the stigma of the emasculated flower of the female parent. The flowers are then protected from contamination to prevent unintended cross-pollination.

Seed development: After successful pollination, the fertilized flower develops into a cotton boll containing seeds. These seeds are harvested, and each seed represents a potential hybrid plant.

Evaluation: The hybrid seeds are grown, and the resulting plants are evaluated for the desired traits, such as yield, fiber quality, disease resistance, or other agronomic characteristics. The best-performing hybrids are selected for further breeding or commercial release.

Selfing (Self-Pollination)

Selfing, also known as self-pollination or inbreeding, involves the fertilization of a flower by its own pollen. Selfing is primarily used to stabilize desirable traits in a cultivar or to produce homozygous lines. The steps involved in selfing are as follows:

Isolation: The cotton plant is isolated from other cotton plants or pollinators to prevent cross-pollination. This can be achieved by bagging the flowers or using cages to exclude insects.

Emasculation (optional): In some cases, emasculation may be performed to ensure that the flower is self-pollinated rather than cross-pollinated. This step involves removing the male reproductive organs (anthers) from the flower.

Self-pollination: The flower is allowed to pollinate itself naturally, or artificial pollination can be performed by transferring pollen from the anthers to the stigma of the same flower.

Seed development: After self-pollination, the flower develops into a cotton boll containing seeds. These seeds represent the next generation and are harvested for further breeding or evaluation.

Evaluation and selection: The resulting plants from selfed seeds are grown, and their traits are evaluated. The plants with desired characteristics are selected for further breeding or genetic improvement.

Doak's method of emasculation and hand pollination

Select a bud from the female parent plant, which possesses the desired traits. Emasculate the bud by carefully removing its male reproductive organs (anthers) to prevent self-pollination. Cover the emasculated bud with a red butter cover to protect it from unintended pollination. Collect pollen from the male parent plant and dust it onto the stigma of the emasculated bud. Cover the pollinated bud with a white butter cover to ensure successful fertilization. Allow the fertilized flower to develop into a crossed boll, which contains seeds representing potential hybrid plants. The resulting crossed plants are grown, and their traits are evaluated. The best-performing hybrids are selected for further breeding or commercial release.

Iyer clay smear method of selfing

Select an unopened bud from the cotton plant that you wish to self-pollinate. Tag the tip of the corolla (petals) of the bud with a clay-cotton sticky substance to prevent cross-pollination. Allow the bud to naturally self-pollinate or perform artificial pollination by transferring pollen from the anthers to the stigma of the same flower. After self-pollination, the flower develops into a cotton boll containing selfed seeds. Harvest the selfed seeds for further breeding or evaluation. Grow the resulting plants from the selfed seeds and evaluate their traits. Select plants with desired characteristics for further breeding or genetic improvement. These methods (Figure), when implemented correctly, contribute to the development of improved cotton cultivars with enhanced traits and are valuable tools in cotton breeding programs.

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Figure. Doak's method (1-6) and Iyer method (A-B). 1. selection of bud; 2. emasculation of bud; 3. covered emasculated bud with red butter cover; 4. dusting of pollen on stigma and covered with white butter cover; 5. crossed boll development; 6. full view of crossed plant. A. selection of unopened-bud; B. tagging the tip of corolla with clay-cotton (B_1 & B_2) sticky substance.

BLOCKCHAIN TECHNOLOGY

A FARM-TO-PLATE TRACEABILITY SOLUTION FOR SEED VALUE CHAIN

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Quality seeds which lead to healthy crops are the foundation of a bountiful harvest. When farmers have access to high-quality, climate-resilient, biotic stress-resistant seeds the crop health, and value improves significantly translating to prosperity for farmers and society. However, farmers' revenue is compromised by low-quality and unavailability of desired seeds. Over 25% of India's seed, pesticide, and fertilizer business is thought to be compromised in that line. Every year, there is an increase in the dissemination of unauthorized, impure seeds, with fraudulent labeling, intellectual property and trademark infringements, regulatory breaches, and proprietary material thefts. According to the International Seed Federation, developed countries able to restrict this inappropriate practice up to 50%-60% on specific crops. However, in the developing and underdeveloped countries a comprehensive seed value chain traceability plan is urgently needed due to the rising number of product safety concerns. As an implication of a compromised seed value chain, traceability domain evolved as a critical policy instrument for tracking and sustaining food safety.

In the past few years, academics have thoroughly investigated means of offering easy and secure resource tracing, and which primarily including the usage of blockchain technology. Blockchain is an immutable distributed database or ledger. It is made up of blocks that include a sequence of transactions, data or information's. Except for the originating block, each successive block in the series includes the 'block's hash' which is actually some stored data and related to previous block. A block's hash is unique data and may be thought of as like a signature or fingerprint. As a result, altering anything in the block will change the entire hash or series of information's. To link the blocks, the preceding block's hash is always referred to. It is extremely safe since the information entered is entirely encrypted. Blockchain seed traceability is gaining pace in the global agriculture-seed industry because of its considerable potential to give a detailed history of the product status, enhanced consumer trust and loyalty, fairer payments flow, authorized suppliers, and proper compliance management.

India's agriculture value chain ecosystem has undergone significant improvements in last few years, and the Ministry of Agriculture has declared the implementation plan of traceability in 2019 through a straightforward software-enabled device that enables farmers to use 'Quick Response' (QR) codes to track the purity and quality of seeds. In 2022, Jharkhand was the first state in the country to deploy a production grade blockchain-based seed distribution programme by implementing the blockchain solution. The Jharkhand Directorate of Agriculture jointly announced the successful rollout of blockchain-based seed distribution to farmers with global blockchain technology firm SettleMint. The platform tracks seed distribution from the impaneled government seed producing agency to distributors, retailers, seed chain actors and ultimately to farmers. For the benefit of the agricultural community, Professor Jayashankar Telangana State Agricultural University (PJTSAU) and 'Trust-O-One' have used blockchain technology in agriculture for seed traceability on Pigeon pea & Safflower. The PJTSAU-TOO platform tracks the seed source, from the nucleus stage to the verified seed, and will be used to store and record all data related to different stages. Blockchain technology is envisioned for tracking the distribution of seeds, farm inputs, implements, etc under all the schemes being implemented by the Directorate of Agriculture like State Seed Distribution Scheme, NFSM, PMKSY, and NHM.

The state of agriculture technology and advancements in seed traceability domain is continually evolving. Customers and agribusinesses now can follow the origin, handling, and other steps involved in seed packaging through the planned traceability model. The modern customers (farmers, seed chain actors) consider the value of being educated and to understand about the items they purchase or consume and thus trusted certified products are becoming more and more popular. Starting with tracking the genealogy of sowed seed to confirm its source, flow through agribusinesses chain have been able to uphold trust and openness to wider farming community. Blockchain technology is proving to be a game-changer and revolutionizing agrarian supply chains by making them more transparent and traceable which is providing prominence to nations current strong policy on 'back to basics' and 'march to future'.■

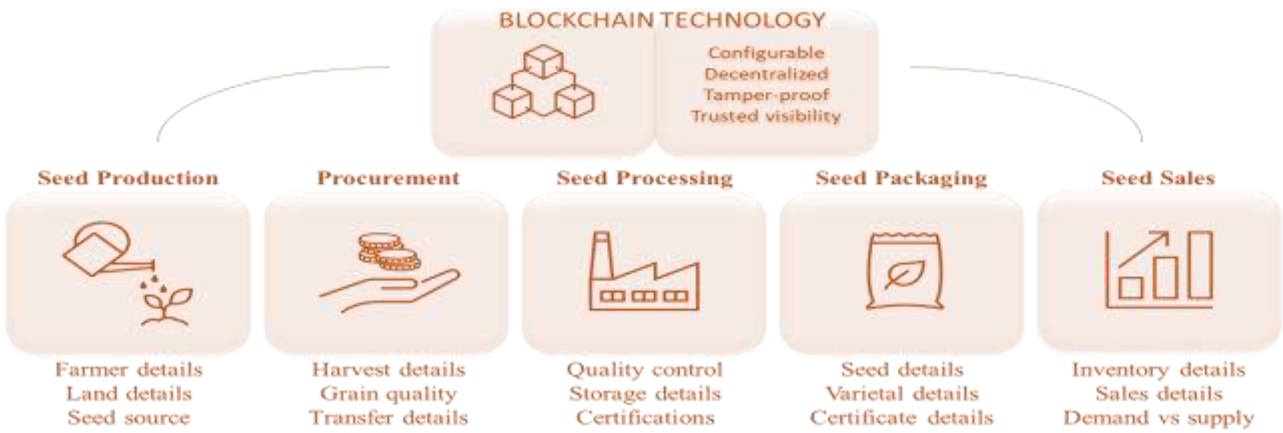

Figure: A schematic representation of Blockchain Technology and its usefulness in linking seed value chain components for traceability and transparency.

MYRMECOPHILIC BEETLES

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Myrmecophilic beetles, are a fascinating group of beetles that have evolved unique adaptations to live in association with ants. The word "myrmecophile" comes from the Greek words "myrmex" meaning ant, and "philos" meaning loving.

These beetles have developed various strategies to coexist with ants and take advantage of the resources provided by ant colonies. Some myrmecophilic beetles have evolved specialized morphological adaptations that mimic ants in appearance, behaviour, or chemical cues. These adaptations allow the beetles to blend in with the ant colony and avoid detection as intruders. Example: They may have elongated bodies, ant-like coloration, or modified appendages that resemble ant antennae or legs.

Importance of myrmecophilic beetles

These beetles can serve as indicators of ecosystem health and biodiversity. The presence or absence of specific beetle species within ant colonies can provide insights into the environmental conditions and the richness of the ant community. Changes in myrmecophilic beetle populations may indicate disturbances in ant-ecosystem dynamics, allowing scientists to monitor and assess the health of ecosystems.

Kinds of interaction

The relationship between myrmecophilic beetles and ants can be mutualistic, commensal, or parasitic. There is a wide diversity of myrmecophilic beetles belonging to various families such as Staphylinidae, Carabidae, and Tenebrionidae. These beetles can be found in different habitats worldwide, including forests, deserts, and grasslands. They often live in the vicinity of ant nests, utilizing nest chambers, tunnels, or specialized structures within the ant colony. Here are some key features and characteristics of myrmecophilous beetles:

Morphological adaptations

1. **Body shape:** Myrmecophilous beetles often have flattened bodies, enabling them to move easily within the narrow tunnels and galleries of ant nests.
2. **Protective structures:** Some species have hardened forewings (elytra) or a thick exoskeleton, providing protection against ant aggression or attacks.
3. **Camouflage:** Certain beetles have evolved to mimic the appearance and chemical cues of ants, allowing them to blend in and avoid detection.

Behavioural adaptations

1. **Chemical mimicry:** Myrmecophilous beetles produce chemical compounds that mimic the pheromones and other chemical signals of ants. This mimicry helps them gain acceptance from the ant colony and reduces the chances of aggression.
2. **Feeding strategies:** These beetles have adapted to feed on ant larvae, eggs, or regurgitated food provided by the ants. Some species even exploit the ants' trophallaxis behaviour (food sharing) to obtain nourishment.
3. **Nesting behaviour:** Certain myrmecophilous beetles live within ant nests, utilizing chambers or crevices for shelter and protection. They often exhibit a highly specific association with particular ant species or colonies.

Types of myrmecophilous beetles

1. **Inquilines:** These beetles live permanently inside ant nests and rely on the ants for protection and food. They do not harm the ants or their brood.
2. **Kleptoparasites:** These beetles steal food or resources from ant colonies without providing any benefit in return. They may actively prey on ant larvae or exploit the ants' food stores.
3. **Phoretic Associates:** These beetles hitch a ride on ants, using them as a means of transport to move between food sources or to access new ant colonies.
4. **Mutualistic Associates:** Some myrmecophilous beetles have established mutualistic relationships with ants. They provide certain benefits to the ants, such as cleaning their bodies or removing parasites, in exchange for protection and access to resources.

The best examples of myrmecophilic beetles are:

1. Atemeles pubicollis: This is a small, elongated beetle found in North America. It lives in ant nests, where it feeds on ant larvae and eggs, as well as other small arthropods. It is protected by a chemical secretion that mimics the odour of ants, allowing it to integrate into ant society without being attacked.
2. Claviger testaceus: This tiny beetle is found in Europe and has a specialized relationship with the ant *Lasius fuliginosus*. *C. testaceus* lives inside the ant nest and feeds on the secretions of the ant larvae. In return, the beetle provides protection to the ant larvae from parasitic flies. The beetle has modified hind legs that allow it to cling onto the ants and hitch a ride to new ant nests.

Conclusion

Overall, myrmecophilic beetles are ecologically significant as they participate in intricate interactions with ants, contributing to ant colony survival, ecosystem functioning, and biodiversity. Studying these specialized associations helps us better understand the complex interdependencies within ecosystems and highlights the importance of preserving the habitats that support these fascinating beetles and their ant hosts.■

BENEFITS AND DRAWBACKS
OF USING SECONDARY METABOLITES AS A MEANS OF PEST CONTROL

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Insects are among the most diverse and numerous groups of animals on the planet. They play an important role in the ecosystem by pollinating plants, decomposing organic matter, and serving as a food source for other animals. However, insects can also be pests that damage crops and transmit diseases. To combat these pests, farmers have used pesticides for decades. However, some insects have developed resistance to these chemicals, leading to the need for alternative methods of pest control. One promising approach is to breed crops that produce insect-resistant secondary metabolites.

Secondary metabolites are organic compounds that are not essential for plant growth or development but have other functions, such as defense against herbivores and pathogens. Many secondary metabolites are toxic to insects and can deter or kill them. However, some insects have evolved mechanisms to detoxify or tolerate these compounds. This has led to the development of insect resistance to some secondary metabolites.

Insects are known for their ability to develop resistance to pesticides, which can be a major challenge for farmers who rely on chemical methods for pest control. As an alternative approach, scientists are exploring the development of crops that produce insect-resistant secondary metabolites. These compounds are naturally produced by plants and can deter or kill insects that feed on them.

The development of insect resistance to secondary metabolites is a complex process that involves multiple mechanisms.

Metabolic detoxification is a mechanism of resistance in which insects produce enzymes that break down or modify the secondary metabolite before it can cause harm. These enzymes can modify the structure of the secondary metabolite or convert it into less toxic compounds that can be excreted from the insect's body. An example of metabolic detoxification in insects is the production of cytochrome P450 enzymes.

Cytochrome P450 enzymes are a large family of enzymes that play a key role in the metabolism of xenobiotics, including secondary metabolites produced by plants. These enzymes are found in many insect species and can modify a wide range of compounds, including alkaloids, terpenes, and flavonoids.

When insects are exposed to high levels of secondary metabolites, they may produce more cytochrome P450 enzymes to break down the compounds. Alternatively, they may produce enzymes that modify the structure of the secondary metabolite, making it less toxic or more easily excreted from the insect's body. For example, some insects can produce enzymes that add a sugar molecule to the secondary metabolite, making it more water-soluble and easier to excrete.

The production of cytochrome P450 enzymes can vary among insect species and populations, leading to differences in the ability to detoxify secondary metabolites. Some insects have evolved to produce higher levels of these enzymes, making them more resistant to secondary metabolites produced by their host plants. However, the production of cytochrome P450 enzymes can also come at a cost to the insect's fitness, as it requires energy and resources that could be used for other purposes.

Behavioral resistance is a mechanism of resistance in which insects avoid or tolerate plants that produce high levels of secondary metabolites. Insects may learn to associate the taste or smell of the secondary metabolite with toxicity and avoid the plants that produce it. Alternatively, they may adapt to the presence of the secondary metabolite by changing their feeding behavior or developing a preference for plants with lower levels of the compound. An example of behavioral resistance in insects is the adaptation of the diamondback moth (*Plutella xylostella*) to plants that produce glucosinolates.

Glucosinolates are a class of secondary metabolites found in plants such as cabbage, broccoli, and mustard. When an insect chews on a plant that contains glucosinolates, the compounds are hydrolyzed by enzymes to form toxic isothiocyanates, which can harm or kill the insect. However, the diamondback moth has evolved to tolerate high levels of glucosinolates by changing its feeding behavior.

Diamondback moths feed on cruciferous plants, which are rich in glucosinolates. To avoid the toxic effects of the compounds, diamondback moths have adapted to feed on the edges of the leaves, where the glucosinolate concentrations are lower. They also use their sense of smell to detect plants with lower levels of glucosinolates, and preferentially lay their eggs on these plants. This behavior allows the diamondback moth to avoid the toxic effects of glucosinolates and survive on a diet of cruciferous plants.

Another example of behavioral resistance is the adaptation of some herbivorous insects to plants that produce tannins. Tannins are secondary metabolites found in many plant species and can have toxic effects on insects. However, some insects have evolved to tolerate high levels of tannins by reducing their feeding time on the plant, avoiding the parts of the plant with high tannin concentrations, or developing a preference for plants with lower tannin levels.

Target site insensitivity is a mechanism of resistance in which insects undergo genetic changes that alter the structure or function of the target site of a secondary metabolite. This prevents the secondary metabolite from binding to its target site and exerting its toxic effects on the insect. An example of target site insensitivity in insects is the resistance of the diamondback moth (*Plutella xylostella*) to the insecticide *Bacillus thuringiensis* (Bt).

Bacillus thuringiensis is a soil bacterium that produces crystal proteins called δ-endotoxins, which are toxic to a wide range of insect pests. These toxins work by binding to specific receptors in the midgut of the insect, causing the gut to break down and the insect to die. However, some insect populations, such as the diamondback moth, have developed resistance to Bt toxins through target site insensitivity.

The target site of Bt toxins in insects is a receptor protein called cadherin, which is found on the surface of midgut cells. When Bt toxins bind to cadherin, they initiate a cascade of events that lead to the death of the insect. However, in Bt-resistant populations of diamond back moth, the cadherin receptor has undergone genetic changes that prevent the toxin from binding to it. Specifically, the resistant cadherin receptor has a mutation that changes a single amino acid in the protein, which alters the structure of the receptor and prevents Bt toxins from binding to it.

Target site insensitivity can also occur in other types of secondary metabolites, such as pyrethroids, which are commonly used insecticides. Pyrethroids target the sodium channels in the nervous system of insects, causing paralysis and death. However, some insect populations have developed resistance to pyrethroids through mutations in the sodium channel, which prevent the insecticide from binding to the target site.

Summary

The development of insect resistance to secondary metabolites is a complex process that involves genetic and evolutionary factors. As insects are exposed to high levels of secondary metabolites over time, they can develop mechanisms to detoxify or tolerate the compounds, leading to resistance. To address this challenge, scientists are exploring the development of crops that produce multiple secondary metabolites to make it more difficult for insects to develop resistance to a single compound

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INTEGRATION OF AGRICULTURAL SURVEYS

A NOVEL APPROACH TO IMPROVE DATA QUALITY AND USABILITY

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Agricultural surveys play a crucial role in understanding and monitoring the agricultural sector in India. These surveys provide valuable information about crop production, land use, agricultural practices, and other relevant factors. The Agricultural Census is conducted by the Ministry of Agriculture and Farmers Welfare once every five years. It collects comprehensive data on the structure of agriculture, including information on operational holdings, land use, irrigation, livestock, machinery, and agricultural practices. The integration of surveys refers to the process of combining data from multiple surveys into a single dataset. This can be done for various reasons, such as improving the accuracy and reliability of the data or increasing the sample size to make more robust statistical inferences.

There are several methods for integrating surveys, including:

- **Data Harmonization:** Harmonization is the process of making survey data comparable across different surveys or time periods by ensuring that the questions, response options, and coding schemes are consistent. This approach is commonly used in cross-national or longitudinal surveys.
- **Weighting:** Survey weighting is a statistical technique that adjusts the results of a survey to make it more representative of the target population. This can involve assigning different weights to different survey respondents based on their demographic characteristics or other factors.
- **Data Fusion:** Data fusion involves combining survey data with other sources of data, such as administrative records or social media data, to create a more comprehensive dataset. This approach can be useful for improving the accuracy and completeness of survey data or for filling in missing data.
- **Meta-Analysis:** Meta-analysis is a statistical technique that combines the results of multiple studies or surveys to provide a more accurate estimate of an effect size. This approach is commonly used in systematic reviews of the literature.

Overall, integrating surveys can be a powerful tool for improving the quality and usefulness of survey data. However, it requires careful planning, analysis, and interpretation to ensure that the results are valid and reliable. The integration of agricultural surveys involves the process of combining and harmonizing data collected from various surveys to provide a comprehensive and unified picture of agricultural activities, production, and related factors. It aims to eliminate duplication, improve data quality, and enhance data usability for analysis and decision-making in the agricultural sector. There are two possible ways of integrating agriculture surveys:

1. Integrating different surveys with common variables:

In this scenario the data is combined from two surveys having one or more variables in common. A thematic representation of the same is illustrated in Figure 1. In this case the data is being combined from two already occurring independent surveys to produce more precise estimates.

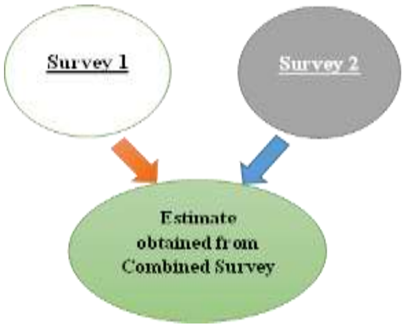

Fig 1: diagrammatic representation of data integration from two independent surveys

2. Integrating Survey data with Non survey data:

The integration of survey and non-survey data involves combining information collected through traditional survey methods with other sources of data, such as administrative records, satellite imagery, sensor data, or big data sources. This integration allows for a more comprehensive and enriched understanding of the subject matter and enhances the quality and depth of analysis. Integrating survey and non-survey data also presents challenges. Data compatibility, standardization, and confidentiality issues need to be addressed. Harmonizing variables, ensuring data quality, and dealing with differences in data structures or formats require careful attention. Additionally, privacy and ethical considerations must be taken.

Key steps and considerations in the integration of agricultural surveys

There are several significant points that are to be considered before embarking on integration of agricultural surveys the major points have been point wise enumerated below:

1) **Survey design and planning**: Proper survey design is crucial to ensure compatibility and harmonization. Surveys should be designed with consistent methodologies, definitions, and data collection tools to facilitate integration.
2) **Standardization:** It is essential to standardize data elements, classifications, and units across surveys to enable meaningful integration. This involves aligning survey questions, response categories, and measurement units to ensure compatibility.
3) **Data cleaning and validation:** Before integration, data from individual surveys need to be cleaned, validated, and standardized. This process involves identifying and resolving data inconsistencies, missing values, outliers, and other data quality issues.
4) **Data harmonization:** Agricultural surveys may cover various aspects, such as crop production, livestock, land use, and agricultural practices. Integrating these diverse data sources requires harmonization, where common variables are identified, and data is transformed or aggregated to a common format.
5) **Statistical analysis and integration:** Statistical techniques are employed to combine data from multiple surveys. This may involve weighting the data to account for different sample sizes or developing statistical models to impute missing values or estimate aggregated measures.
6) **Metadata documentation:** Detailed documentation of survey methodologies, data sources, transformations, and integration procedures is crucial for transparency and reproducibility. Metadata should be recorded to provide information about the integrated dataset's structure, limitations, and data sources.
7) **Data dissemination:** The integrated dataset should be made accessible to researchers, policymakers, and other stakeholders. This can be achieved through data portals, online platforms, or specialized agricultural databases. Proper data privacy and security measures must be implemented to protect sensitive information.

Benefits of integrating agricultural surveys:

There are several fold benefits of integration of data in agricultural surveys from more precise estimates to greater information content which would eventually help in formulating better agricultural policies. The major benefits are enumerated as follows:

a) **Comprehensive information:** Integration enables a holistic view of agricultural activities, allowing policymakers and researchers to analyze and understand the sector's dynamics more accurately.
b) **Data quality improvement:** By standardizing and harmonizing data, integration helps reduce errors, inconsistencies, and redundancies, resulting in improved data quality.
c) **Enhanced analysis:** Integrated datasets provide a richer source for in-depth analysis and modeling, enabling better insights into trends, patterns, and relationships within the agricultural sector.
d) **Resource optimization:** Integration reduces duplication of efforts and resources by leveraging existing survey data, thereby optimizing survey costs and reducing respondent burden.
e) **Policy development and decision-making:** Integrated agricultural surveys provide policymakers with a robust evidence base for formulating effective

agricultural policies and making informed decisions.

The integration of agricultural surveys is a valuable process that enhances the usability and reliability of agricultural data, facilitating evidence-based decision-making and policy formulation in the agricultural sector.

Scope of integration of agricultural surveys in Indian scenario:

In the context of India, agricultural surveys play a significant role in understanding and monitoring the agricultural sector. Surveys such as the Agricultural Census, All India Debt and Investment Survey (AIDIS), Crop Cutting Experiments (CCE), and National Sample Survey (NSS) provide valuable insights into agricultural structure, indebtedness, crop production, input usage, and rural employment. Integration of these surveys will help to create a comprehensive and accurate picture of India's agricultural landscape, aiding policymakers in formulating targeted interventions to address challenges and promote sustainable rural development. Integration of agricultural surveys is essential for leveraging the potential of agricultural data, enhancing its reliability and usability, and enabling evidence-based decision-making to drive agricultural development and improve the livelihoods of farming communities.

Conclusion:

Integration of agricultural surveys is an important process that brings together data from multiple surveys to create a comprehensive and unified view of the agricultural sector. By harmonizing and standardizing data, integrating surveys enhances the quality and usability of agricultural information for analysis, policymaking, and decision-making. It allows for a holistic understanding of agricultural activities, production trends, land use patterns, and related factors. The improved data quality resulting from integration reduces errors and inconsistencies, enhancing the reliability of the information. Integrated datasets facilitate in-depth analysis and modeling, enabling better insights into trends, patterns, and relationships within the agricultural sector. Furthermore, integration optimizes resources by reducing duplication of efforts and costs associated with conducting separate surveys. It also supports evidence-based policy development and decision-making by providing a robust evidence base for formulating effective agricultural policies.

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WATER FOOTPRINTS

A NEW WAY OF MEASURING WATER CONSUMPTION

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Water is the greatest gift of nature. It is a transparent fluid which forms the world's streams, lakes, oceans and rain, and is the major constituent of the fluids of living things. Water is essential for sustaining life on the earth. 70% of the earth's surface is covered with water. Out of total water present, 97.5% water is saltwater and the remaining 2.5% water is freshwater. To fulfill the demand of water, the dependency on groundwater tremendously increased and per capita surface water availability may be fall to 1,191 m³ by the year 2050 The declining water levels in north Indian states is mainly attributed with the over consumption of the underground water for irrigation of agricultural crops and increased run-off as well as evapotranspiration losses, which is exacerbated with unfavorable climatic changes.

Water crisis in India

UNESCO has released a report that suggests that India would face an acute water shortage by 2050.Due to India's Groundwater Crisis, water scarcity will be a significant issue for 65% of the rice and 74% of the wheat growing areas by 2030 and Sixty percent (60%) of the irrigated land in India is supported primarily by groundwater supplies, and approximately 90 million rural households are directly dependent on groundwater irrigation

What is water footprints?

Water footprint indicates the quantitative as well as the qualitative use of water As the water footprint estimates the consumed and embedded water volume thus, it is quantitative besides, it also accesses the concentration of pollutants into water bodies hence, it is qualitative. Therefore, water footprint of any production system is the quantity of freshwater either used or polluted during the entire process . The water footprint is same as 'virtual water content' but includes a temporal and spatial dimension i.e., when and where was the water used.

Types of agricultural water footprints:

There are three types of water footprints:

Blue water footprint: Water that has been sourced from surface or

groundwater sources and is either evaporated, or incorporated into a product. Water present in sea, lakes, rivers and groundwater is called Blue Water. It is extensively used in agriculture.

Green water footprint: Green water footprint is the water from precipitation that is stored in the root zone of the soil and evaporated, transpired and incorporated by plants. It is particularly relevant for agricultural, horticultural and forestry products.

Grey water footprint: It is the amount of freshwater required to assimilate pollutants to meet specific water quality standards.

Total water footprint = Blue water footprint + Green water footprint + Grey water footprint.

Virtual water

The water consumed in the production process of an agricultural or industrial process has been called the 'virtual water' contained in the product**.** The virtual water trade (also known as embedded or embodied water) is the hidden flow of water in food or other commodities that are traded from one place to another. The virtual water concept, also known as embodied water, was coined by John Anthony Allan (Tony Allan) in 1993. He received the Stockholm Water Prize for the concept in 2008.

Water footprint of different products:

- Do you know the fact that, for production of 1 T-Shirt that is made up of Cotton? It consumes 2500 litres of water.
- 700 litres of water consumed for production of 1kg of rice.
- 15,500 litres of water consumed for production of one kg beef.
- 120 litres of water consumed for making one glass of beer.
- 10 litres of water consumed for making single sheet of A4-paper.
- 180 litres of water for production of 1 kg Tomato.
- 140 litres of water for one cup of coffee.
- 8000 litres of water to make a pair of shoes.
- 34 litres of water consumed for making 1 cup of tea.

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Enterocytozoon hepatopenaei IN SHRIMP

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Enterocytozoon hepatopenaei (EHP) is a prevalent microsporidian parasite that affects shrimp farming globally. In 2009, the microsporidian parasite *Enterocytozoon hepatopenaei* (EHP) was formally identified as an uncommon infection of the Penaeus monodon black tiger shrimp. It remained largely unstudied until about the middle of 2010, when Pacific whiteleg shrimp (*Penaeus vannamei*), the most widely cultivated shrimp species in Asia, started showing signs of rising EHP infection. This infectious disease poses a significant threat to the shrimp aquaculture industry, leading to substantial economic losses. Hepatopancreatic microsporidiosis (HPM), a disorder that has been linked to the host's poor growth in aquaculture settings, is brought on by EHP infecting the hepatopancreas of its host. EHP has been proven more difficult to control than other infectious disease agents that have led to financial losses in international shrimp aquaculture because too little is currently understood about its environmental reservoirs and routes of transmission during the industrial shrimp production process. This article aims to provide an overview of EHP disease in shrimp and discuss preventive measures that can be implemented to minimize its impact.

EHP disease – Target organs:

EHP primarily affects the hepatopancreas, the digestive organ responsible for nutrient absorption and digestion in shrimp. Infected shrimp typically exhibit clinical signs such as slow growth, reduced appetite, and pale hepatopancreas. The disease weakens the shrimp's immune system and makes them more susceptible to other infections, leading to increased mortality rates and decreased overall production. The disease can lead to reduced survival rates, decreased production, and

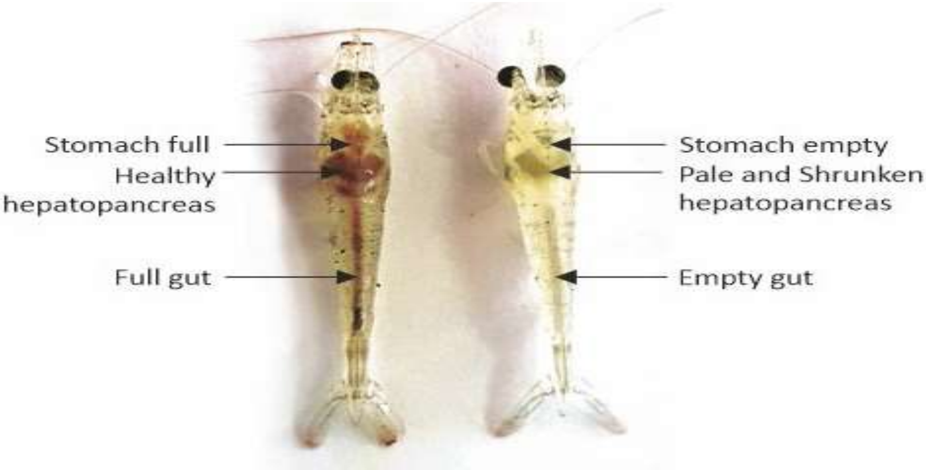

Figure 1: Difference between healthy and EHP affected shrimp

increased susceptibility to other pathogens. EHP is known to coexist with other diseases, making its diagnosis and management challenging.

Prevention measures for EHP disease:

1. **Biosecurity:** Implementing strict biosecurity protocols is crucial in preventing the introduction and spread of EHP. This includes controlling the movement of shrimp stocks, maintaining proper sanitation, and preventing the introduction of infected or carrier animals. Regular monitoring and screening of incoming and existing stocks can help identify infected individuals and prevent the disease from spreading further.
2. **Water quality management:** Maintaining optimal water quality is essential for preventing EHP outbreaks. Shrimp ponds should have adequate water exchange rates and effective filtration systems to minimize stress on the shrimp and reduce the likelihood of disease transmission. Regular testing of water parameters, such as temperature, pH, and ammonia levels, can help identify potential issues and allow for prompt corrective actions.
3. **Disinfection and quarantine:** Thorough disinfection of equipment, tanks, and ponds is crucial to eliminate EHP spores. Chlorine-based disinfectants or other recommended disinfectants should be used according to appropriate concentrations and contact times. Additionally, newly acquired shrimp should undergo a quarantine period in separate tanks to observe any signs of disease and prevent the introduction of infected individuals to existing stocks.
4. **Genetic selection:** Selective breeding programs can aid in developing EHP-resistant shrimp strains. Identifying and selecting shrimp with increased resistance to EHP can help reduce the impact of the disease. Genetic markers associated with resistance can be utilized to identify and breed more resilient shrimp populations, thereby minimizing the risk of EHP infection.
5. **Nutritional management:** Proper nutrition plays a crucial role in strengthening the immune system of shrimp. A balanced diet that meets the nutritional requirements of shrimp can help improve their resistance to diseases, including EHP. High-quality feed with adequate levels of essential nutrients, vitamins, and minerals should be provided to optimize shrimp health and enhance their ability to combat infections.
6. **Integrated Pest Management (IPM):** Adopting an integrated approach to disease management can be effective in preventing EHP outbreaks. IPM involves the combination of various strategies, including regular monitoring, early detection, and targeted treatment of diseases. Implementing IPM practices can help reduce the overall disease pressure, including EHP, by promoting a healthy shrimp farming environment.

Conclusion:

Enterocytozoon hepatopenaei (EHP) poses a significant challenge to shrimp aquaculture, impacting productivity and profitability. However, by implementing effective preventive measures, the risk of EHP outbreaks can be minimized. Combining biosecurity measures, water quality management, disinfection and quarantine practices, genetic selection, nutritional management, and integrated pest management can help prevent and control EHP disease in shrimp farms. Continuous research and collaboration among farmers, scientists, and industry stakeholders are essential to develop new strategies and technologies to combat EHP and ensure the long-term sustainability of the shrimp aquaculture industry. It is essential for shrimp farmers to collaborate with researchers, industry experts, and relevant authorities to stay updated on the latest scientific developments and best practices for EHP prevention and management. Through continuous research, improved diagnostics, and effective preventive measures, the impact of EHP on shrimp farms can be minimized, leading to improved productivity and sustainability in the shrimp aquaculture industry.

PUNGANUR COW

THE MOTHER OF ALL COWS

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Punganur cow (Cattle) is the world's smallest *Bos indicus* cattle originated in Punganur town in Chittoor district of Andhra Pradesh, India. This breed is known for its short stature, high milk production efficiency and efficient reproductive characters. In Ancient Ayurvedic scriptures such as Charaka Samhita, Shushruta Samhita and Brahad-Wagbhatt mention various medicinal properties of cow urine. It is used as an insecticide and in disorders like intestinal gas, acidity, and cough. Punganur Cattle is one of the world's smallest *Bos indicus* cattle. Punganur cattle originated from Punganur in Chittoor district, situated at the south-eastern tip of the Deccan Plateau in Andhra Pradesh, India. This breed was developed by the Rajas of Punganur and was used for milking and other light agricultural operations. The Punganur cattle are being reared mainly on the Government Livestock Farm, Palamaner, Chittoor district, while a small informal group of private breeders are also working on reviving the species. It is not officially recognized as a breed since there are only a few animals remaining.

Religious views

Punganur cow in Tirupathi temple "Dhenunam Asmi Kaamadhuk" (Bhagavad Gita 10.28) Meaning: Among cows I am the wish-fulfilling Cow. Here Lord Krishna is manifest as Kamadhenu, the divine, wish-fulfilling cow.Kamadhenu, also known as Surabhi, is described in Vedic text as the mother of all cows.

Divine offering

Tirumala Tirupati Devasthanam runs a dairy farm. There are more than 3,000 cows with them.They have Ongole, Gir and Sahiwal breed of cows whose milk is used at the temple including performing the abhishek. They also have the Punganur cow but since this breed is near extinction so these are put under protection and conservation at the farm. They give only a few litres of milk. All cows are venerated in Hinduism as the earthly embodiment of the Kamadhenu. The milk of this small breed has high fat content and rich medicinal properties.

Cow Milk with rich medicinal values

Considered among the world's smallest breed of cows, the Punganur breed's milk has a high fat content and rich medicinal properties. While cow milk normally has a fat content of 3 to 3.5 per cent, the Punganur breed's milk contains 8 per cent, similar to buffalo milk.

Punganur is perhaps the world's smallest humped cattle breed. It is widely known as an efficient milch breed. It is also drought resistant and able to survive exclusively on dry fodder. The Punganur cow is said to have the grace of a deer and a beautiful walking style. It is considered auspicious to have this cow. These cows are said to receive cosmic energy at a higher magnitude and disseminate it all around.

Breed characteristics

- Punganur is a popular dwarf cattle breed. Punganur have compact build, comparatively tight skin and extensively hanging dewlap.
- Punganur cows are generally white, grey or light brown to dark brown in colour. White mixed with red or black colour is also available.
- Punganur breed have black, small and crescent shaped horns, slightly mobile and almost flat along the back which are normally at different heights from each other.
- Punganur breeds horns are stumpy in males and longer in females; horn length ranges from 10 to 15 cms. The back slopes downwards from front to the hind quarters.
- Punganur have short legs and long body with well sprung ribs.
- Punganur cows have tails that touch the ground; humps of small size in females and medium but drooping in males. The average height is about 70-90 cms and weight is around 115-200 kgs.
- The lactation milk yield is approximately 540 litres and lactation length is 260 days.
- The average milk fat content is 5 to 8 % and their average daily feed intake is 5 kg. The bulls are more docile than the females.

Conservation efforts

This breed is on the verge of extinction. The decline of this pure Indian breed is mainly due to an earlier policy decision taken by the Government to "better" Indian cattle breeds by cross-breeding the Punganur with the Holstein-Friesian and Jersey cattle while banning the rearing of native bull breeds. The Punganur cattle are now being reared mainly on the Government Livestock Farm, Palamaner, Chittoor district, while a small informal group of private breeders are also working on reviving this revered species.

Divine offering

Perhaps, this is why the Tirumala Tirupati Devasthanams (TTD) has about 200 Punganur cows in its cattle-yard. Ghee prepared from the milk of these cows is being used in 'archana' (offering) for Lord Venkateswara Ghee prepared from the milk of these cows is in the 'archana' (offering) for Lord Venkateswara and for preparation of the famous Tirupati laddoos. Available only in small numbers, the Punganur cow has become a craze, a status symbol, among the wealthy in the Andhra Pradesh capital of late. "They are shelling out at least Rs.1 lakh to buy the cow, which is believed to bring good luck.

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USES OF LEAF COLOUR CHART

FOR PRECISION NITROGEN MANAGEMENT TO INCREASING

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Precision agriculture (commonly also known as 'precision farming' or 'site specific management') as a win–win solution both for improving crops yield and environmental quality of agriculture. Precision farming emphasizes the site-specific crop management practices considering the spatial variability of land in order to maximize crop production and minimize environmental damage. Cereal crops are very exhaustive and deplete soil nutrients in large quantities. In world, total more than half of the nitrogen fertilizer is consumed by cereals *viz.*, rice, wheat and maize. Nitrogen have very important role in plant metabolism. It is essential constituent of protein, chlorophyll and other physiological processes. Now a day, we clearly know that our population increasing day by day, so food consumption is also increasing. To fulfill the demand of food, we need to produce more food and requirement of large Nitrogen, During Rabi (2019-20) total N consumption of India was is 179.04 LMT and Requirement of urea during Kharif (2019) is 156.22 LMT. If farmer apply 100% dose of nitrogen blanket recommendation but plant only 33% nitrogen used by plants remaining 67% lost. They generally over-apply it because they want to ensure enough N for crop requirements increase. The excessive use of N may cause weed problems and could result in an increased risk of lodging, delayed maturity and greater wheat susceptibility to diseases Moreover, this practice leads to greater N loss to ammonia volatilization, denitrification, runoff and leaching. To minimize potential N losses, N fertilizer should be applied according to the time and the needs of the crops. In addition, to solve these problems, farmers could have recourse to variable-rate N fertilization, accounting for the spatial patterns of N fertility, as suggested by precision agriculture applications. Farmers generally use leaf colour as a visual and subjective indicator for the crop's nitrogen status and need for N fertilizer application. Simple diagnostic tools as leaf colour chart (LCC) and the SPAD (Soil and Plant Analysis Development) meter have been developed to monitor plant N status for fine tuning of N management.

What is precision nitrogen management?

Precision nitrogen management - the 4 R's

1. Applying the right rate of nitrogen
2. At right time.
3. In the right place.
4. Using the right source of nitrogen fertilizer / Manure.

Advantages of precision nitrogen management

- ✓ The economic margin from crop production may be increased by inputs reduction.
- ✓ Under or over fertilization (with risk of environmental pollution and degradation) can be avoided.
- ✓ Sustains high grain yield with low N optimum dose and thus may help reduce the escape of reactive nitrogen from soils to the atmosphere.
- ✓ To increase production efficiency and improve product quality.
- ✓ Use of chemicals more efficiently and Energy conservation

1. Precision nitrogen management using leaf color chart (LCC)

Use of the leaf color chart (LCC) is one of the components of real time N management. The LCC is very simple, inexpensive, handy, and easy to use tool that compares leaf color with the color shades of the device. It acts as a better guide to the farmers for thoughtful and right time nitrogen application. LCC is an ideal tool to optimize N use in most of the cereal crops and it consists of series of four/six green coloured shades horizontally ranging from light yellowish green to dark green colour strips fabricated with veins resembling those of leaves that are used to compare with a leaf in the same light conditions. LCC is being used successfully in crops like rice, wheat and maize to evaluate the efficient N requirement.

Guidelines for using (LCC):

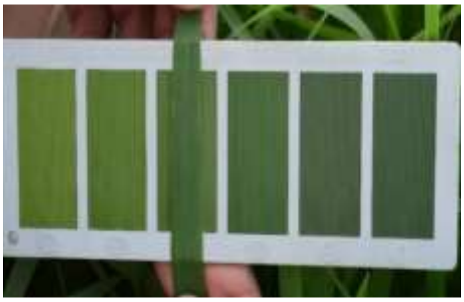
Randomly select at least 10 disease-free rice plants or hills in a field, where plant population is uniform. Select the topmost, youngest, fully expanded leaf from each hill or plant. This part best reflects the N status of the plants. Place the middle part of the leaf on the LCC and compare its color with the color panels. Do not detach or destroy the leaf. Measure the leaf color under the shade of your body. Direct sunlight affects leaf color readings. If possible, the same person should read the LCC at the same time of the day, every time. If the color of a rice leaf is in between two shades, take the average of the two values as the reading. For example, if the color is in between 3 and 4, the reading should be 3.5. Take the reading of the 10 leaves, and determine the average. If the color is more or less than 3, N fertilizer top dressing is needed. Use the LCC once every 7−10 days starting from the beginning of tillering (14 DAT). Continue this process up to 5−10 days after panicle initiation.

LCC developed for major crops

Rice: Always take LCC reading in 10 leaves opposite to sun in shade in fully matured leaf after 21 DAT or 28 DAS up to panicle initiation. If > 6 leaves show <4 reading, then apply 25 Kg urea under Irrigated. If > 6 leaves show <3 reading, then apply 25 Kg urea under DSR. If > 6 leaves show <3 reading, then apply 35 Kg urea under Boro. Repeat LCC reading at 7-10 days interval for medium and 10- 12 days for late duration varieties.

Maize (PAU Ludhiana): Apply 25 kg urea (basal) If > 6 leaves show <5 reading at 21 DAS, then apply 25 Kg urea. Repeat LCC at 10 days interval and Stop applying fertilizer after silking.

Wheat (PAU Ludhiana): Apply DAP 55 kg (basal); 40 kg or 25 kg urea at 1st irrigation 21-28 DAS. Always take LCC reading in 10 leaves opposite to sun in your shade in fully matured leaf (MRML) before 2nd irrigation. If > 6 leaves show <4 reading at 55-60 DAS, then apply 40 or 25 Kg urea for normal or late sown. If >/=4 reading then 25 or 15 kg urea for normal or late sown.



MODERNIZATION AND SCOPE IN INDIAN AGRICULTURE SECTOR

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India is called as "Land of Villages". More than 67% of India's population lives in villages and rural areas. The basic occupation of villagers is agriculture and framing. Therefore the" Agriculture and Farming" is the dominant sector of our Indian economy & which also contributes in various ways which will be discussed further.

In this article, we will discuss the scope and opportunities in agriculture sector specifically in India which will be helpful for us to understand the Indian agricultural market and their schemes. Moreover, the current favorable government policies running across the India in order to update, support and upgrade the overall Indian agricultural infrastructure, including credit and debit facilities for farmers/agriculturists ,animals and crop insurance schemes and availability of various subsidies and incentives for the movement of agriculture products by rail, road and air transport worldwide, is impacting the market favorably.

Emerging new trends in the Indian agricultural sector that are quite remarkable in the post-liberalization epoch include heightened production, increased speculation, variegation of the sector, use of current and latest modern techniques, advancement of horticulture and floriculture, increasing volume of exports and progression of the food processing industry.

In India most of the population is based on agriculture and farming. Where, the Agriculture is the process which deals with the raising of domestic animals and cultivation of specific plants and to produce food, fiber, feed, and a variety of other desired products (including the livestock). The primary role of Agriculture is to provide, raw materials for industry, employment for a large number of people, and importantly food for people, capital for agrarian development, and surpluses for the national economy if practiced efficiently. It also generates the economical balance for the society. But it requires a proper planning for maximizing the agricultural benefits, from crop selection to market sales.

Not only this, but also requires in line with this, the increasing adoption of advanced methods and technologies, such as block-chain, Geographic Information System (GIS) and tools, Artificial Intelligence (AI), remote sensing technologies and drones systems, along with the launching of several e-farming applications, is providing a boost to the market .Beside this worldwide market is further driven by the widespread preference for organic agricultural products on a mass level. Other factors, including the rising development of allied services, such as a high proportion of agricultural land, and rapid digitization, warehouses, cold storage and, are also positively influencing the market across India.

Following are the points which describe the scope and opportunities in modern agriculture of Indian market:

National economy

In 2020-21 was 20.1%, it was 19% in 2021-22 and it again came down to 18.3% in 2022-23, says MoSPI (Ministry of Statistics & Programme Implementation) (March, 2023).

Contribution to the Government's revenue

Agriculture provides a significant and attracting source of income for the Indian government by agriculture taxation includes direct tax and indirect tax. Direct taxation involves cases, land revenue, and surcharge on land revenue, cesses on crops & taxation on agricultural incomes. Indirect tax induces sales tax, local taxes and custom duty etc. which is paid by farmers on purchase of agriculture inputs.

Trading and transportation

Government of the Indian country has substantial revenues from the rising land revenue. Not only this but the transportation of agricultural goods helps in generating the revenues for the Indian railways, which helps the government in revenue generation. Indian agriculture plays and important role outside the countries. Indian in roads, rails airways and waterways used to transport considerable amount of agril. produce and agro based industrial products.

Industrial and commercial significance

Agriculture of India is important for the national industrial sector and economical and trading purposes both externally and internally. Products like sugar , coffee, tea, groundnuts, sesame seeds, basmati-rice, cereals, cashew-nuts, other nuts, tobacco (unmanufactured), spices, meat, etc., which are edible and textile products such as sugar, flour mills, , and apparel, silk, wool- woolen, fibres , jute, cotton, and others contribute 50% and 20% respectively to the total export of the total country. Cottage industries and the small scale industries like and power loon and handloom ginning and pressing, oil crushing, rice husking, sericulture, fruit processing, etc are also main and important agro based industries They all add more than 70% of the total earnings in foreign exchange of our country.

Correlation between agriculture sector and industry sector

For perpetual manufacturing of products, there is a ceaseless need for raw materials, in the industries so as fulfill this need, most of the industries/ firms /organizations meet their requirements of the raw materials directly from the farmers/agriculturists or agricultural fields. In India, almost half of the total income is generated by the industrial sector which comes from agricultural-based industries. Therefore, we can say that in India, the industrial sector is highly dependent on the agricultural sector no doubt t holds a strong relation in between.

Largest employment sector

In India, the agriculture sector directly or indirectly supports around two-third of the total Indian population's livelihood, and are supposed to be engaged in such related work. So therefore it makes this sector with the most number of employees in the country. If we compare it with the developed nations, India has about 54.6% of the total population engaged in the agriculture sector, on the another hand developed nations such as the USA, UK, USA, Australia and France, only 2-6% of the total population is engaged in the agriculture sector. In India it employees upto 65% of the workforce of the total population on agriculture and allied activities, including on processing & marketing of agricultural products.■

MARKET LIBERALIZATION AND AGRICULTURAL SECTOR TRANSFORMATION

PAVING THE PATH TO A DYNAMIC FUTURE

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Market liberalization, a process aimed at reducing government interventions and barriers in the economy, has been a driving force behind transformative changes in various sectors worldwide. One crucial area profoundly affected by market liberalization is agriculture. Agricultural market liberalization involves the removal of trade restrictions, subsidies, and regulations within the agricultural sector, allowing market forces to shape prices and allocate resources. This article delves into the multifaceted aspects of market liberalization and its profound impact on the transformation of the agricultural sector. The process of market liberalization in agriculture encompasses a range of policies and measures aimed at fostering a more market-oriented environment. It entails dismantling trade barriers, such as tariffs and quotas that restrict the flow of agricultural goods across borders. Additionally, it involves reducing or eliminating government subsidies that distort market signals and impede fair competition. Moreover, market liberalization entails deregulation, which minimizes the administrative burden on farmers and agribusinesses, enabling them to operate more efficiently.

The benefits of market liberalization in agriculture are manifold. Firstly, it promotes increased efficiency and productivity within the sector. By allowing market forces to determine prices and resource allocation, farmers are incentivized to produce based on consumer demand and adopt innovative and sustainable farming practices. This drives productivity growth, as farmers strive to enhance their competitiveness in the market. Furthermore, agricultural market liberalization opens up new avenues for trade and economic growth. By eliminating trade barriers, farmers gain access to larger domestic and international markets, creating opportunities for increased exports and higher revenues. The expansion of agricultural trade not only enhances farmers' income but also stimulates economic development, generates employment opportunities, and fosters rural prosperity.

In addition to improving efficiency and trade, market liberalization can lead to price stability within the agricultural sector. When market forces dictate prices, they tend to reflect the true dynamics of supply and demand. This stability benefits both farmers and consumers, allowing them to make informed decisions and plan for the future with greater certainty. Price stability also contributes to a more resilient agricultural sector by reducing the vulnerability of farmers to sudden price fluctuations and market shocks. However, market liberalization in agriculture also presents challenges and potential implications that must be carefully considered. One concern is the potential exacerbation of income inequalities. While market competition can benefit larger and more efficient farms, it may pose challenges for small-scale and subsistence farmers. It is crucial to implement supportive policies and safety nets to ensure that vulnerable farmers are not left behind, fostering inclusive growth and safeguarding rural livelihoods.

Moreover, market liberalization exposes farmers to increased risks and uncertainties. Fluctuations in prices, weather conditions, and exchange rates can significantly impact farmers' incomes and livelihoods. Hence, it becomes imperative to implement comprehensive risk management strategies, including insurance programs, forward contracting, and financial instruments that mitigate the potential adverse effects of market volatility.

Another critical consideration is the need for environmental sustainability in the context of market liberalization. While market forces drive efficiency and productivity, unregulated practices can lead to overexploitation of natural resources, deforestation, and environmental degradation. Policymakers must ensure that market liberalization is accompanied by robust environmental safeguards and incentives that promote sustainable farming practices and the conservation of biodiversity. In conclusion, market liberalization in agriculture has the potential to bring about transformative changes by fostering efficiency, expanding trade opportunities, and ensuring price stability. However, it is essential to address the challenges and implications associated with this process. Policymakers must strike a delicate balance between the imperatives of market forces and social objectives, implementing supportive policies, investing in rural infrastructure, and strengthening institutions. By navigating the path of market liberalization with prudence and foresight, countries can foster a dynamic and sustainable agricultural sector that meets the evolving needs of the global food system and drives inclusive economic growth.

Benefits of market liberalization in agriculture:

Increased efficiency

Market liberalization promotes competition, innovation, and efficiency in the agricultural sector. By eliminating subsidies and trade barriers, it encourages farmers to produce based on market demand and adopt more productive and sustainable farming practices. This leads to increased productivity and cost-effectiveness in agricultural production.

Trade expansion

Liberalizing agricultural markets opens up opportunities for international trade. Farmers can access larger markets and export their produce, contributing to economic growth and creating employment opportunities. Import competition also stimulates domestic producers to improve their efficiency and product quality.

Price stability

Market liberalization can lead to more stable and predictable prices for agricultural products. When market forces determine prices, they tend to reflect supply and demand dynamics more accurately, reducing price fluctuations caused by government interventions. This stability benefits both farmers and consumers by providing greater certainty in planning and decision-making.

Challenges and implications:

Income inequality

Market liberalization may exacerbate income disparities within the agricultural sector. While some farmers may thrive in a more competitive environment, others, particularly small-scale and subsistence farmers, may struggle to adapt to market pressures. To ensure equitable outcomes, policies should be implemented to support vulnerable farmers, such as providing access to credit, technical assistance, and social safety nets.

Risk exposure

As agricultural markets become more open, farmers are exposed to increased market volatility and risks. Fluctuations in prices, weather patterns, and exchange rates can significantly impact their income and livelihoods. Implementing risk management strategies, such as insurance programs and forward contracting can help farmers mitigate these risks and enhance their resilience.

Environmental sustainability

Market liberalization should be accompanied by environmental safeguards to ensure sustainable agricultural practices. Unregulated market forces may lead to overexploitation of natural resources, deforestation, and pollution. Governments should enforce regulations and incentives that promote sustainable farming methods, conservation of biodiversity, and responsible land management.

Policy Recommendations:

Gradual transition

Market liberalization in agriculture should be implemented gradually, allowing farmers and other stakeholders to adjust to the changing dynamics. This approach enables the development of supportive infrastructure, institutions, and capacity-building programs to facilitate the sector's transformation.

Investment in rural infrastructure

To maximize the benefits of market liberalization, governments should invest in rural infrastructure such as roads, irrigation systems, and storage facilities. These investments improve farmers' access to markets, reduce post-harvest losses, and enhance overall competitiveness.

Supportive institutions

Developing robust agricultural institutions is crucial to ensure fair competition, enforce standards, and provide necessary support services to farmers. Establishing extension services, market information systems, and farmer cooperatives can strengthen the agricultural value chain and enhance farmers' bargaining power.

Conclusion

Market liberalization has the potential to transform the agricultural sector by promoting efficiency, trade expansion, and price stability. However, careful consideration must be given to the challenges and implications associated with this process. By implementing supportive policies, investing in rural infrastructure, and strengthening institutions, countries can navigate the path of market liberalization in agriculture successfully. Striking a balance between market forces and social objectives is essential to ensure sustainable and inclusive agricultural development in a liberalized market environment.

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JEEVAMRUT

FOR SUSTAINABLE CROP PRODUCTION

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Jeevamrut is made up of two words. Jeevan + Amrit it means life and medicinal potion. Jeevamrut is available in two forms solid and liquid. That is prepared by the distinctive technique of fermentation of the combined mixture of cow dung, cow urine, jaggery, pulses flour,soil and water.

It is a good source of natural corbon biomass that contains macro and micro nutrients required by crop/plant like- nitrogen, phosphorus, potassium and many more jeevamrut can be best for organic farming. It also prevents plants from pest and diseases. It helps to maintain the soil Ph, improves aeration, increase beneficial bacteria, applicable to all plants and much more.

In comparing any other manures jeevamrut found very affective easy and quick to prepare. Other organic manures that takes months to be prepared, you can prepare jeevamrut within a week. It's a microbial culture. Its prepared from natural material.

Ingrediants

1. 200 liter water
2. 10 kg cow dung
3. 2 kg jaggery
4. 2 kg pulses flour
5. 5-10 lit cow urine
6. Handful of forest soil/ Handful soil

Cow dung + 200 lit water + cow urine + pulses flour + jiggery + Handful soil = Jeevamrit.

Procedure

1. Liquid Jeevamrit

Step 1: Take 200 lit water in barrel add 10 kg cow dung in water add 540 lit cow urine in that add 2 kg jaggery and pulses flour add hand full soil to it.

Step 2: Stier the solution well and keep it for 48 hrs in shadow after 48 hrs it solution is fermented and its ready to use.

2. Solid Jeevamrit:

Take 100 kg of cow dung + 2 kg of jaggery + 2 kg of pulses flour + handful soil. Add a small amount of cow urine to it and mix well spredd. The solution/Solid material in shadow for drying. After drying the solid material is converted in powder form and its ready to use.

Content (%):

N	1.40
P	0.104
K	0.084
PH	4.92
Mn	46
Cu	51

How to apply?

1. Liquid form: Take a 5-10% of jeevamrit, 100-200 litres of jeevamrit per acer is recommended rate.

2. Solid form: Solid Jeevamrit also known as Ghanjeevamrutam can be spread directly in field. It can be used for 6-9 months.

Effect on crop

1. Increase the yield of crop.
2. Improves soil health.
3. Improves plan health.
4. Alternaria leaf spot caused by alterneria alternata can be managed by jeevamrit.

Advantages

- We know that the jeevamrit is natural and organic. It doesn't have any toxic effect on crop.
- Its used for betterment of crop.
- Its prepared from cow dung and cow urine in the farm.
- It helps in enruiching the soil.
- Balance nutrition.
- It increase the growth of plant.
- Makes plant resistant from disease.

Disadvantages

- It has very foul smell.
- Liquid form jeevamrit is not easy to handle.
- Liquid form of jeevamrit has sift life of 10-12 days.

ETHANOL

THE FUTURE FUEL TO MAKE INDIA SELF RELIANCE

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India is the world's third largest energy consumer, and a considerable portion of its energy needs are fulfilled by oil, which is still mostly imported. By 2050, India's proportion of global energy consumption is expected to double. Rising energy demand and a large reliance on imports pose substantial concerns to energy security. It also causes a significant outflow of foreign currencies. Domestic biofuel production offers the nation a strategic advantage because it lessens its reliance on foreign imports of fossil fuels. Additionally, when used properly, biofuels can be sustainable, ecologically benign energy sources. Additionally, Biofuel can support Make in India, Swachh Bharat, the doubling of farmer incomes, and the creation of waste to wealth.

What is ethanol?

Ethanol, commonly known as ethyl alcohol, is a liquid that is transparent, volatile, and flammable. It is the principal alcohol present in alcoholic beverages, but it can also be manufactured industrially. Ethanol is an important biofuel that is created naturally by yeast fermentation or through petrochemical processes such as ethylene hydration.

Ethanol is produced through the fermentation of sugars by yeast or other microorganisms. This process converts sugars, such as those found in grains (e.g., corn, barley), fruits, or vegetables, into ethanol and carbon dioxide. In the context of alcoholic beverages, the fermentation of sugars in grapes produces wine, while the fermentation of sugars in barley or other grains produces beer and spirits. It is used in medicine as an antiseptic and disinfectant. Apart from being an alternate fuel source, it is utilized as a chemical solvent and in the production of organic molecules. Ethanol is widely utilized as a solvent, fuel, and a precursor in the manufacture of numerous compounds.

Methods of ethanol production

There are two methods of ethanol production:

1. **Fermentation based ethanol production**

By using yeast or other microorganisms, fermentation-based ethanol manufacturing entails converting carbohydrates into ethanol. Agricultural materials high in fermentable sugars, such as sugarcane, corn, barley, wheat, or other types of feedstock, are frequently used in this process. The two most popular techniques for producing ethanol using fermentation are:

a. Sugar fermentation: In this process, sugars obtained from plants like sugarcane, sugar beet, or molasses are directly fermented. In order to extract the juice from the sugar-rich feedstock, it is crushed or processed. The juice is then fermented with yeast or bacteria, turning the sugars into ethanol and carbon dioxide. This method is frequently applied when sugarcane is used to make bioethanol.

b. Starch fermentation: Starch-rich feedstock, such as corn, wheat, or barley, is saccharified, which converts the starch into fermentable sugars. Enzymes are used to break down the starch molecules into simpler sugars, which yeast ferments to make ethanol. This technology is commonly employed in the manufacture of corn-based ethanol.

2. **Synthetic ethanol production**

Synthetic ethanol, also known as ethyl alcohol or ethylene hydration, is created through the chemical reaction of ethylene with water. Ethylene, a hydrocarbon sourced from fossil fuels or created by natural gas cracking, is hydrated in the presence of a catalyst to form ethanol. This approach is mostly employed in industrial settings and can use non-renewable feedstock.

Current scenario of ethanol production in India

The supply of ethanol has increased from 380 million liters in 2013-14 to 1.89 billion litres in 2019. This year, offers of around 3.5 billion liters are expected from both sugar/molasses and grain-based distilleries. Aside from sugarcane,

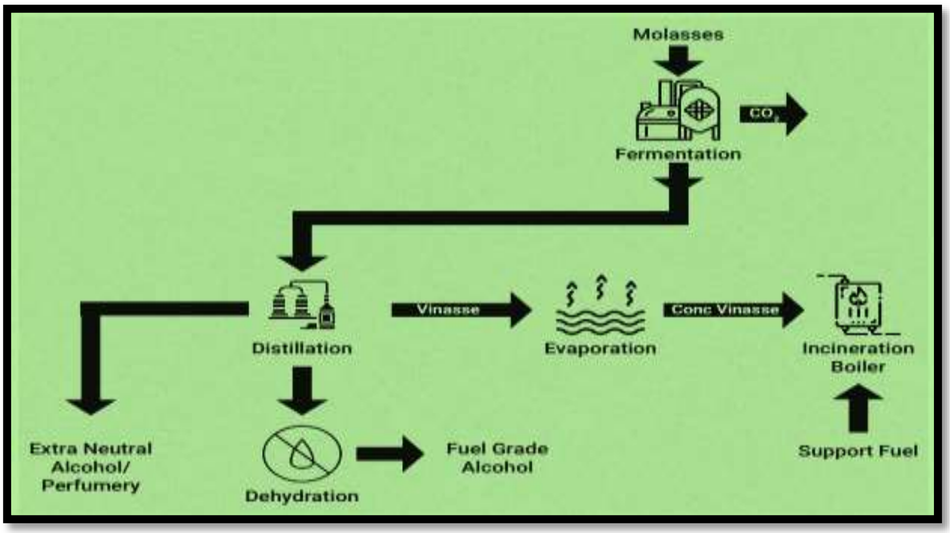

Fig 1: Process of sugar-based ethanol production (Source: - pib)

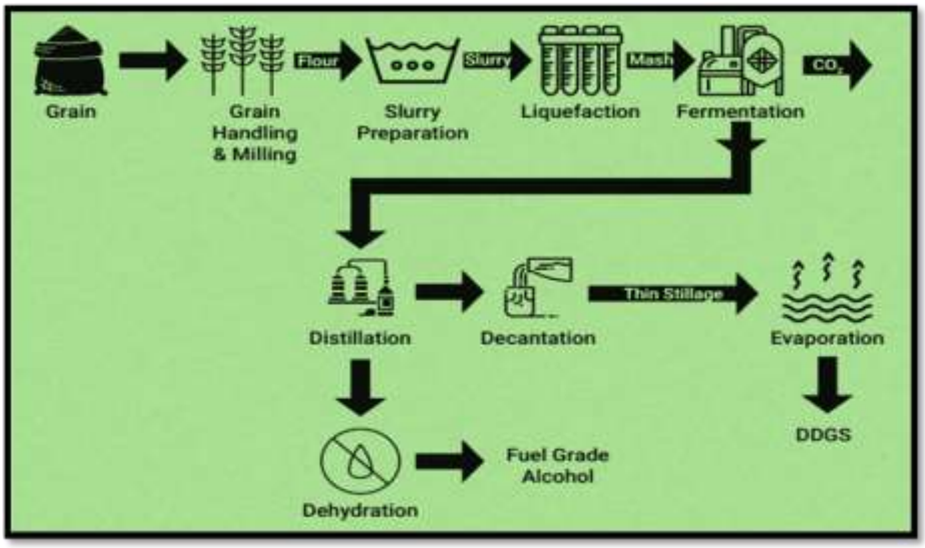

Figure 2: Starch Fermentation (Source: - pib)

ethanol can also be made from damaged food grains, B-heavy molasses, and sugarcane juice. This amounts to almost 35,000 crore in the last six years, money that has returned to farmers via sugar mills and distilleries as oil marketing companies (OMCs) grant off-take guarantees at set prices.

This arrangement also benefits the farmers' payment cycle because OMCs repay their ethanol dues to distilleries in 21 days rather than the months that farmers had to wait for payment from sugar mills. Farmers will now have an alternate market for their grain thanks to the Food Corporation of India's recent decision to use surplus rice and maize as an extra source of feedstock for ethanol manufacturing beginning this year.

Government initiatives for ethanol

The government of India started pilot projects in 2001 that delivered 5% ethanol blended petrol to retail outlets in order to strengthen the agriculture industry and reduce environmental pollution. Aside from field trials, R&D investigations were also carried out concurrently. The success of these field experiments and studies cleared the path for EBP to be implemented throughout India. The Government of India, in a resolution dated September 3, 2002, agreed to commence the Ethanol Blended Petrol (EBP) Programme in January 2003, with the sale of 5% ethanol blended petrol in nine states and four union territories.

According to PIB report published on 22 Dec 2022 by Ministry of Petroleum & Natural Gas. During the Ethanol Supply Year (ESY) 2021-22, public sector oil marketing companies (OMCs) blended more than 10% ethanol into fuel. The government changed the National Policy on Biofuels - 2018 to move the aim of 20% ethanol blending in petrol to ESY 2025-26 from 2030. OMCs obtain the required ethanol quantity from sugarcane and grain-based feedstocks for blending under this Programme from registered bidders/suppliers.

Nodal agency for ethanol production

In India the Nodal agency for the production of Ethanol is the Department of Food and Public Distribution (DFPD for promoting fuel grade ethanol producing distilleries. The government has authorized the manufacturing and procurement of ethanol from sugarcane-based raw materials such as C & B heavy molasses, sugarcane juice/sugar/sugar syrup, surplus rice with Food Corporation of India (FCI), and maize.

Conclusion

Our country's energy demand is increasing due to a developing economy, growing population, increasing urbanization, changing lifestyles, and rising purchasing power. Currently, fossil fuels meet 98% of the fuel requirement in the road transport industry, with biofuels meeting the remaining 2%. Ethanol production in India has made tremendous development in recent years, owing to favorable government regulations, plentiful feedstock supply, increased investments, and expanding demand. The emphasis on ethanol blending in petrol has helped to minimize the country's reliance on imported crude oil while also contributing to environmental sustainability and rural development. However, ongoing efforts are required to solve difficulties such as feedstock supply, infrastructural development, and guaranteeing the long-term sustainability of ethanol production.