Volume 1, Issue 3

AgriTech Today

AGRICULTURE AND ALLIED SCIENCES E-MAGAZINE

World Environment Day

#beatplasticpollution

www.agritechmagazine.com

June 2023

AgriTech Today

VOLUME 1, ISSUE 3
JUNE, 2023
www.agritechmagazine.com

Publisher
Valmiki Sahitya Sampada
Harthikote Post
Hiriyur, Chitradurga
Dist., Karnataka - 577545

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From the Editors Desk

Welcome to the latest issue of AgriTech Today Magazine, an English e-Magazine dedicated to publish popular articles of Agriculture and allied Sciences. The purpose of the magazine is to provide a platform for the academicians, researchers, Post Graduate students, research scholars etc to express their view on their specialization.

As we celebrate World Environment Day this June, it is crucial for us to reflect on the significant role that agriculture technology plays in ensuring a sustainable future for our planet. Agriculture has always been deeply intertwined with the environment, but the ever-growing global population and the challenges posed by climate change have heightened the urgency for innovative solutions. The use of single use plastic needs to be viewed seriously as it pollutes the soil. The farmers are unable to manage it scientifically. In this issue, a special cover story on World Environment Day with a theme on beat plastic pollution along with thirty scientific popular articles are reviewed and published in different topics.

I whole heartedly thank to the editorial team and authors for their contribution in bringing up this issue.

Editor-in-chief

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World Environment Day: A Day Dedicated to the Future of Earth

Hemanth Gowda K., Jaishankar N. and Jagadeeswary V.

Cover Story

The annual commemoration of World Environment Day has evolved into a momentous event that resonates with people worldwide. Led by the United Nations Environment Programme (UNEP), this significant occasion, observed on June 5th every year since 1973, has grown into the largest platform for raising environmental awareness, engaging millions of individuals globally.

Historical Origins of World Environment Day

World Environment Day emerged from the imperative need to increase awareness about pressing environmental concerns. The event was initially established by the United Nations General Assembly in 1972 during the Stockholm Conference on the Human Environment. This conference aimed to address global environmental challenges and laid the groundwork for subsequent efforts to safeguard the future of our planet. A year later, World Environment Day was established, serving as a catalyst for environmental action and consciousness.

The Significance of World Environment Day

World Environment Day holds immense significance as it unites individuals, communities, organizations, and governments in addressing environmental challenges collectively. It serves as a reminder of our responsibility to preserve and protect the planet for future generations. By encouraging people to take action and make sustainable choices in their daily lives, World Environment Day fosters a sense of environmental stewardship on a global scale.

The Theme for World Environment Day 2023

The theme for World Environment Day 2023 is "Beat Plastic Pollution" or "solutions to plastic pollution." This theme addresses the urgent need for effective strategies to combat the detrimental impact of plastic on ecosystems and human health. The campaign's objective this year is to raise awareness

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about the issue of plastic pollution and inspire people to take steps towards reducing their use of single-use plastics. Every year, millions of tons of plastic waste end up in our oceans, rivers, and landfills. The decomposition of this plastic can take hundreds of years, causing harm to wildlife and polluting our environment. To tackle this issue, we can take various measures such as using reusable bags, water bottles, and coffee mugs, avoiding single-use plastic products like straws and utensils, and prioritizing plastic recycling. By taking these small yet significant steps, we can make a substantial impact in reducing plastic pollution and safeguarding our environment.

In India, the Ministry of Environment, Forest and Climate Change, Government of India, has announced that World Environment Day 2023 will focus on the Mission LiFE (Lifestyle for Environment). The objective is to encourage people to adopt sustainable lifestyle practices to protect the environment. The concept of LiFE was introduced by the Prime Minister of India at the 2021 United Nations Climate Change Conference (COP26) in

Glasgow. He called for a global effort to adopt sustainable lifestyle practices, and since then, India has been mobilizing its citizens to embrace LiFE.

The Host Country for World Environment Day 2023

Côte D'Ivoire, in partnership with the Netherlands, has been selected as the host country for World Environment Day 2023. This African nation has been actively involved in environmental conservation efforts and will provide a platform to discuss and address regional and global

environmental challenges. Hosting World Environment Day in Côte D'Ivoire offers a unique opportunity to raise awareness about the environmental issues faced by the country and the continent as a whole.

The Importance of Participating in World Environment Day

Participating in World Environment Day is crucial for individuals, communities, and organizations as it amplifies our collective efforts to protect the environment and promote sustainable practices. By actively engaging in World Environment Day activities, we contribute to global initiatives aimed at combating climate change, conserving biodiversity, promoting clean energy, and creating a more sustainable future for all.

Actions and Initiatives on World Environment Day

World Environment Day 2023 offers a wide range of activities and initiatives that individuals and organizations can partake in to make a positive impact on the environment. It serves as a platform to initiate and showcase various actions and projects.

Communities and organizations organize events such as tree-planting campaigns, clean-up drives, awareness campaigns, sustainable development projects, and educational programs. These activities aim to mobilize people and encourage concrete actions to protect the environment and promote sustainable living. Here are some key highlights:

Tree Planting Campaigns

Trees play a vital role in mitigating climate change, conserving water, and providing habitats for numerous species. Participating in tree planting campaigns not only helps increase global forest cover but also enhances local biodiversity and improves air quality. Planting trees is a tangible action that individuals and communities can take to combat deforestation and restore ecosystems.

Embracing Sustainable Lifestyle Choices

Adopting sustainable lifestyle choices can significantly reduce our ecological footprint. Conserving energy, minimizing waste, and promoting recycling are simple yet effective ways to make a difference. By embracing renewable energy sources, using eco-friendly products, and reducing the consumption of single-use plastics, we contribute to a cleaner and greener planet.

Environmental Education and Awareness

Education and awareness about environmental issues are paramount in driving positive change. Organizing awareness campaigns, workshops, and seminars can spread knowledge about the importance of environmental protection. By empowering individuals with information, we inspire them to become environmental stewards in their own communities.

Clean-up Drives

Cleaning up our surroundings, be it beaches, forests, or urban areas, helps combat pollution and preserves the natural beauty of our planet. Organizing community clean-up drives, mobilizing volunteers, and working together to create cleaner and healthier environments can make a tangible impact on our local ecosystems.

Advocacy for Policy Change

Engaging with policymakers and advocating for stronger environmental regulations and policies is crucial for long-term sustainability. By lobbying for changes in legislation, supporting renewable energy initiatives, and promoting sustainable agricultural practices, we can create an enabling environment for a greener future.

The Impact of World Environment Day

Over the years, World Environment Day has had a significant impact on environmental awareness and action. It has played a pivotal role in shaping policies, driving sustainable practices, and inspiring individuals to make positive changes. The collective efforts made on this day contribute to raising awareness, fostering environmental consciousness, and encouraging long-term behavioral changes that benefit both people and the planet.

Future Challenges and Goals

While World Environment Day has achieved notable successes, there are still immense challenges ahead. Climate change, biodiversity loss, pollution, and unsustainable consumption patterns continue to pose threats to our planet's well-being. World Environment Day serves as a reminder that we must continually strive to address these challenges and work towards achieving sustainable development goals. It calls for a united effort from individuals, communities, governments, and organizations to create a greener, cleaner, and more sustainable future for all.

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Artificial Intelligence in Indian Agriculture

Poonam Kaushal

Agriculture is one of the most fertile industries there are for artificial intelligence (AI) and machine learning (ML). AI, machine learning and the Internet of Things (IoT) sensors that provide real-time data for algorithms increase agricultural efficiencies, improve crop yields and reduce food production costs. Global spending on smart, connected agricultural technologies and systems, including AI and machine learning, is projected to triple in revenue by 2025, reaching $ 15.3 billion. IoT-enabled Agricultural (IoTAg) monitoring is smart, connected agriculture's fastest-growing technology segment projected to reach $ 4.5 billion by 2025, according to PwC.

Indian Government, during 2020-21 and 2021-22, has allocated funds to the tune of INR 1756.3 cores and INR 2422.7 crores to the States for introducing new technologies including drones, artificial intelligence, blockchain, remote sensing and GIS etc. in agriculture. Further, the Government also allocated INR 7302.50 crores and INR 7908.18 crores in 2020-21 and 2021-22 respectively to ICAR (Indian Agricultural Research Institute) for undertaking Research and Development in Agriculture for developing new technologies, their demonstration at farmer's fields and capacity building of farmers for adoption of new technology.

In addition to due focus on ensuring improved service delivery and facilitating market access to farmers, the government also accords adequate emphasis on reducing transaction costs, and promotion of Farmer Producer Organisations (FPOs) to improve their bargaining power. The development of infrastructure has also been given due attention to ensure better connectivity of farmers to national and international markets. High-yielding, cost-saving, disease/pest resistant, and climate-resilient varieties and technologies in crops, horticulture, animal, and fisheries science developed by ICAR have played an important role in increasing production and productivity, reducing the cost of production and enhancing the income of the farmers. The adoption of Farming Systems Models developed by ICAR has also enabled farmers to enhance their income and strengthen their economic condition. Besides, State-specific strategies for increasing farmers' income, provided to States by ICAR, are also helping farmers to increase their incomes.

Some of the areas that exhibit maximum potential to improve agriculture, with the integration of artificial intelligence are described below:

Cognitive computing has become the most disruptive technology in agricultural services as it can learn, understand, and interact with different environments to maximize productivity. Microsoft is currently working with 175 farmers in Andhra Pradesh to provide agricultural, land, and fertilizer

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advisory services. This initiative has already resulted in 30 percent higher average yield per hectare last year. The pilot project was completed using agricultural AI applications to communicate dates, soil preparation, fertilization based on soil tests, seed treatment, optimal spreading depth, and more. Further, mobile robots and field sensors support digital agricultural robots, and multidisciplinary cameras and laser scanners are used for facilities and areas of radiation that cannot be measured.

Proximity sensing, remote sensing, Internet of Things (IoT), and image-based Precision Farming are being used for intelligent data integration related to historical meteorology, soil reports, recent research, rainfall, and insect infections, along with drone imagery is being used for in-depth field analysis, crop monitoring, and field surveys.

The artificial use of image recognition using intelligence approaches for plant identification, cation, pest infestation, and disease diagnosis is also becoming prevalent. Using AI and machine learning-based surveillance systems to monitor every crop field's real-time video feed identifies animal or human breaches, sending an alert immediately can become very useful to prevent crop damage.

Yield mapping to find patterns in large-scale data sets and understand the orthogonality of them in real-time, and optimizing irrigation systems to measure the effectiveness of frequent crop irrigation is invaluable for crop planning.

Today, there is a shortage of agricultural workers, making AI and machine learning-based smart tractors, robots and robotics a viable option for many remote agricultural operations that struggle to find workers. These robots can harvest faster, locate and remove weeds more accurately, and thus reduce operating costs and dependence on labor. In the meantime, farmers are already turning to chatbots for help. Chatbots help farmers by answering their questions and providing advice and guidance on specific agriculture and yield-related queries.

Improving the track-and-traceability of agricultural supply chains by removing roadblocks to get fresher, safer crops to market can help reduce inventory shrinkage by providing greater visibility and control across supply chains.

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Microgreen - New Functional Food

Jyothi R., Kiran Kumar N., Kavitha Ullikashi and Raghavendra Yaligar

Agriculture Vegetables are often referred as protective food in terms of nutritive and medicinal value. It is one of the important components in Indian agriculture towards nutritional security. In recent days demand for fresh and pesticide free vegetables is increasing. The transition from rural to urban areas has led to the emergence of megacities, but at the same time, more arable land is needed to support the growing population. The expansion of arable land, unfortunately, often encounters various environmental challenges, such as the depletion of groundwater resources and deforestation. As a result, vertical cultivation techniques, as part of the mission toward sustainable agriculture, have evolved as an effective approach to alleviate the conflict between urbanization and the need of arable land. So, microgreens are the new class of edible vegetable with lots of potential in terms of nutritional ability to cure various deficiencies. Vegetables which are harvested after the cotyledon leaves have developed and one set of true leaves are referred as microgreens.

Microgreens stats their journey from San Francisco which was included in chef's menu in early 1980s. The first documented use of the word microgreens strated in UAS during 1998. Microgreens are contained high number of Carotenoids, Chlorophyll, organic acids without sugars. These greens exhibit higher anti-diabetic and anti-cholinergic activities than sprouts. Microgreens take generally 7-14 days to harvest and they are of 4-7inches in length. These can be grown both in soil and hydroponics way with good air ventilation. Nutrient content of microgreens are more than sprouts. Microgreens are rich in vitamin C, mineral like K, Cu, Zn, Fe, and also Phyto chemicals including carotenoids and phenolic compounds, which act like antioxidants. Some of the researches shown that microgreens have both anti-inflammatory and anti-cancer, anti-bacterial and anti-hypoglycaemic properties. These properties make the microgreen as new functional foods for human begins. The suitable way of growing microgreens is vertical farming, green house, hydroponics aquaponics. One can grow 80 different types of microgreens. Some of the well-known seeds from different plant families which are suitable for production of microgreens.

Brassicaceae – Broccoli, Cauliflower, Water cress, Cabbage, Arugula, Radish

Asteraceae family – Endive, Lettuce, Radicchio, Chiory

Apiaceae family – Carrot, Dill, Cellery, fennel

Amaryllidaceae family – Onion, Leek, Garlic

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Amaranthaceae family – Quinoa, Swiss chard, Amaranth, Spinach, Beet

Cucurbitaceae family – Cucumber, Squash and melon

Cereals – Rice, Oats, Wheat, Corn and Barley

Legumes – Chickpea, Beans, Lentils

In one of the research, it was also found that vitamins and antioxidants values were upto 40 times higher than that of fully grown vegetable leaves. According to some more research microgreens have great content of antioxidants i.e. polyphenols, which can reduce the risk of heart disease. They also have the ability to lower the triglycerides and LDL. On the other hand, microgreens can decrease the probability of Alzheimer's as they contain polyphenols. Presence of antioxidants can facilitate to lower the risk of type-2 diabetes and they also have the ability to reduce the danger of different kinds of cancers.

With respect to the food safety hazards, sprouts are mainly grown – up in dark environment of moisture where ready to microbial proliferation and their use different from microgreens has been applied in out breaks of food borne epidemics.

One of the major limitation of microgreens is their rapid quality deterioration that occurs soon after harvest, and so restricts their commercialization to local sales. Microgreens can be also commercialized in boxes with substrates, without harvesting. This strategy allows longer shelf life and wide opportunity for the commercialization.

Special attention must be addressed to the choice of growth media, which represents one of the key factors in the production process and could influence microgreens yield and quality. Among common substrates used for the microgreens production, peat-based media are the most utilized, followed by coconut coir and several synthetic media. Recently, natural fiber-based media—such as jute, cotton, cellulose, etc.—have gained increasing popularity since they could represent a sustainable alternative.

There are many ways to include microgreens in your diet. They can be incorporated into a variety of dishes, including sandwiches, wraps and salads. Microgreens may also be blended into smoothies or juiced. Wheatgrass juice is a popular example of a juiced microgreen. Another option is to use them as garnishes on pizzas, soups, omelets, curries and other warm dishes.

There is scope to explore broad range of area especially commercialization of microgreens cultivation. The effect of both light and temperature on nutritional value need to be studied elaborately. Study mainly related to the quality and safety of microgreens has to be the focus area.

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Role of Krishi Vigyan Kendra's in supporting FPO through Capacity Building and Marketing Opportunities

Anil Kumar

Most of the farmers in India including Punjab are small and marginal with seasonal produce. There are fargmented buyers for small quantity of seasonal marketable produce. Moreover, there is problem of long marketing channels, transport and warehousing owing to high storage cost. The farmers are also not updated with market information. On other hand, it is not possible for government to provide subsidies to each individual farmer. That's why there is need of aggregation or grouping in the form of farmers' producer compnies, farmers' interest group, cooperatives, self help groups, farmers' associations, etc. so that small and marginal farmers may club their markertable produce and find broader marketing opportunities locally as well as in super markets. The govt is also providing subsidies or extending maximum help to farmers' group. In this context, government of India is actively promoting farmers' producer organisations (FPOs) to provide opportunities for small and marginal growers to come together and sale their produce in collective way. The govt of India has also set target to establish 10000 FPOs across the country. Actually, FPOs are emerging as a greater tool in aggregating farmers, empowering them and ensuring better incomes.

FPOs are voluntary organizations command and managed by their farmer members. The members are actively involved in setting up of policies and making decisions related to their particular organization/company. The FPOs are actually open to all persons of similar interest who are willing to accept the responsibilities and give services to the organization without any gender, social, political and or religious discrimination. There are several examples of successful FPOs running across the India particularly in Gujarat, Maharashtra, Madhya Pradesh and Rajasthan that have made significant growth with time and have shown encouraging results leading to better returns for their produce.

The Krishi Vigyan Kendras' which are working under the mandate of Indian Council of Agricultural Research (ICAR), New Delhi are established in almost every district in India. The KVKs are functioning at grass root level and are playing a vital role in agricultural development and execution of lab to land programmes through their extensive role in transferring technologies by regularly organising various extension activities such as skill development training programmes, agro-advisories, exposure visits, exhibitions, demosntartions, literature support, etc. The KVK in other words help in overall socio-economic development of the farmers. The KVKs are also supporting FPOs to greater extent. KVKs are developing and nurturing FPOs for betterment of Farmers. KVK are helping FPOs in business development to marketing. The various services provided by KVKs for the successful running of FPOs are given below:

- Capacity building trhough skill development programmes (5-7 days) to farmers and farm women or members belonging to FPOs on various technologies viz. improved seed production & planting material/germplasm, scientific cultivation package, improved processing, sorting & grading, packaging technieques, hygienic storage & transportation, dairy farming, pig farming, goat farming, poultry farming, beekeeping, mushroom farming, value addition, integrated farming system, nuresery production, embroidry & stiching, organic farming, etc.). Beside short trainining

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programmes (1-3 days) are also conducted time to time or as per the demand of the farmers.

- Extension activities like frontline demonstrations, field days, kisan gosthis, farmers'-scientists interaction programmes, advisories through various platforms like whatsapp groups, youtube channel, m-kisan, exhibitions (also give opportunity to FPOs to display their products), radio/TV programmes, film shows, etc.
- Exposure visits to FPOs running successfully, institutes with well equipped infrastructure & facilities, fields/units of progressive farmers, local mandis, centre of excellence, etc.
- Method demonstrations on sampling techniques, nuresery raising, value added products, hygiene & sanitation, harvesting techniques, handling, packaging, sorting grading, etc.
- Diagnostic visits to identify causes and provide on the spot solutions.
- Tie-ups with reputed of institutes for cross learning and trainings.
- Business planning programmes (offering courses, technical guidance in setting up of units, infrastructure developments, machinery purchase, linkages with firms for branding and packagin, etc.).
- Guide members/farmers regarding credit facilities and establish linkages of farmer-members with banks for loan procedures. Also guide farmer-members for subsidies available with differnt line departments as farmers are usually not aware of different govt. schmes and flagship programmes.
- Making quality seed/ germplasm available at KVK and providing literature support in local language.
- **Marketing opportunities provided by KVK to FPOs**
- The KVK provide opportunity to FPOs to display their products by making provison of stalls/ exhibitions in various events viz. kisan melas, kisan sammelans, other district/block/village level programmes melas, etc.
- Some KVKs are also helping FPOs associated with them in finalizing demand, arranging transport facility and supplying produce to the wholesaler and retailers. In this way farmers are getting 15-20% extra price due to direct linkages and value addition of produce.
- KVKs also help making provision of marketing of produce with SHGs.
- Provide opportunity of marketing with reputed organisations by creating linkages
- 'Kisan Hut' help farmers sell their produce directly to consumers this increase the profit margin.
- KVKs also help FPOs directly by financial support received in the form of projects from NABARD, etc.
- E-commerce is an online platform of marketing where KVKs can play a pivotal role by guiding FPOs through technical knowledge.

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Aquamimicry: The Key to Building Sustainable Water System

Patekar Prakash[1*], Samad Sheikh[1] and Swapnil Narsale[2]

In aquaculture, Biofloc is being acknowledged as an environmentally sustainable technology and a cost-effective means of managing waste generated within the system. Nonetheless, it is accompanied by certain drawbacks that dissuade shrimp farmers from adopting it. The primary limitation of this technology is the requirement for continuous aeration to suspend the generated waste, enabling active bacterial metabolism for protein production. Additionally, nitrification leads to a decline in pH and alkalinity, necessitating careful monitoring and the addition of adequate carbon, in contrast to conventional shrimp farming methods (Thong, 2014). Consequently, a new innovative technology, copefloc, has been developed to overcome these constraints. Copefloc relies on the natural production of copepods within the system, which the stocked shrimps subsequently consume. This approach eliminates the need for external feed sources or intensive agitation and oxygenation in the culture system (Romano and Kumar, 2017).

The copepods, acting as zooplankton, offer numerous advantages as they convert energy within the food chain, serve as a food source for marine animals, and effectively recycle nutrients (Christenson, 2016). Shrimps fed with these copepods demonstrate enhanced growth and improved survival rates due to the superior biochemical composition of the plankton. Shrimp farming is a booming industry that plays a vital role in meeting the global demand for seafood. However, traditional shrimp farming practices often lead to environmental degradation, including water pollution and habitat destruction. In the quest for sustainable solutions, aquamimicry has emerged as a game-changer. Emulating nature aquamimicry offers a promising approach to revolutionizing shrimp farming and building environmentally friendly water systems. In this article, we delve into the fascinating world of aquamimicry and explore how it holds the key to a more sustainable future for shrimp farming.

Understanding Aquamimicry

Aquamimicry represents a novel approach in shrimp farming that offers potential solutions to address the existing limitations associated with conventional methods. In recent years, various countries, such as Thailand, Australia, Bangladesh, Brazil, Brunei, China, Ecuador, Egypt, India, Korea, Malaysia, Mexico, Peru, Singapore, Sri Lanka, the USA, and Vietnam, have adopted this technique in their shrimp farming practices (Zeng et al., 2020). By simulating natural conditions, aquamimicry creates an environment that promotes microbial growth and enhances phyto and zooplankton populations, particularly copepods, which serve as valuable supplementary food sources while also contributing to in situ water quality management (Romano, 2017).

This approach effectively emulates the natural environment, fosters environmental stability, and reduces feeding costs. However, limited information is available regarding the specific details of this method, its associated benefits, and how it compares to other approaches, such as Biofloc Technology (BFT). By mimicking the efficiency and resilience of natural ecosystems, aquamimicry enables us to create sustainable solutions for various industries, including shrimp farming. It focuses on optimizing water usage, improving water quality, and reducing waste while ensuring the well-being of aquatic organisms.

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Advantages of the Aquamimicry in Shrimp Culture

- Stability Enhancement: The system offers a more stable culture environment than conventional systems.
- Improvement in Shrimp Health: The presence of bacterial secondary metabolites such as liposaccharides and peptidoglycans in probiotics can enhance farmed shrimp's immunocompetence, resulting in healthier individuals.
- Feed Conversion Ratio Improvement: The abundance of zooplankton, especially copepods, improves feed conversion ratios.
- Disease Prevention: Providing a more natural and welfare-focused environment reduces the likelihood of disease outbreaks in shrimp aquaculture.
- Applicability to Large and Semi-Intensive Systems: Aquamimicry can be utilized in large-scale and semi-intensive cultivation systems, leading to reduced feed consumption and water exchange rates.
- Improvement in Nutrition: The presence of live foods in the culture media improves the overall nutrition of farmed shrimp.
- Stress Alleviation and Biosecurity: The limited water exchange rate alleviates stress conditions in farmed shrimp and enhances biosecurity.
- Reduction in Pathogen Propagation: Aquamimicry creates unfavorable conditions for the propagation of harmful bacterial pathogens and reduces the formation of black soil.
- Rise in Production Yield and Profitability: Implementing will help to increase shrimp production yield, reduce expenditures, and enhance profitability. The reduced dependency on commercial feeds decreases biological oxygen demand and the need for intense aeration, leading to improved energy consumption efficiency.
- Better Growth Performance: Simulating natural conditions in this system can trigger better growth performance in shrimp.
- Simplified Implementation: This system requires less technology, infrastructure, and technical knowledge for establishment and operation. Aquaculture farmers can implement it with lower technical expertise.

Fermentation in Aquamimicry

Fermentation is a biotechnological process employed in aquamimicry systems to enhance the utilization efficiency of lignocellulosic materials. By breaking down complex compounds into simpler forms, fermentation increases the bioavailability of nutrients, improves digestion, and promotes animal growth rates (Razak et al., 2017). This microbial process is commonly used in aquaculture to improve the nutritional value and reduce anti-nutritional factors (ANF) in alternative protein sources and cereals incorporated into feed formulations. Cereals typically have low levels of essential amino acids, high fiber content, and ANF, which negatively impact digestion and growth. Through fermentation, undesirable substances are reduced, and the nutritional quality of plant proteins and cereals is enhanced by the activity of microbial-derived enzymes in an anaerobic environment (Qiu and Davis, 2018). During this process, bacteria and yeast use carbohydrates as an energy source and convert them into microbial proteins. Consequently, fiber and ANF levels are reduced, while amino acids, vitamins, minerals, and proteins are increased in fermented products. Studies have shown that the inclusion of fermented grains with probiotics in shrimp farming significantly improves digestion (Lara-Flores, 2011).

Furthermore, fermented cereal meals can partially replace dietary fishmeal in shrimp feed, exhibiting higher digestibility and improved nutritional content compared to non-fermented cereals. Among various cereals, rice bran, an

agricultural waste, is commonly used as a carbon and energy source in aquafeeds. It is readily available and cost-effective, contains substantial nutrients, and has a relatively high fiber content (Deepak et al., 2020).

crustaceans with short lifespans and small sizes, play essential roles in nature, including serving as food for marine animals, facilitating nutrient recycling, and participating in energy conversion within the food

Figure 1. Preparation of fermented rice bran. A: start of preparation (rice bran and probiotic). B: 24 hours after preparation. (Image: Catalani, 2020)

Figure 2. A: Anaerobic fermented rice bran maintained for 24 hours in an experiment on feed replacement. B: Application of fermented rice bran in pond during feed replacement experiment (Image: Gonçalves, 2022)

Live Food Importance

Aquamimicry technology utilizes natural organisms, particularly copepods, as a feed source for shrimp in a method known as copefloc technology (Deepak et al., 2020). In this approach, copepods become the dominant species, replacing other zooplankton species and indicating system maturity (Chakravarty et al., 2018). Copepods, which are

chain (Chakravarty et al., 2018). Due to their favorable biochemical composition and ability to improve survival and growth in farmed shrimp at different life stages (including eggs, nauplius, pre-adults, and adults), the use of copepods in the aquaculture industry is increasing (Chakravarty et al., 2018). Compared to rotifers and Artemia, copepods offer higher nutritional value, particularly in terms of

LC-PUFA (e.g., eicosapentaenoic, docosahexaenoic, and arachidonic acids), which are crucial for growth and development (Satoh et al., 2009). Additionally, copepods are rich in carotenoids, free amino acids (such as taurine), peptides, vitamins, and minerals (including selenium, iodine, copper, and manganese).

Moreover, copepods exhibit significant variation in protein levels, ranging from 52.4% to 57.6% of dry weight, surpassing the protein content of *Artemia franciscana* (41% in newly hatched nauplii and 34% after 24-hour enrichment). With nauplius sizes ranging from 50 to 60 µm, copepods are more suitable in size than rotifers and Artemia for the larval stages of various farmed aquatic species with smaller mouth gaps. Copepodites and adult stages, being larger, have been successfully utilized to feed larger larvae.

The stages of establishing an aquamimicry system

Step 1: Pond Preparation

- Fill the cultivation pond with filtered seawater using a filter bag (around 200-300 µm).
- Introduce probiotics (*Bacillus sp.*).
- Gently drag the sediments at the bottom of the ponds to facilitate mixing with the added probiotics and minimize biofilm development.
- Control aquatic weed growth by adding tea seed cake (20 ml L–1) along with fermented rice bran or wheat bran (without husk) at a rate of 50-100 mg L–1 to promote the zooplankton population. Proper aeration is important for nutrient and probiotic mixing while mitigating the negative effects of tea seed cake.

Step 2: Carbon Source Utilization

- Mix rice bran and wheat bran (without husk) with water at a ratio of 1:5 to 1:10, along with probiotics, and aerate the mixture for 24 hours. Slowly add the mixture to the pond once the bran is fully powdered.
- If the mixture has crumbled, add the upper layer to the pond. The pH of the mixed water should be maintained between 6 and 7.

Step 3: Stocking of Shrimp Post-Larvae (PL)

- Stock shrimp post-larvae (12-15) at a density of 30 to 40 m^{-2}.
- The inclusion of fermented carbon sources depends on water turbidity: 1.0 ml L^{-1} for extensive systems and 2.0 to 4.0 ml L^{-1} for intensive systems.
- Monitor and analyze water quality parameters daily.
- Perform gentle dragging every 15 days after stocking to minimize biofilm growth.
- Add probiotics monthly during the cultivation period to maintain water quality.
- In intensive rearing systems, excess sediment must be removed to sedimentation ponds through a central drainage system two hours after feeding. Sedimentation ponds should be regularly emptied to prevent the proliferation of pathogens like *Vibrio sp.*
- Sediment ponds are typically 4.0 m deep in the center and 2.0 m at the edges. Stocking low-density fish species such as milkfish and catfish can help control plankton and detritus, providing an additional income source for farmers. Sediments from cultivation ponds produce worms, which aquatic animals can consume.
- Overflow from sedimentation ponds is directed to another pond acting as a biofilter, with low-density species like tilapia. Water with minimal nitrogenous waste can be further overflowed into the grow-out pond.
- Thoroughly clean sediment ponds every three years.

Step 4: After Harvesting

- After harvesting, completely clean the pond of black soil and accumulated sediment. Add

fermented rice and prepare probiotics for the next production cycle.

Conclusion

Aquamimicry represents the convergence of aquatic biology and technology to replicate the characteristics of natural aquatic ecosystems to cultivate healthy shrimp. This approach shares similarities with Biofloc Technology (BFT), although there are notable distinctions. Firstly, the aquamimicry system reduces the amount of carbon added and eliminates the reliance on nitrogen input ratios. Moreover, instead of allowing a large volume of flocs to form and remain suspended, aquamimicry employs more intensive systems to remove sediments, which other farmed aquatic species can recycle. In an ideal aquamimicry environment, the water closely resembles the composition and appearance of natural estuarine water, complete with microalgae and zooplankton. By achieving such a balance, dissolved oxygen and pH fluctuations are minimized. Additionally, chemical fertilizers are unnecessary as rice bran serves as a food source for zooplankton and a carbon source for bacteria. The aquamimicry system minimizes water exchange, ensuring biosecurity, and incorporates probiotics and FRB-derived oligosaccharides as synbiotics to stimulate immune responses in shrimp, ultimately yielding organic marine shrimp without the need for therapeutics. While challenges persist, further research and implementation are necessary to overcome these obstacles and facilitate the progressive development of this sustainable aquaculture technique.

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Effective Strategies for Managing Root Diseases in Mulberry Plants

Anusha M. Nayak, Farooqkhan and Tanuja S

Mulberry and sericulture have played a significant role in human civilization for centuries, intertwining nature, culture and economic prosperity. The cultivation of mulberry trees, particularly the white mulberry species (*Morus alba*) serves as a crucial foundation for sericulture, the practice of rearing silkworms to produce silk. This symbiotic relationship between mulberry trees and sericulture has been nurtured for centuries, contributing to the growth of vibrant silk industries in different parts of the world. From the intricate silk fabrics adorning royal garments to the economic benefits for farmers and the preservation of cultural heritage, mulberry and sericulture have left an indelible mark on society.

Mulberry (*Morus* spp.) is a perennial, fast growing and predominantly cross-pollinated plant. Commercially exploited mulberry varieties are prone to number of diseases and creates major constraint in the production of quality leaves. Plant disease can be defined as any malfunctioning of host cells and tissues that result from continuous irritation by a pathogenic agent or environmental factor and leads to development of symptom(s). Moreover, mulberry garden is being maintained over 20 years with regular pruning in every year in India. Therefore, pathogens seem to perpetuate in various seasons over the year. Diseases account for 10-25% leaf yield loss and reduce leaf quality, which in turn affecting the overall silkworm cocoon productivity. Therefore, timely adoption of suitable management measures is essential.

In the present article the efforts have been made to consolidate the information available on various root diseases which is affecting growth and development of mulberry gardens. The management strategies for effective control and mitigation of root diseases to ensure the sustainable growth of mulberry crops were also discussed.

Root-knot Nematodes

Root rot

Dry root rot

Black root rot

Root diseases of mulberry

As per the records or literature available in social domain portraits that there are numerous pathogens which causes the root diseases in the mulberry garden. The brief on various root diseases along with its causal agents, symptoms and favourable conditions for disease incidence is given below table.

Integrated Disease Management (IDM) in Root Disease of Mulberry

Integrated Disease Management (IDM) is a decision-based strategy that involves the coordinated application of multiple methods to optimise pathogen control in an environmentally and economically sustainable manner. Implementing an integrated pest management approach is crucial for comprehensive root disease management. IDM involves combining multiple strategies such as cultural practices, biological control and targeted chemical interventions, if necessary. By integrating various methods, farmers

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can optimize disease control while minimizing environmental impact.

Table 1: Diseases and Symptoms

Disease	Causal organism	Symptoms	Favourable conditions
Root-knot Nematodes	*Meloidogyne* spp.	They form galls or knots on the roots, leading to stunted growth, yellowing leaves, and overall decline in plant health.	Soil temp. - 20-30 ºC, Soil moisture- 60 %, pH of 4-8
Rhizoctonia Root Rot	*Rhizoctonia* spp.	Symptoms include discolored and decaying roots, stunted growth, and wilting.	Soil temp.- 28-34ºC, Soil moisture- >40%
Dry (Fusarium) Root Rot	*Fusarium solani* and *F. oxysporum*	• Infected trees may exhibit yellowing or browning, sudden withering and defoliation of the leaves. • Decay of roots, vascular discoloration and bark can be peeled of easily. Wilting and a decline in overall vigor.	Soil temp.-26-35ºC, Soil moisture- >40%, pH- 5-10
Armillaria Root Rot	*Armillaria* spp.	• Infected trees may display yellowing leaves, wilting, and a decline in overall health. • The presence of honey-colored mushrooms around the base of the tree is a common sign of Armillaria infection.	Soil temp.-26-28ºC, Soil moisture- 70%, pH- 4.2-7.2
Black root rot	*Botrydiplodia theobromae*	• Sudden wilting and defoliation of leaves. • Drying of branches, decay of roots, rotting and peeling of the bark extends up to stem region near the soil line.	Temp.- 25-30ºC, Soil moisture- 40-60%
Charcoal rot	*Macrophomina phaseolina*	• Yellowing of the leaves and drooping of the braches. • Roots turn brownish black charcoal like, sclerotial bodies on roots and weak tissues breaking off easily.	Soil temp.-25-35ºC, Soil moisture- >40%

In order to effective control of root diseases in mulberry various practices can be taken-up. These practices are discussed in brief:

Cultural Practices: One of the fundamental approaches to managing root diseases in mulberry plants is to adopt proper cultural practices. These practices include:

- Soil Preparation: Ensure well-drained soil with adequate organic matter to promote healthy root development and prevent waterlogging, which can exacerbate root diseases.
- Sufficient quantity of organic matter should be applied in the affected areas.
- Deep ploughing of the infested land and soil should be exposed to sunlight during summers to kill the pathogen.
- Intercropping: with marigold, sesame, sun hemp at 30 cm distance between the rows reduces 60-65% root galls and egg masses of nematode.

Physical Practices:

- Sanitation: Remove and destroy infected plant debris to prevent the spread of pathogens. Proper disposal of infected plant material reduces the chances of disease recurrence.
- Hot water treatment at temperature of 48^{0}C for 20 min used for the saplings of mulberry roots to eliminate nematode population.

Disease-Resistant Varieties: Selecting disease-resistant varieties is a proactive measure in managing root diseases. Breeding programs have developed mulberry cultivars that exhibit resistance to specific pathogens. By planting resistant varieties, farmers can minimize the risk of disease occurrence and reduce the need for chemical interventions.

Biological Control: Employing biological control agents can be an effective and environmentally friendly approach to combat root diseases. Beneficial microorganisms, such as certain strains of bacteria and fungi, can suppress pathogen growth and enhance plant defence mechanisms. These bio-control agents can be applied to the soil or directly to the roots, providing a natural defense against root diseases.

Talc based bio-nematicide (Bio-nema) produced by *Verticillium chlamydosporium* used with neem oil cake can parasites the eggs of *M. incognita* and stops egg hatching also neem oil cake kills the larvae present in the soil (Alam, 1993).

Combined application of Dithane M-45 (10 gm/pit) and after 15-20 days, talc-based biofungicide named Raksha produced by *Trichoderma harzianum* at the rate of 500 g/plant should be applied in the root zone and irrigated and FYM (1:24:200) @ 200gm/plant is recommended at three split doses.

Dipping of cuttings in Dithane M-45 (0.1%) solution and application of bioformulation called as **Nursery-Guard** prepared by using *Trichoderma pseudokoningii* (a product of CSRTI, Mysore).

Chemical Treatments: Chemical treatments should be considered as a last resort and used judiciously. Fungicides and nematicides can provide effective control against specific root pathogens. However, their use should be based on thorough diagnosis, adherence to recommended dosage, and proper timing. It is important to follow safety guidelines and regulations to minimize potential risks associated with chemical applications.

Root dipping of saplings in 0.1% bavistin (Carbendazim 50% WP) solution for 30 min and planting in pits dusted with 10 g of Dithane M-45 (Mancozeb 75% WP).

Nematicides like Furadon 3G @ 40 kg/ha/year or Rugby 10G @30kg/ha/year in four split doses is recommended.

Conclusion

The management of root diseases in mulberry plants requires a multi-faceted approach that combines cultural practices, disease-resistant varieties, biological control, integrated disease management and when necessary, targeted chemical treatments. By implementing these strategies, farmers can minimize the impact of root diseases, maintain healthy mulberry crops and ensure a sustainable supply of high-quality leaves for the sericulture industry. It is essential to promote awareness and provide support to farmers in adopting these management practices to protect their livelihoods and contribute to the overall success of the mulberry silk industry.

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Success Story of Annai Kaveri FPO of Millets in Salem, Tamil Nadu

Malathi, G, P.Kalaiselvi, R.Jegathambal and M.Ravi

Annai Kaveri Collective Farmers Producer Company Ltd., located at Kolathur, Mettur, Salem was registered as a Producer Company on 17/11/2020th with 1000 members covering about 10 revenue villages promoted by TNSFAC under National Mission for Sustainable agriculture scheme (NMSA).In this connection, the Department of Agricultural Marketing and Agri Business, Salem and the Erode Precision Farm Producer Company Ltd, the Resource Institution have conducted preliminary levels of meetings with farmers and had started enrolling farmers who would become potential shareholders. Most of the farmers are small and marginal cultivating predominantly cultivating paddy, groundnut, sesame, millets, banana and chillies in rainfed conditions.

Around 85% of the land holdings are small and Marginal Farmers, being unorganized and divided into small fragments these farmers are not able to get remunerative prices for their produce at the right time. A prosperous and sustainable Agriculture is needed that enables farmers to enhance productivity through efficient, cost-effective cost productive resource use and realize higher returns. In search of avenues for getting higher net profit, the CEO and BODs of Annai Kaveri FPO were imparted knowledge with organic farming practices, waste management technologies, value addition technologies etc., from KVK, Salem through different On Farm Trials, Front Line Demonstrations, trainings, method demonstrations and entrepreneurship development programmes etc., They were imparted their knowledge and skill from the Directorate of Agri Business Development (DABD), TNAU, National Institute of Food Technology Entrepreneurship and Management (NIFTEM), Tanjore and Indian Institute of Millet Research, Hyderabad too regarding different techniques of millets value addition, packing, branding etc.,

Mrs. Rani Murugesan, one of the BODs of Annai Kaveri FPO applied for getting organic certification for her 3.5-acre land as per the suggestions of KVK and now it is organically certified. She is also encouraging other too in getting organic certification for better remuneration. Being a women board of directors, with assistance of four of the women members of FPO, she started producing the traditional value-added products like murukku, mixture etc., from minor millet produces received from her organically certified land.

The Women Director Mrs. Rani Murugesan from Anna Kaveri FPO, won first prize in the "COOKATHAN" event conducted by Indian Institute of Technology – Madras, RESEARCH PARK, Tharamani with a cash prize of twenty-five thousand.

Few women farmers of Anna Kaveri FPO were converted into traditional entrepreneurs for making confectionery and sweets using minor millets and traditional rice under the brand name of "UZHAVAR MAGAL."

The list of traditional snack food from millets from Anna Kaveri FPO is as follows.

- Murkku from Little Millet, Pearl Millet, Barnyard Millet, Finger Millet, Kodu millet, Foxtail Millet
- Ribbon murukku from Little Millet, Pearl Millet, Barnyard Millet, Finger Millet, Kodu millet, Foxtail Millet
- Mixture from Foxtail Millet, Finger Millet
- Sweet boondhi from Foxtail Millet
- Finger millet sweet ball (kolu kattai)

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Packing of snack food items prepared from millets by Annai Kaveri FPO

Branded pack of snack food from minor millets by Annai Kaveri FPO

Burfi prepared from Zn fortiied cumbu and ground nut by Annai Kaveri FPO

Thenai Buri prepared by Annai Kaveri FPO

Participation of Annai Kaveri FPO in Cookathan Competition at IITM, Chennai

Receiving first prize in Cookathan Competition at IITM, Chennai

- Uzhavar magal millet health mix
- Karupukavooni and Foxtail Millet Athirasam.

All these snacks were already launched by our honourable Tamil Nadu Agricultural Minister Thiru M.R.K. Panneerselvam at Dharamapuri.

In Kolathur bus stand, this FPO started a stall for selling their snack food items from traditional millet and rice varieties. So traditional snack foods from traditional millets that too from organically grown millets in the brand name of Uzhavar Magal will be available not only across the country but also across the world in near future.

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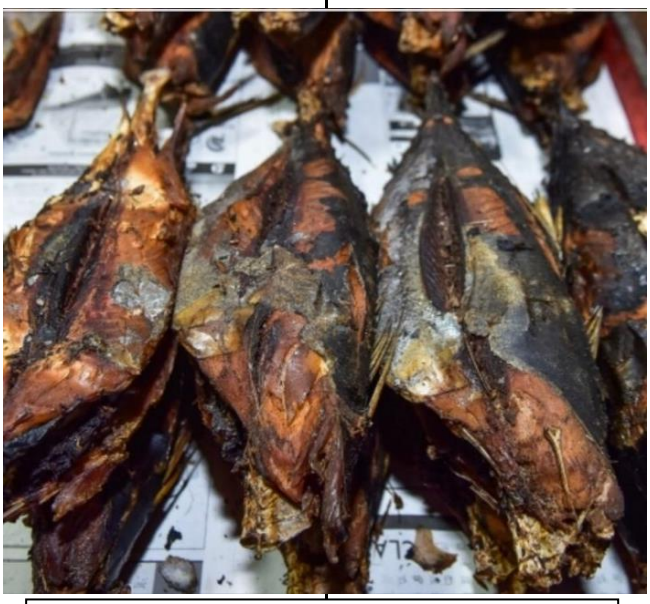
An Efficient Smoking Kiln for Fisherfolks

K. C. Neethu, D. S. Aniesrani Delfiya, S. Murali

Fish is one of the most cost-effective animal protein sources and is rich in nutrients like omega-3 fatty acid, calcium and minerals. But it is highly perishable due to its high-water activity, protein content, neutral pH and presence of autolytic enzymes. So different methods are used to preserve and store the fish for longer duration. Smoking is one of the oldest methods of preservation of fish and smoked fish is one of the delicious cuisines in the north eastern region and consumed by many tribal communities across India.



Hot smoked and dried tuna fish

The advantages of smoked fishery products are many. Fish that has been smoked has a longer shelf life, better flavour, and gets used more often in delicious cuisines such as sauces and soups. It allows storing the fish for the lean season and saves post-harvest loss during times of bumper catches. It makes fish easier to store, pack, transport and market, especially in the areas where it is scarce, and it boosts people's access to protein throughout the year.

Smoking preserves the fish through combination effects such as heat treatment, drying, salting and deposition of chemicals (phenols) produced from burning wood. Smoke has been reported to have both antioxidant and bactericidal properties. Smoked fish is preserved and has flavors that are in part due to the components of the smoke. The bactericidal action of smoking is enhanced by the heat produced during smoking. Salting is done usually before smoking which improves the flavor and appearance of the smoked fish. Additionally, salting makes the fish flesh solid and manageable. Drying also happens during smoking simultaneously with smoke deposition. A tasty, smoky flavored and firm product is produced as a result of the smoking and drying process.

In addition to the domestic consumption, these smoked fish products also fetch high export value. The indigenous way of preparing smoked and dried fish, causes wide variation in the physico-chemical and sensory attributes of the product. So, it is necessary to process it under controlled and optimized conditions in order to ensure the product quality.

Hygienic processing of hot smoked and dried fishes requires an appropriate system known as smoking kiln. Even though many smoking kiln designs are available, a cost-effective, easy to handle, hygienic and production of healthy smoked fish is a major concern. Hot smoking equipment works by the function of applying heat to remove the moisture and by applying smoke under controlled conditions. Modern fish smoking kilns are frequently made with sufficient airflow and heat exchange mechanism to remove moisture from the product. The use of a smoking kiln to mechanically smoke the fish allows for the elimination of traditional smoking's drawbacks and the production of uniformly high-quality goods that satisfy international standard. ICAR-Central Institute of Fisheries Technology has been working to

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facilitate hygienic production of hot smoked and dried fish by designing and fabricating a smoking kiln. CIFT's existing design is very simple in construction having a holding capacity of 10 kg fish. The smoking kiln had a furnace at the bottom and trays are stacked above the furnace where the product gets smoked as the smoke passes through it and exit at top. The ash is collected at the bottom in the ash trays after smoking. Even though the fish is smoked in hygienic conditions, the smoking parameters are not properly controlled. Hence, an improved version of smoking

Smoking kiln

kiln is designed to solve the drawbacks of existing smoking kiln.

This new design of smoking kiln has a provision to smoke and dry the fish using the heat energy from biomass furnace and electrical heating coil as an auxiliary heating system. The advantage is that new design can be operated as biomass dryer when smoking is not needed. This smoking kiln is designed to have 20 kg capacity with a furnace to supply hot smoke, a filter mechanism to remove undesirable smoke particles/hydrocarbons and a provision to facilitate the cross flow of smoke and air, so that no manual turning of fish is needed during smoking and drying by placing it on the perforated trays inside the smoking chamber. Intermittent smoking and drying will be provided to have an optimum quality product with desirable moisture levels. Airflow and feed flow in the furnace will be controlled to increase smoking efficiency. The equipment is provided with electrical heating coils to maintain the internal temperature of the product to not less than 70°C for at least 30 min. smoking is done for 90 to 180 min with intermittent heating to reduce the moisture content to 10% (F.No.1-10(8)/Standards/SP/(Fish and Fishery Products)/FSSAI-2013).

The new smoking kiln design will help to reduce the risk of contamination from human resources, unhygienic surroundings, and hazardous smoke components. A standardized method of production of hot smoked and dried fish or shrimp is possible through the design and development of this smoking kiln. When smoking is not required, the smoking kiln can also be utilised as a biomass dryer.

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GIS and Remote Sensing in Plant Pathology

Pravallika Sree Rayanoothala

According to the world summit on food security, the global population is expected to be doubled by 2050. Over the past century, numerous technical advancements, including the green revolution, have impacted how agriculture is practised. The third agricultural revolution, commonly referred to as the "Green Revolution," occurred between the 1960s and the 1980s and was characterised by high yield crop varieties, the use of synthetic fertilisers, pesticides, and a water system (Pingali, 2012). Since the 1960s, the global population has doubled and the consumption pattern has increased threefold, but agriculture has only been able to keep up with demand by increasing its cultivated area by 30% (Wik *et al.*, 2008). According to the world bank, the need for food and agricultural products will rise by another 30% by 2025 and by more than 70% by 2045.

Remote sensing is the art and science of acquiring data from a distance about real-world items or areas without coming into contact with the object being studied directly. It is a tool for more precise and accurate monitoring of the earth's resources using satellite technology in addition to terrestrial observations. The idea behind remote sensing is to analyse the features of the earth using electromagnetic spectrum (visible, infrared, and microwaves). These wavelength ranges are utilised to differentiate between vegetation, bare soil, water, and other similar characteristics because the normal responses of the targets to these wavelength regions vary. Along with field observations, it can also be used for crop growth monitoring, land use pattern and land cover changes, water resource mapping and water status in the field, disease and pest monitoring, yield estimation, forecasting the harvest date, precision farming, and weather forecasting (Gebeyehu, 2019). Crop yield forecasting greatly benefits from the use of inputs from remote sensing in conjunction with crop simulation models.

Application of RS and GIS in plant pathology:

GIS can be used to track the spread of diseases in crops by analysing data from remote sensing and other sources. GIS can integrate spatial data on pest and disease occurrences with crop distribution, weather patterns, and environmental factors. By analysing these data, GIS can generate maps that identify high-risk areas for specific diseases. This information helps farmers and agricultural experts in implementing targeted disease control measures, such as precision spraying or timely application of fungicides. India began using remote sensing for national development comparatively earlier than other developing nations. Prof. Pisharoth Rama Pisharoty conducted the first experiment utilising remote sensing on the coconut root-wilt disease in Kerala in the early 1970s (Dakshinamurti *et al.,* 1971). In India, Professor Pisharoty—who also served as the founding director of the Indian Institute of Tropical Meteorology, Pune—is known as the “Father of Remote Sensing”.

Sensors used for plant disease detection:

Nearly all applications for remote sensing in precision agriculture research are covered by four types of sensors: RGB (Red Green Blue), multispectral, hyperspectral, and thermal. The role of sensors is to take pictures with a high spatial and temporal resolution, which can be useful for tracking a variety of vegetation related traits. Some of these sensors are discussed below.

RGB: In order to identify disease symptoms, nutrient deficiencies, damaged plants, specific weeds, and plant species in crop fields, colour or RGB (red, green,

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blue) images are helpful. An object's appearance in RGB images is determined by the light that it reflects, its optical properties, and how people perceive it. For weed discrimination, crop mapping, variable physiological process across a leaf surface, and plant stand counting, RGB-based image analysis has been used in agriculture.

Multispectral: Spectral data from the red, green, and blue electromagnetic spectrums, as well as the red edge and near-infrared wave ranges, are typically detected by multispectral sensors. For multispectral image processing, band ratio and the normalised difference vegetation index (NDVI) are the two effective vegetation indices used. These techniques can be used to detect weed species, crop damage from herbicide application, and various disease symptoms.

Hyperspectral: Using 5–10 nm bandwidths, hyperspectral cameras analyse the spectral reflectance of plants in the visible, near–infrared, and mid–infrared (350–2500 nm) portions of the electromagnetic spectrum. A spectral signature is the distinctive spectral reflectance of a particular plant species at the canopy or single leaf scale. The first step in determining the potential of remote spectral data to categorise weeds and crops and to identify various disease symptoms is to measure the spectrum of reflectance.

Thermal: The principle behind thermal imaging is that objects emit infrared energy in proportion to their temperature. In general, objects that are warmer emit more radiation than objects that are colder. In essence, thermal cameras are heat sensors that can identify temperature differences between objects. The infrared thermal camera detects electromagnetic radiation in the infrared range (800–1400 nm) and conveys it as a false colour image. A thermal sensor's pixels each have a distinct temperature value. Plant temperatures can be tracked using thermal imaging across an entire field. Increased canopy or plant leaf temperatures can be brought on by plant disease symptoms, water stressed plants, and pest infestations.

How remote sensing works in plant disease detection?

Depending on the remote sensing methods used, there are three distinct spectral domains of vegetation reflectance. Sahoo *et al.*, (2015) discussed how the biophysical and biochemical characteristics of vegetation, such as the leaf area index, the amount of living and dead biomass, the pigment and moisture content, and the spatial arrangement of cells and structures, strongly influence their spectral properties. The emerging diseases can be easily detected by the changing colour and pattern of the field. By analysing differences in the spectral characteristics of images collected at different times, remote sensing can help to track and monitor changes in various environments, including urban areas, forests, and agricultural landscapes. The ability to detect changes through remote sensing provides valuable insights for decision-makers in various fields, such as resource management, disaster response, and environmental monitoring.

Conclusions

The current chapter gives a thorough overview of how remote sensing and GIS are used in many aspects of agriculture. Globally, GIS is becoming an increasingly significant component of agriculture production, assisting farmers in improving output, reducing expenses, and better managing their land. It is necessary to establish a state- or district-level information system based on the information that is now available on different crops gathered through remote sensing and GIS techniques in order to properly use the information on crops for improving the economy. A GIS map makes it easier to compare data from the past and the present, which aids in disease and pest predictions. As a result, by offering a variety of geospatial maps, GIS has given researchers and planners additional options for tracking and

predicting agricultural disease pests. These and other innovative methods will undoubtedly increase the value of remote sensing and GIS in many different areas of agricultural sciences.

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Hydroponics Technology for Horticultural Crops

Rupali Sharma and Sandeep Bhardwaj

Providing quality nutritive food to more than 1.6 billion people by the Year 2025 would be a major challenge for the country. Increasing population, decreasing land and water holding, urbanization, industrialization, global warming are some of the major impediments for the country. Various biotic and abiotic stress factors are threatening the open field agricultural production systems throughout the world in varying degrees. The soil fertility status has attained almost the saturation level in most parts of the country as the productivity is not rising pro rata with the amount of inputs.

Hydroponics refers to cultivation of plants without soil, either in water or based on various soil-less media. Utilizing this technology, the roots absorb balanced nutrients dissolved in water that meet all the developmental requirements of plants. The word hydroponics was derived from the Greek words, HYDRO (water), and PONOS (labour), literally "water working". Protected Hydroponics cultivation technology including greenhouse production systems require adherence to GAP protocols because intensive cultivation in greenhouses often involves excessive use of chemicals since the stakes are high due to intensive inputs and high expectations on quality front.

Hydroponics cultivation has great prospects for Indian agriculture. It is one of the potential technologies for doubling farmers income. In the changing scenario of food habits and growing fad for green vegetables, herbs and fruits, hydroponics technology is going to play a major role for sustainable and round the year production in urban and peri-urban areas.

The impact of desertification and climate change requires aquaponics to ensure food security. Aquaponics has been identified as a farming approach that, through nutrient and waste recycling, a solution for sustainable development goals, particularly for arid regions while energy saving and higher growth rates through increased CO2 levels in the crop environment are advantageous in moderate climate zones. Traditional aquaponics designs comprise of aquaculture and hydroponic units involving recirculating water between both subsystems. In such one-loop aquaponics systems, it is necessary to make trade-off conditions of both subsystems in terms of pH, temperature, and nutrient concentrations as fish and plants share one ecosystem. Secondly in decoupled dual-loop aquaponics systems separate the recirculated aquaculture system (RAS) and hydroponic units from one another, creating detached ecosystems with inherent advantages for both plants and fish. Recently, there has been an increased interest in closing the loop in terms of nutrients as well as increasing the input/output efficiency. For that reason, remineralization and distillation loop have been incorporated into the overall system design to form multi-loop aquaponic systems (Goddek and Körner, 2019).

Aquaponics is an integrated system that links hydroponic plant production with recirculating aquaculture. Aquaponics systems use resources and energy more efficiently than single production systems, thus facilitating sustainable and environmentally friendly food production. Recirculating aquaculture systems (RASs) are systems that treat and reuse the wastewater from fish farming. In an aquaponics system, fish wastewater from a recirculating aquaculture system is delivered to hydroponics systems. In a recirculating aquaculture system, ammonia and nitrite produced from the residual bait and faeces of fish are the major metabolic wastes that harm the growth of fish. Nitrification

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through biological filters converts NH4 into NO3 via NO2, and NO3 is an excellent fertilizer for plants. This process can purify fish wastewater, and then the water is recycled back to the aquaculture system. Recycling of the aquaculture water for plants saves water and nutrients (Ren et al., 2018).

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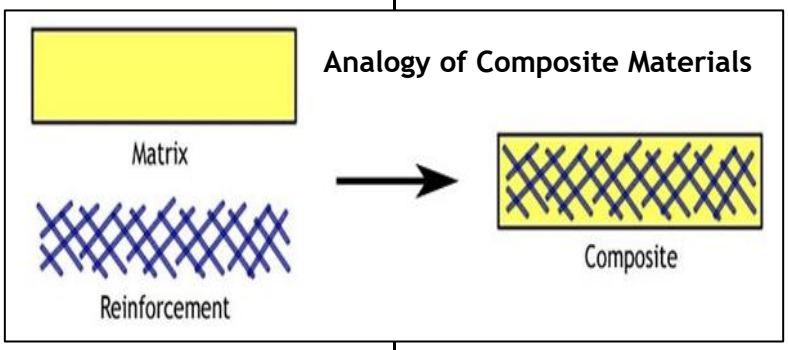
Green Bio composites: A Sustainable Resource for the Future

Shalini Rukhaya, Neelam M. Rose, Saroj Yadav, Arpita Grover and Neenu Poonia

Sustainability is becoming an ever more compelling argument in the materials selection process. The current world environment scenario demands new and more eco-friendly solutions to global problems that cover the need for sustainable resources. A composite material is defined as a two-component system, where two dissimilar materials are integrated together to produce a new type of material with improved functionality. Two important components are typically termed as matrix phase and dispersed phase or reinforcement. A bio-composite is a composite material formed by a matrix (resin) and a reinforcement of natural fibres. Environmental concern and cost of synthetic fibres have led the foundation of using natural fibre as reinforcement in polymeric composites. The matrix phase is formed by polymers derived from renewable and non-renewable resources. Bio-composites are strong, lightweight and durable materials which are emerging as a viable alternative to glass fibre reinforced composites and finding applications in various industrial sectors.



Green Bio composites

Green composites are classified as a bio-composite that are generally constructed by the incorporation of a biodegradable polymeric matrix reinforced by eco-friendly and renewable fibres. They are called green bio-composites mainly because of their degradable and sustainable properties, which can be easily disposed without harming the environment. Because of their durability, unique characteristic feature, superior functionality and environmental compatibility, green bio-composites are mainly used to increase the life cycle of products with short life. The growing awareness of depletion in petrochemical resources, limited reserves, and concern for reduced carbon footprint are the reasons for designing green bio-composites.

The green bio composites have potential to attract the traditional petroleum-based composites which are toxic and non-biodegradable. The green bio composites eliminate the traditional materials such as steel and wood with biodegradable polymer composites. In a situation like increment in oil price, the use of green bio composites is helpful not only in making the environment better but also from an economical perspective as these are less in cost and are decomposable.

Two Main Components of Green Bio composites

Green bio composites are continuously being developed by embedding natural fibres with renewable resource–based biopolymers such as cellulosic plastics; polylactides; starch plastics; polyhydroxyalkanoates (bacterial polyesters); and soy-based plastics.

A. Reinforcing Natural Fibres

Natural fibres in simple definition are fibres that are not synthetic or manmade and are categorized based on their origin from animals, mineral, or plants sources. Some of the natural fibres are in readymade form such as vegetable, cellulose (cotton and linen), and mineral (asbestos) fibres. The

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fibres are produced and provided by nature from various parts of the plants, trees, and geographies.

The advantages of natural fibre over synthetic fibre in terms of its relatively renewable resources are its abundance, less damage to processing equipment, low weight, low cost, good relative mechanical properties such as tensile modulus and flexural modulus and improved surface finish of molded parts composite. Loose fibre, nonwoven mats, aligned yarns, and woven fabrics are possible forms of natural fibre for composites, with aligned variants offering the best mechanical properties. The techniques utilized to fabricate green bio composites are based largely on existing techniques for processing plastics and conventional composite materials. Depending on the types and form of natural fibre–reinforced green bio composites, the processing techniques would be chosen accordingly. For instance, compression molding, extrusion, hand lay-up, injection molding, resin transfer molding, and sheet molding compound can be utilized for short natural fibres, while compression molding, filament winding, hand lay-up, pultrusion, and resin transfer molding can be appalled for long fibres. The properties and performance of products made from natural fibre bio composites depend upon processing techniques, the properties of their individual components, as well as their compatibility and interfacial bonding between polymer and fibre.

The market size of natural fibre bio composites is projected to grow at CAGR of 11.68% between 2021 and 2025. This growth is attributed to the high demand for natural fibre bio composites in the construction and automotive industries and driven by regulatory requirements and superior product performance. Lightweight, high stiffness-to-weight ratio, consumer awareness regarding recyclable, and bio-degradable materials are the advantages of using natural fibre composites in the composites market.

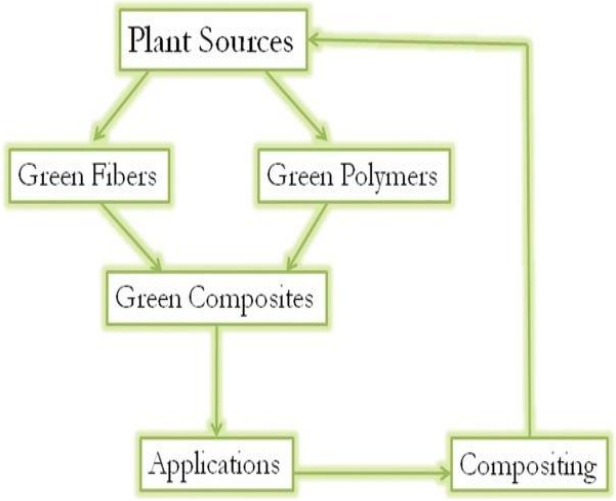
B. Biobased and Biodegradable Polymers:

Biopolymers are polymers obtained from natural resources and are consisting of monomeric units that are covalently bonded to form larger structures. Bio-polymers vary among their melt flow indices, impact properties, hardness, vapor transmission characteristics, coefficient of friction, and decomposition. Biopolymers can be thermoset, thermoplastic, and elastomer. One can find vast range of applications of biopolymers in different fields such as agricultural films, automotive, medical and pharmaceutical, food packaging, hygiene, and protective clothing. Because of the increasing environmental issues, the world has moved to the greener side, i.e., on zero or low emission side. The same case has been followed in the case of the composites development. Green bio composites is the main answer to this problem, as the name itself tells that the composite which is fabricated by reinforcing the natural fibres in the biopolymer matrix. These biopolymers degraded with respect to time so named as biodegradable type.

Biopolymers are cost effective and have great functionality as compare to the polymers derived from fossil fuel. The reason behind this is well known as the cost of the fuel or oil is very high as compared to the cost of available feedstocks such as starch; also the main advantage of using biopolymer is their biodegradability, which is of utmost important from the environmental point of view. Waste disposal problem has also been solved by the utilization of these biopolymers. The main aim for the development of biopolymers is their stability during storage and life cycle assessment. Biopolymers reinforced with natural fibres ultimately produced green bio composites which can replace the conventional or synthetic fibre reinforced composites.

Why Do We Need Green Bio composites?

The resins and fibres used in the green composites are biodegradable, when they are dumped, decomposed by the action of microorganisms. They are converted into the form of H_2O and CO_2. These H_2O and CO_2 are absorbed into the plant systems.



Life-cycle of Green Bio composites

Characterization of Green Bio composites

The greatest challenge in working with green bio composites is their large variation in properties and characteristics. The properties of green bio composites are influenced by a number of factors including the fibre type, environmental conditions (where the plant fibres are collected), processing methods, and any modification of the fibre. Careful selection of the reinforcing fibres and matrix biopolymers is the first step to obtain a composite with the desired properties in light of the intended application. The performance of natural fibre reinforced bio composites depends on several factors, including fibres chemical composition, cell dimensions, microfibrillar angle, defects, structure, physical properties, and mechanical properties, and also the interaction of a fibre with the polymer. To expand the use of natural fibres for composites and improved their performance, it is essential to know the fibre characteristics.

Physical Characterization

The advantage of natural fibre over synthetic fibre is increasing day by day because of its low cost, less weight, low manufacturing cost, abundance, renewable resources, relatively good physical and mechanical properties such as tensile strength, tensile modulus, bending strength and bio-degradable and environmentally friendly qualities. Natural fibres have been cultivated and used especially in rural developing countries for creating non-structural applications such as bag, broom, fishnet, and filters. The fibre's dimensions, defects, strength, variability, crystallinity, and structure are very important variables in measuring their physical properties. Knowledge of fibre length and width is necessary to compare natural fibres of different types. Major structural differences such as density, thickness of the cell wall, length, and diameter result in differences in physical properties.

Mechanical Characterization

Tensile, flexural and impact properties are the most widely studied mechanical properties of natural fibre-reinforced biopolymer composites. Impact strength in terms of mechanical performance is one of the undesirable weak points of such materials. In addition to these tensile, flexural and impact properties, the long-term performance (creep behavior), dynamic mechanical behavior, and compressive properties of green bio composites are also investigated. Several factors i.e., the kind of natural fibres, surface chemistry between fibre, type of fibres, moisture content and form of fibres and other composition and the quality of the interface should be considered to achieved desired mechanical properties of the green bio composites. These properties of the natural fibres depend on the types of natural fibres, their cultivation, growing period and extracting process, isolation and processing method. Mechanical properties of the natural fibres especially flax, abaca, kenaf, ramie, hemp, jute, sisal, bamboo,

and bagasse are very good and strength and modulus are higher than synthetic fibre.

Potential Applications of Green Bio composites

Green bio composites use is of great importance in numerous applications including automotive, building and construction industries, sports, aerospace, and others, such as, decking, panels, window frame, and bicycle frame. Several automotive components and construction materials are already produced with natural fibres composites with various biopolymers where moderate strength, lower cost, and environmentally friendly properties are required. Some of the other areas in which the green bio composites are used includes false ceilings, partition purposes, doors, furniture and boxes for agriculture purposes. Other miscellaneous applications are rims, mobile panels, toys, aircraft, ships and so on.

Conclusion and Future Scope of Green Bio composites

- Green bio composites can be easily composted after their life, completing nature's carbon cycle. These can supplement and eventually replace petroleum-based composite materials in many applications, offering new agricultural, environmental, manufacturing, and consumer benefits.
- Eco-friendly green bio composites from plant-derived fibre (natural/bio fibre) and crop-derived plastics are novel materials of the twenty-first century and would be of great importance to the materials world, not only as a solution to growing environmental threat but also as a solution to the uncertainty of petroleum supply.
- Green bio composites have made an overwhelming impression on the world's economy as these are the materials of future and found applications in diverse markets including aerospace, automobile, packaging, shipping, biomedical, building etc.
- Many industries are seeking green replacement of the non-degradable and synthetic components used in their products to become a part of sustainable future. At present, this segment represents an important income for some economies, especially those where these resources are available, enhancing the creation of green economies, strengthening the world's efforts toward sustainability.

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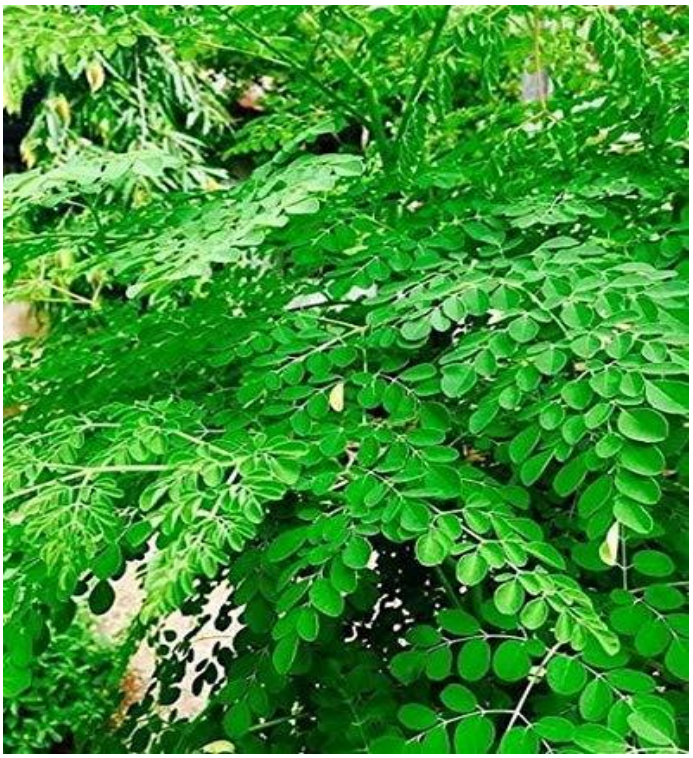
Sahjan - A Tree with Ample Benefits

Anil Kumar[1], Mamta Khaiper[2], Monika Jangra[2] and Preeti Verma[2]



The Sahjan tree, scientifically known as Moringa oleifera, is a versatile and remarkable plant that has been revered for its numerous uses and benefits throughout history. Native to India, it is now cultivated in various tropical and subtropical regions around the world. Also known as the "drumstick tree" or "horseradish tree,". It is typically sown during the warm season when temperatures are consistently above 70°F (21°C) and frost is not a concern. The specific time of sowing may vary depending on the region and climate conditions. In general, it is recommended to sow Sahjan seeds in the early spring or at the onset of the rainy season, as this allows the plant to establish its root system before the hot summer months. Sahjan has gained significant popularity due to its exceptional nutritional value and medicinal properties.

Nutritional Powerhouse

One of the most notable features of the Sahjan tree is its exceptional nutritional profile. Its leaves are packed with essential vitamins and minerals, including vitamin C, vitamin A, vitamin B complex, iron, calcium, potassium, and magnesium. These nutrients make Sahjan an excellent dietary supplement, particularly in regions where access to a diverse range of food sources is limited. Incorporating Sahjan leaves or powder into one's diet can help combat malnutrition and fulfil the body's nutritional requirements.

Vitamins

Vitamin A: Sahjan leaves are rich in beta-carotene, a precursor to vitamin A, which is essential for maintaining healthy vision, skin, and immune function.

Vitamin C: Sahjan leaves are a fantastic source of vitamin C, a powerful antioxidant that supports immune function, collagen production, and iron absorption.

Vitamin E: Sahjan seeds contain vitamin E, another potent antioxidant that helps protect cells from damage.

Minerals

Calcium: Sahjan leaves are an excellent source of calcium, which is crucial for maintaining strong bones and teeth, muscle function, and nerve signaling.

Iron: Sahjan leaves are high in iron, an essential mineral for red blood cell production and oxygen transport throughout the body.

Potassium: Sahjan leaves and pods are a good source of potassium, which plays a vital role in regulating blood pressure, fluid balance, and nerve function.

Magnesium: Sahjan leaves contain magnesium, an essential mineral involved in more than 300 enzymatic reactions in the body, including energy production and muscle function.

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Phosphorus: Sahjan leaves and seeds are rich in phosphorus, which is necessary for bone health, cell growth, and DNA synthesis.

Proteins and Amino Acids

Sahjan leaves are notable for their high protein content, containing all nine essential amino acids necessary for building and repairing tissues and supporting various bodily functions.

Antioxidants and Phytochemicals

Sahjan leaves are rich in antioxidants, including flavonoids, phenolic acids, and carotenoids, which help neutralize harmful free radicals and reduce oxidative stress in the body.

Medicinal Benefits

The Sahjan tree has been widely used in traditional medicine for centuries. Its leaves, bark, seeds, and roots possess various medicinal properties. Some of the key health benefits associated with Sahjan include:

a. Anti-inflammatory and Antioxidant Properties Sahjan contains compounds with powerful anti-inflammatory and antioxidant effects, such as flavonoids, phenolic acids, and isothiocyanates. These properties help protect the body against oxidative stress and inflammation, which are underlying factors in many chronic diseases.

b. Boosts Immunity: The high vitamin C content in Sahjan leaves strengthens the immune system, making it more resilient against infections and diseases.

c. Improves Digestion: Sahjan is known for its digestive benefits. It acts as a mild laxative, aiding in relieving constipation. The presence of isothiocyanates also helps combat harmful bacteria in the gut, promoting a healthy digestive system.

d. Supports Bone Health: Sahjan is a rich source of calcium and phosphorus, essential minerals for bone health. Regular consumption of Sahjan can help prevent osteoporosis and maintain strong bones.

e. Regulates Blood Sugar: Some studies suggest that Sahjan may help regulate blood sugar levels, making it beneficial for individuals with diabetes. However, further research is needed to establish its efficacy.

Environmental Sustainability

In addition to its nutritional and medicinal benefits, the Sahjan tree holds great significance in terms of environmental sustainability. It is a fast-growing plant that requires minimal water to thrive, making it suitable for arid and drought-prone regions. Sahjan's deep root system also helps prevent soil erosion, making it an excellent tree for reforestation efforts and combating desertification.

Agricultural Applications

Sahjan has numerous agricultural applications. Its seeds can be crushed to extract oil, which is highly valued for its stability and nutritional content. The oil is commonly used in cooking, cosmetics, and as a biodiesel feedstock. The remaining seed cake after oil extraction can be used as a natural fertilizer or as a coagulant in water treatment processes.

Livestock Feed

Sahjan leaves and pods are rich in protein and essential nutrients, making them an excellent feed supplement for livestock, particularly poultry and cattle. Adding Sahjan to animal feed can improve the overall nutritional value, leading to better growth and productivity.

The Sahjan tree's versatility, nutritional benefits, medicinal properties, and environmental sustainability make it an invaluable resource for communities around the world. Its cultivation and utilization can contribute to food security, healthcare, poverty alleviation, and environmental conservation. As further research unfolds the potential of Sahjan, its importance is likely to grow, benefiting both individuals and the planet as a whole.

It's worth noting that the nutrient content of Sahjan can vary depending on factors such as the maturity of the plant, growing conditions, and preparation methods. However, overall, Sahjan's nutritional profile is highly impressive, making it a valuable addition to a balanced and healthy diet.

It's important to consult with a healthcare professional or nutritionist before making significant changes to your diet or incorporating Sahjan or any other new food into your routine, especially if you have any underlying health conditions or are taking medications.

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Mission LiFE: Lifestyle for Environment

Shilpa V Chogatapur, Sangeeta Jadhav and Shweta A. Mannikeri

Mission Lifestyle for Environment recognises that Indian culture and living traditions are inherently sustainable. The importance of conserving our precious natural resources and living in harmony with nature are emphasised in our ancient scriptures. The need of the hour is to tap into that ancient wisdom and spread the message to as many people as possible. Mission LiFE seeks to channel the efforts of individuals and communities into a global mass movement of positive behavioural change.

Save energy

Energy consumption is a significant contributor to greenhouse gas emissions, which is the primary cause of climate change. By reducing energy use, we can reduce our carbon footprint and help mitigate the effects of climate change. Saving energy is essential for preserving natural resources. By using energy efficiently and investing in renewable energy sources, we can reduce our reliance on non-renewable resources and ensure a sustainable future. When we take small steps to save energy, we reduce our costs, and help create a healthier environment and an energy secure nation.

- Use LED bulbs tube-lights
- Use public transport wherever possible
- Take the stairs instead of an elevator wherever possible
- Switch off vehicle engines at red lights and railway crossings
- Use bicycles for local or short commute
- Switch off irrigation pumps after use
- Prefer CNG/ EV vehicle over petrol/ diesel vehicles
- Use carpooling with friends and colleagues
- Drive in the correct gear. Keep your foot off the clutch when not changing gears.
- Install a solar water or solar cooker heater on rooftops
- Switch off appliances from plug points when not in use
- Use biogas for cooking and electricity needs
- Keep temperature of air conditioners to 24 degrees
- Prefer pressure cookers over other cookware
- Keep your electronic devices in energy-saving mode
- Use smart switches for appliances that are used frequently
- Install community earthen pots for cooling water
- Defrost fridge or freezer regularly
- Run outdoors instead of on a treadmill

Save water

Water is a finite resource and the demand for water is rapidly increasing. There is a risk of water scarcity in many regions of the world. Saving water

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can help to ensure that there is enough water to meet the needs of the current and future generations. Saving water can also help to reduce water bills for households and businesses, as well as reduce the strain on water treatment facilities and infrastructure. Water is also essential for plant and animal life, and water scarcity can have severe consequences for natural habitats and the species that depend on them. When we take small actions to save water, we are securing a sustainable future, reducing energy consumption and greenhouse gas emissions, saving money, and preserving ecosystems and biodiversity.

- Adopt cultivation of less water-intensive crops like millets
- Participate in recharge of rural water bodies through the Amrit Sarovar Scheme
- Practice crop diversification. Move from rice & wheat cultivation to pulse & oil seed cropping system
- Use effcient water-saving technologies (like micro-irrigation, bunding, laser levelling, farm ponds, zero tillage, direct seeded rice, alternate wetting and drying and others)
- Create rainwater-harvesting infrastructure in home/schools/offices
- Use drip irrigation systems created with waste materials, wherever possible
- Reuse water from washed vegetables to water plants and other purpose
- Pre-soak heavy pots and pans before washing them
- Use buckets instead of hose pipes to water plants/ floors/ vehicles
- Fix leaks in flushes, taps and waterpipes
- Use water-effcient fixtures for taps, showerheads, and toilet flush units
- Invest in a water metre for your house to measure water consumption regularly
- Reuse water drained out from AC/RO for cleaning utensils, watering plants and others
- Prefer a water purification system that wastes less water
- Turn off running taps when not in active use

Say no to single use plastic

Single-use plastics are designed to be used once and then discarded, contributing to the massive amount of plastic waste that is polluting our planet. It is typically made from fossil fuels, a non-renewable resource. By reducing our reliance on single-use plastic, we can help to conserve natural resources and reduce greenhouse gas emissions. According to the Central Pollution Control Board, India generated around 34.7 lakh (3.47 million) tonnes of plastic waste in 2019-20. Avoiding the use of items made from plastic that can only be used once is an important step to reduce its damaging impact on our health and environment. From the 1st of July 2022, the Government of India decided to ban certain single-use plastic items, such as plates, cups, glasses, cutlery such as forks, spoons, knives, straws, trays and cigarette packets, plastic or PVC banners of less than 100 microns. Single-use plastics take hundreds of years to break down, and they can harm wildlife that ingests or becomes entangled in them. Therefore, refusing single-use plastic also helps to protect our marine and terrestrial ecosystems. By making small changes in our daily lives to refuse single-use plastics, we can help to create a more sustainable and resilient future for all.

- Use cloth bag for shopping instead of plastic bags
- Carry your own water bottle wherever possible
- Reuse glass containers/ packaging plastic items as storage boxes
- Participate in and mobilize participation for clean-up drives of cities and water bodies

- Prefer using non-plastic eco-friendly cutlery during gatherings and events
- Use menstrual cups instead of sanitary napkins
- Use recycled plastic over virgin plastic, wherever possible
- Use steel/recyclable plastic lunch boxes and water bottles
- Cut the packaging bags used for milk, buttermilk,etc., only partially to avoid plastic bits
- from mixing into biodegradable waste
- Opt for bamboo toothbrushes and neem combs

Reduce E-waste:

Electronic waste, or e-waste, is a growing environmental problem that results from the improper disposal of electronic devices. These devices contain hazardous materials, such as lead, mercury, and cadmium, which can pollute the environment and pose a risk to human health. Electronic devices also contain valuable materials, such as gold, silver, and copper, which can be recycled and reused in the production of new devices. By recycling e-waste, we can conserve our natural resources and also create jobs and stimulate local economies. We must take action to reduce E-waste, while ensuring the proper disposal and recycling of the same.

- Repair and use electronic devices over discarding the devices
- Discard gadgets in nearest e-recycling units
- Use rechargeable lithium cells
- Prefer cloud storage over a pen drive / hard drive

Adopt sustainable food systems

Consuming locally available and seasonal foods are key ways of contributing to sustainable food systems. By doing so, we can support local farmers and communities, and reduce the carbon footprint associated with transporting food long distances. Food waste is another critical issue that must be addressed to ensure our food systems are sustainable. According to the Food and Agriculture Organization of the United Nations, around one-third of all food produced globally is lost or wasted each year. This waste has economic, social, and environmental implications, including the loss of valuable resources such as water, land, and energy. By reducing food waste, we can conserve these resources and reduce greenhouse gas emissions. Our consumer choices and sustained efforts by our farming communities can ensure that the food systems of the future are resilient and sustainable.

- Include millets and nutri cereals in diets
- Compost food waste at home
- Create kitchen gardens/terrace gardens at homes/schools/offices
- Prepare organic manure from cow dungs and apply to farms
- Prefer locally available and seasonal foods
- Use smaller plates for daily meals to save food wastage

Reduce waste

Reducing, Refusing and Recycling are key ways to reduce the heavy burden of waste on our environment and health. Efficient waste management is key to keeping our surroundings clean, which in turn leads to a lot of social, economic and environmental benefits. Many of the products we use and consume require the use of finite resources, such as fossil fuels and minerals. By reducing waste, we can conserve these resources and use them more efficiently. By taking action to reduce waste in our daily lives, we can help to create a more sustainable future for all. Doing so will set a good example for others and encourage more sustainable behaviours.

This can help create a culture of sustainability and inspire others to take action to reduce waste

- Contribute cattle waste, food waste, and agricultural waste to biogas plant (provided under GOBARdhan)
- Practice segregation of dry and wet waste at homes
- Use agricultural residue, animal waste for composting, manuring and mulching
- Recycle and reuse old newspapers and magazines
- Feed unused and uncooked vegetables leftovers to cattle
- Set printer default to double-side printing
- Repair, reuse and recycle old furniture
- Buy paper products made from recycled paper
- Donate old clothes and books
- Do not discard waste in water bodies and in public spaces
- Do not let pets defecate in the public places

Adopt healthy life style:

Indigenous herbs and medicinal plants are an important part of the natural ecosystem, providing important habitats for wildlife and promoting biodiversity. Many local communities rely on these plants for traditional medicine and other uses. Indigenous trees are essential for maintaining a healthy environment, providing a range of benefits such as absorbing carbon dioxide, preventing soil erosion, and providing shade and shelter for wildlife. Biodiversity conservation efforts, both at the individual and community level (through green clubs and volunteer groups, for instance), are essential enablers of healthy lifestyles. By taking such actions to protect the environment and promote sustainability, we can help to create a better world for ourselves and future generations.

- Encourage use of millets in food and indigenous herbs and medicinal plants for nutrition and well being
- Prefer consuming natural or organic products
- Start biodiversity conservation at community level
- Plant medicinal plants such as neem, tulsi, giloy, mint, curry leaves, ashwagandha, curry leaves, etc., within household premises
- Practice natural or organic farming
- Plant trees to reduce the impact of pollution
- Avoid purchasing products/souvenirs made from skin, tuskers and fur of wild animals
- Create and volunteer at community food and cloth banks, and at animal shelters
- Initiate and/or join green clubs in your residential area/ school/ office

Let us draw inspiration from ancient Indian literature that is replete with references to the management, conservation, and protection of the environment. Texts like the Arthashastra, Upanishads, and Vedas, are full of verses that highlight the values of environmental protection. Let us continue to invest in technological innovations that can improve the efficiency of our resource consumption, while developing alternative materials that are less harmful to the environment. This potent combination of traditional Indian wisdom and modern scientific development forms the core of Mission LiFE.

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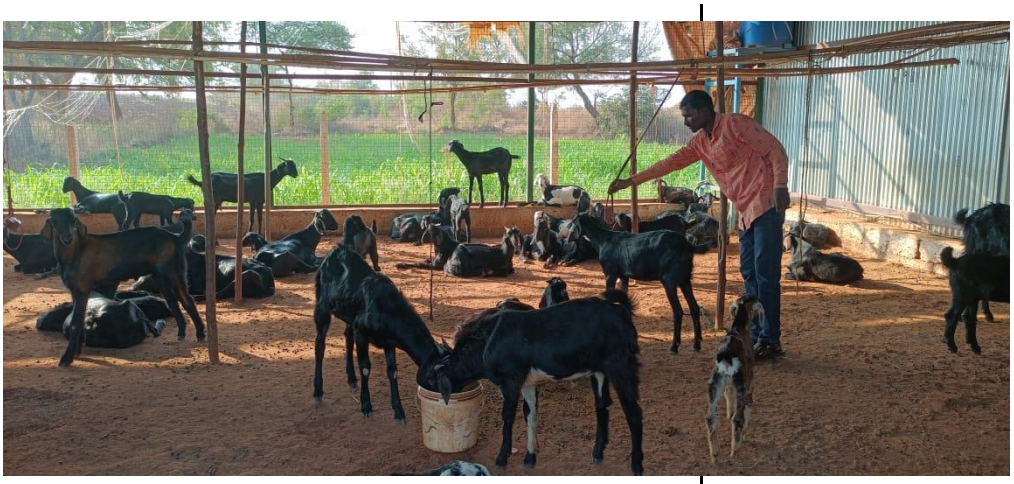
Sustainable Goat Farming - A Success Story of a Farmer in Kalyan Karnataka

Sunilkumar N.M, Akshaykumar, Ningdalli Mallikarjun, Gynadev Bulla and Sidramappa V Manige



Goat rearing under intensive and semi-intensive system is having good economic prospects. The commercial intensive Goat rearing is very much popular in recent years. Many farmers are getting good returns from goat and its products. Many progressive farmers, businessmen, professionals, ex-servicemen and educated youths to take up the goat enterprise on a commercial scale. Commercial goat farming in India is becoming very popular day by day. As goat farming is a proven highly profitable business idea so, the popularity of this business is increasing rapidly in India. It is also one of the finest and established livestock management department in the country. Goat farming business is one of the traditional occupations of some Indian people. It is also the only economic activity of some people of rural areas. Like poultry farming, goat farming business is also very profitable and can employ a large number of unemployed educated people. Which will help to eradicate unemployment problem from the country. Goat meat (chevon) is one of most preferred meat type by the consumers in several countries including India. The goat milk is easily digestible due to smaller size of fat globules and serves as a ready source of family nutrition. In last few years, goat production in the country gained momentum in the form of a commercially viable enterprise as evidenced by increasing interest of young entrepreneurs to develop knowledge and skill in this species. Mr Navanth Raghunath Mangalure basically a mason labor hales from Narayanpur village of Bidar district Karnataka. He has attended a capacity building programme on Commercial Goat Farming organized by ICAR Krishi Vigyan Kendra, Bidar for 3 days in the year 2000 which included the lectures on scientific housing, feeding, breeding, health care management so also marketing of the goats and one day exposure visit to Sri Vinod Muthanna's farm, Sindabandagi village (Humnabad taluka). Mr Navanth got inspired and motivated by the scientists of Bidar Krishi Vigyan Kendra and started his own goat farm as an enterprise.

Mr Navanth has constructed low-cost goat shed by using locally available resources. Mr. Navanth purchased 10 female and 01 male Osmanabadi goats from Latur District of Maharashtra which is a home tract of Osmanabadi goats in July 2020. Adequate supply of fodder, either green or dry, is crucial to the livelihoods of farmers involved in Goat rearing activity to meet their fodder requirements through a

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combination of crop residues, grazing on community and private property resources. Feed and fodder reserves increased substantially of the goat farm. So, he has established the fodder cafeteria including the different fodder varieties like Super Napier, CoFs 29, Hedge Lucerne and Sesbania multi cut fodders each in an area of half acre so totally comprising of 2 acre and he has also started silage unit of capacity 500-600 kg silage green fodder to solve the problem of green fodder during offseason.

In addition to this he is also buying goat feed ingredients and dry fodder from the other neighboring farmers. To make goat farming more profitable he is selling the goat manure to needy farmers. He is practicing the all most scientific practices of goat farming i.e., feeding, breeding, housing, health care management and marketing.

Interventions by KVK, Bidar

Constant advise by KVK Scientist on selection of breeding stock, construction of scientific goat shed, demonstration on establishment of fodder cafeteria, Silage making in silage bags, health management in goats, preparation of concentrate feed, treatment of sick goats, deworming and vaccination in goats and also gave timely advice on marketing of goats.

Mr. Navanth is selling surplus male goats of 10 months to one year old which have gaining body weight around 20-25 kg and earning gross profit of around Rs.9000/- per buck on live body weight basis @ Rs.400/- per kg. Last year he sold total of 27 males and got a gross profit of Rs. 2,43,000. He spent towards purchase of dry fodder, concentrate and medication. He earned net profit of Rs.2,12,500/- from sale of male goats and the female goats kept for himself and now his herd size is comprising of 55 goats which includes 5 males buck for breeding. He is also earning by selling of goat manure, he is also generating employment for one labour for 12 months to maintain 55 goats. Looking after his success seven neighbouring farmers have started scientific goat farming in and around the Narayanpur.

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Preparation of Rice Husk and Paddy Straw Bricks- An Introduction

Sandeep Bhardwaj[1] and Rupali Sharma[2]

Rice husk and paddy straw is a lingo-cellulosic material. Mainly composed of combinations of cellulose, hemicelluloses, and lignin, along with appreciable amounts of silica and other minor components. Burning of rice husk and paddy straw is socially unacceptable due to extreme levels of pollution including greenhouse gas emissions. Manufacturer Dharam Bricks, Ludhiana, Punjab, India manufacturing these bricks in 3 Rice husk: 7 brick clay ratios. These 30% rice husk brick is of size 228mm×107mm×169mm as per Indian Standard IS2117. The water absorption capacity of these rice husk and paddy straw bricks taken from literature review was around 8% by weight of the brick and compressive strength of these bricks were near to 12.8 MPa after 28 days taken from literature review. SEM, EDX and XRD analysis suggests higher percentages of fusing of quartz results in better silica percentage which results in increased durability of these bricks.

Rice Husk is used in India for production of biogas, filler and binder material in bricks, animal feed etc. However, rice husk and paddy straw may be used in synthesis of SiC for brick and concrete. The hydraulic characteristics of RHA and paddy straw bricks are equally important due to its water absorption capacity. The use of RHA and paddy straw, amended with coco-peat and soil, has potential for ameliorating the hydro-physical environment in RHA and paddy straw brick affecting air–water relations. Rationing of rice husk ash (RHA) and composted biogas sludge (CBS)) amended with different proportions of soil: RHA and paddy straw mixture (0: 75, 25: 50, 50: 25, 75: 0) may be utilized for similar purposes and to improve the brick making time and cost. These mixtures of RHA, paddy straw and ameliorations' must be <50 % (per cent of pot volume) to improve the hydraulic characteristics of bricks. The use of RHA and paddy straw amended with soil: CBS was not suitable as a brick material due to higher relative evaporation rate and higher rate of infiltration. Water retention in terms of maximum water-holding capacity and available water increased with RHA and paddy straw addition, the increase being enormous with 75 % RHA and paddy straw. Infiltration rate of water in the bricks improved with addition of RHA and paddy straw (0–50 %), showing a steep increase (4.25–8.10 $cm.min^{-1}$) at highest (75%) proportion of RHA and paddy straw. Drainage rate was highest in CBS and soil mixtures.

These mixtures may be treated this include grinding the husks in hammer mill grinder, sieving to eliminate fine material, standardization and improvement of biomass adhesion to the soil-cement system and immersion in 5 % concentrated lime solution, for a period of 24 hr. This pre-treatment Favors the minimization of the incompatibility between the vegetal biomass and Portland cement, besides allowing removing extractives that solubilize in the water and inhibit cement hydration. In general, the quality of soil-cement mixtures is evaluated through destructive tests, such as those of simple compression and water absorption. Likewise, quality can be evaluated through non-destructive tests, such as the ultrasonic wave propagation technique. The use of anisotropic resistance to measure the quality of a brick is based on the relationship between the physical stress produced on the brick during the compression test and a mathematical parameter (its anisotropic structure). The higher its value, the better the quality of the material.

Before making brick its granulometry was corrected through the addition of sand, to make it meet the norm (100 % passing through 4.78 mm mesh sieve, 10 to 50 % passing through 0.075-mm-

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mesh sieve, liquid limit ≤ 45 % and plasticity index ≤ 18%). The pre-treatment consisted in the immersion of rice husks and paddy straw in 5 % hydrated lime solution (24 h) and subsequent drying in an oven at 80 ºC (48 h) to minimize the chemical incompatibility between the cement and the husks and straw. In its natural condition, rice husk and paddy straw were characterized as a light material, with bulk density of 0.086 g/cm^3 and uniform granulometry (89 % between the sieves of 2.00- and 1.19-mm mesh). On the other hand, after undergoing the processes of fractionation, sieving and pre-treatment, rice husk and paddy straw bulk density increased to 0.152 g/cm^3. After this RHA and paddy straw with ameliorations' may be used for brick manufacturing.

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Poultry Management During Heat Stress

Ranjan Kumar[1], Bhushan Kumar Singh[2], Dhiru Kumar Tiwari[2], Pramod Kumar[1] M.L. Meena[2] and A. Kundu[1]

Heat stress is a condition that can be caused by exposure to extreme heat. It occurs when the body is unable to maintain a healthy temperature in response to a hot environment. As we know poultry do not having sweat gland in their skin, hence poultry can tolerate low range of temperature fluctuation. Ideal temperature for poultry rearing is 18-28°C and temperature above which heat stress starts is 30°C.

Effect of summer on poultry performance

- Rapid respiration/panting
- Prostration due to heat stroke
- Poor feed conversion efficiency
- Decrease in weight gain of birds
- Lowers resistance to disease
- Decrease in egg production
- Reduction in egg size, poor shell quality of eggs.
- Decrease in feed intake and increase in water intake.
- Increase in cracked egg, decrease in fertile eggs and reduced hatchability %.

Steps to minimize heat stress in poultry

Following steps will help to combat heat stress in poultry farming in summer.

- Housing management
- Water management
- Feeding management
- General management

Housing management in poultry farming during summer

- Orient the long axis of poultry house in east west direction to minimize solar heating and direct access to sunlight.
- Poultry house in tropics should have good roof insulation (if possible, with false roof to reduce the conduction of heat) with support of foggers and cooler systems.
- Increased air movement over the birds by cooler, fan/exhaust to produce a wind chill effect which cool birds even without drop in the house temperature.
- Shed design and construction should allow direct sunlight on birds.
- Thatching of roof with paddy straw or sugarcane leaves will reduce temperature inside the shed.
- The roof should be painted with white wash to reflect light.
- Shades from tall trees and plantation around the shed can reduce the radiant heat. The plantation of trees should be such that trees will be leafy during summer& bald during winter.
- Roof overhangs should be sufficient (3-5 ft) to protect the birds from strong sunrays.

Water management in poultry farming during summer

Practically water is the most important criteria of these four management factors during summer. In summer water consumption is 3-4 times more. normally feed water consumption ratio is 1:2 but when temperature shoots beyond 95°F, this ratio may increase up to 1:4 or more.

Following Points to be taken into consideration during water management:

- Supply of plenty of clean & fresh/cold water must be insured.
- Cover water tanks with wet gunny bags to avoid direct exposure to sun.
- Increase frequency of watering.

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- Addition of 0.25% salts to drinking water like sodium carbonate increase the water consumption.
- Do not withhold drinking water from flock when vaccine is provided through drinking water.
- In case of nipple drinkers, insulate nipple pipe with wet gunny cloths.

Feed management in poultry farming during summer

- During summer consumption of feed by birds is reduced considerably leading to reduced body weight, egg production and shell quality.
- Increase the frequency of feeding.
- Do not offer feed during day time, offer feed during cooler part of the day (early morning and evening).
- Increase nutrient density of feed to compensate for depressed feed intake.
- Supplementation of limiting amino acids like methionine, lysine, threonine will give better results rather than supplying total proteins.
- 20- 30% extra vitamins and trace minerals should be added to feed.
- Vitamin C is antistressor & increase survivability of heat stressed birds. Supplementation of 200mg/kg of vitamin C in combination with vitamin E (125 mg/kg) or 1 gm ascorbic /litre of drinking water throughout heat period is recommended.
- Vitamin E act as antioxidant and supplementation of vitamin E @125 mg/kg diet was beneficial to improve body wt. gain, breast & liver yield, immunocompetence, economic & overall welfare of broiler chicken during extreme hot conditions.
- Administration of vitamins like B2, B6, B12 have positive effects on body wt. & immunomodulatory effect under heat stress.
- Addition of ammonium chloride, potassium chloride and /or sodium bicarbonate have improved performance of broilers by improving water and feed intake.
- Use of probiotics-by controlling the corticosterol level and the excessive release of proinflammatory agents. Lactobacillus based probiotics enhance goblet cell count in duodenum and jejunum of heat stressed broilers thereby improving feed conversion ratio (FCR)
- Addition of multistrain probiotics (*Lactiplantibacillus plantarum*, *L. bulgaris*, *L. acidophilus*) increase egg production and feed intake in poultry.
- To enhance increase in feed intake & prevent selective feeding, feed may be given in pelleted form.
- Since hot humid climate favors growth of mold/ fungi in feed so constant use of antifungal is recommended.

General management in poultry farming during summer

- Depth of litter should be 2-3 inch on floor. Stir the litter regularly to prevent caking.
- 10% extra floor space should be provided in summer. overcrowding of birds must be avoided.
- Shifting, transportation, debeaking and vaccination should be done during night or cool hour of the day.
- Birds severely heat stressed may be dipped in cold water for 2-3 minutes keeping their head & neck above water level.
- Use foggers in shed which reduce the shed temperature up to 5-10°C depends upon quality.
    - The house should be situated away from other buildings in order to facilitate free movement of air.

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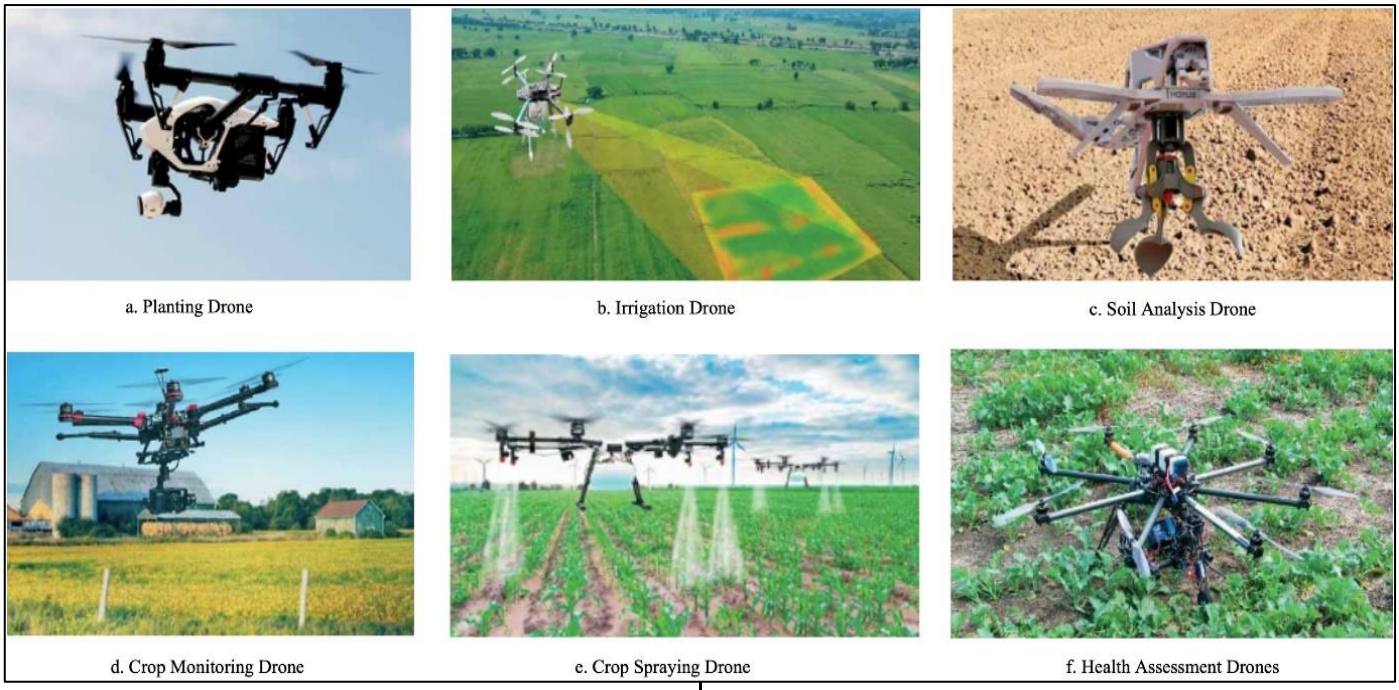
Advancements in Precision Agriculture: Harnessing the Power of Artificial Intelligence and Drones in Indian Agriculture

Abhishek Patel, Aman Mahore, Rohit Dilip Nalawade, Abhishek Upadhyay and Vishal Choudhary



a. Planting Drone | b. Irrigation Drone | c. Soil Analysis Drone

d. Crop Monitoring Drone | e. Crop Spraying Drone | f. Health Assessment Drones

(Source: Unpaprom et al., 2018)

In recent years, the field of precision agriculture has witnessed remarkable advancements with the integration of cutting-edge technologies such as artificial intelligence (AI) and robotics in farm machinery. This article explores the revolutionary impact of AI and robotics on agricultural practices, highlighting their potential to optimize resource utilization, enhance productivity, and promote sustainable farming methods.

The Rise of Precision Agriculture

Precision agriculture is a data-driven approach that utilizes advanced technologies to make informed decisions and maximize agricultural efficiency. Traditional farming methods often rely on generalized practices, but precision agriculture offers a more targeted and customized approach. By combining AI and robotics with farm machinery, farmers can achieve unprecedented levels of precision, accuracy, and productivity.

Artificial Intelligence in Farm Machinery

AI algorithms, coupled with sophisticated sensors and imaging technologies, empower farm machinery to gather and analyze real-time data on crop health, soil conditions, and weather patterns. This wealth of information enables farmers to make data-driven decisions regarding irrigation, fertilization, pest management, and harvesting. AI also helps in predicting crop yield, optimizing resource allocation, and reducing environmental impact by minimizing chemical usage.

Robotics Revolutionizing Agricultural Practices

The integration of robotics in farm machinery has revolutionized labour-intensive tasks and increased operational efficiency. Autonomous robots equipped with advanced sensors and algorithms can perform various tasks, such as precision seeding, spraying, harvesting, and weed control. These robots operate with exceptional precision, adaptability, and

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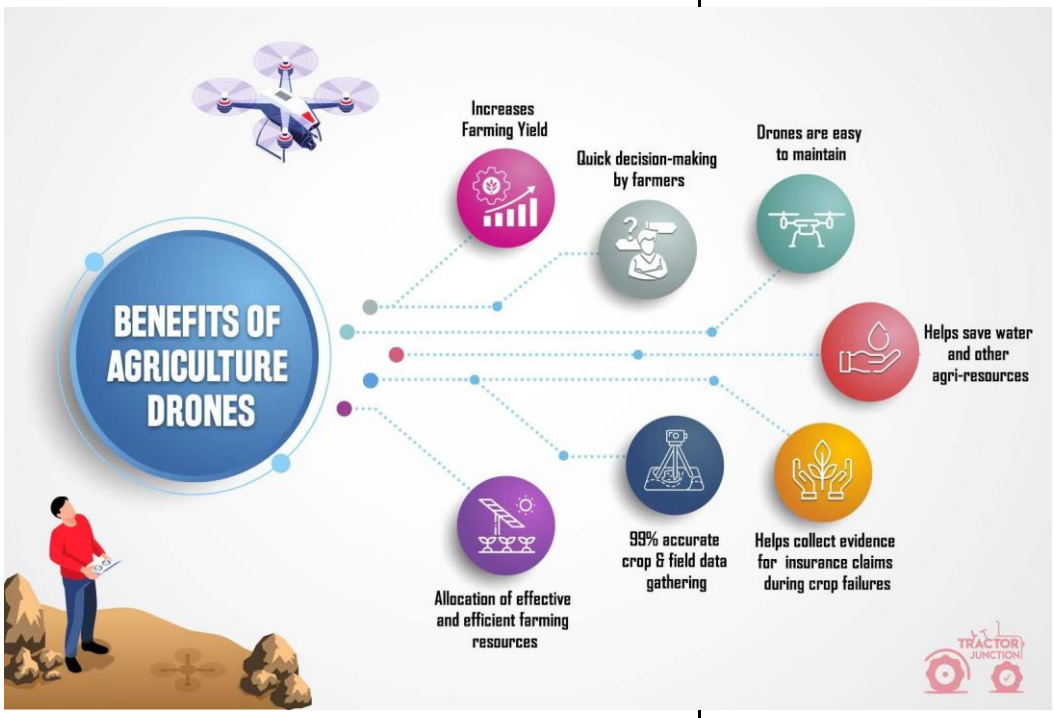
speed, significantly reducing human labour requirements and increasing productivity on the farm.

Benefits of AI and Robotics in Farm Machinery

The utilization of AI and robotics in farm machinery brings several notable benefits to agricultural practices.

Increased Efficiency: Precision agriculture enables farmers to optimize resource utilization by applying inputs (such as water, fertilizers, and pesticides) precisely where and when needed, minimizing waste and reducing costs.



(Source: Tractor junction., 2023)

Enhanced Crop Health: AI-powered farm machinery can monitor and detect early signs of plant diseases, nutrient deficiencies, and pest infestations. This enables prompt intervention, leading to improved crop health and higher yields.

Sustainable Farming: By using AI and robotics, farmers can adopt more sustainable farming practices, including reduced chemical usage, minimized environmental impact, and improved resource management.

Labour Savings: The automation of tasks through robotics reduces labour requirements, allowing farmers to focus on higher-level decision-making and farm management activities.

Data-Driven Decision Making: The abundance of real-time data collected by AI-powered farm machinery provides valuable insights for optimizing farm operations, improving yield predictions, and ensuring more efficient use of resources.

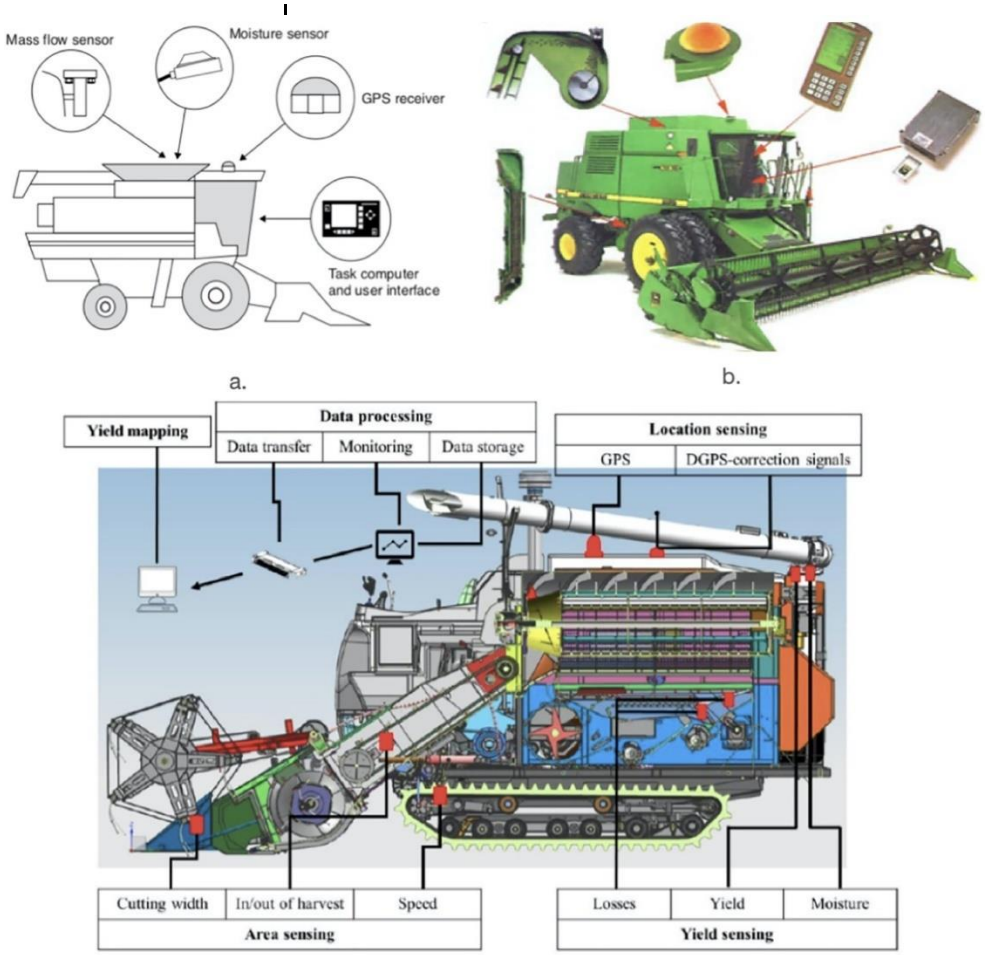
Yield mapping and monitoring

One of the key segments of the unprecedent progressions in exactness cultivating frameworks, yield mapping, enables the farmer to see spatial variety over the field perceiving zone for future activities and outcome of the past sessions, management. It alludes for the most part to the way toward gathering geo-referenced information on harvest yield and qualities, for example, showing in-field fluctuation, and the soil moisture content of the yield giving a benchmarking apparatus, when the yield is being harvested. In combination with soil examining data, yield maps empower the arrangement of variable compost maps which considers soil supplement levels just as the supplement which was expelled in the collected harvest. Last result of yield mapping is typically a tonal or shaded guide showing scopes of yield inside a field. Fundamental segments of grain yield mapping framework incorporate grain fow sensor (determines grain volume gathered), grain moisture content sensor (remunerates for grain moisture variability), GPS antenna (receives satellite sign), Yield screen show with a GPS receiver (geo-reference and records information), header position

sensor (distinguishes estimations logged during turns), travel speed sensor (determines the separation the join goes during a specific logging interim.

Challenges and Future Directions

While the advancements in AI and robotics in farm machinery hold immense potential, certain challenges must be addressed. These include the initial investment costs, compatibility with existing machinery, data privacy concerns, and the need for skilled personnel to operate and maintain these complex systems. Efforts should be made to make these technologies more accessible and affordable for small-scale farmers, enabling them to reap the benefits of precision agriculture.



Yield mapping devices - (a) Schematic diagram (b) Location sensing devices (Plant et al., 2000) (c) yield mapping harvester equipped to do both tasks (Kormann et al., 1998)

Government Schemes & Financial Support for Drones in Indian Agriculture

The Union Ministry of Agriculture and Farmers Welfare has issued guidelines to facilitate farmers and stakeholders in the agriculture sector to have better access to and affordability of drones for agricultural purposes. Furthermore, the Government of India promotes the use of drones in agriculture by providing financial support through its sub-mission on agriculture mechanization. Additionally, agricultural institutes in India can receive a grant of up to Rs. 10 lakhs for the purchase of drones. To assist with the purchase of agricultural drones, custom hiring centers established by cooperative societies of farmers, rural entrepreneurs, and Farmers Producers Organizations (FPOs) offer financial aid and support. FPOs are eligible to receive grants of up to 75% of the cost of agriculture drones for use in farmers' fields.

Under the "sub-mission on Agricultural Mechanization" (SMAM), grants of 100% on agriculture drones or up to Rs. 10 lakhs (whichever is less) are provided. The government also allows a contingency expenditure of Rs. 6000 per hectare for agencies that prefer to hire drones for demonstrations from custom hiring centers, hi-tech hubs, startups, and drone manufacturers. However, the contingent expenditure for implementing agencies is limited to

Rs. 3000 per hectare. Moreover, to support agricultural services through drone applications, financial assistance is available for the purchase of drones by existing custom hiring centers. This assistance covers 40% of the basic cost of the drone and its attachments, or up to Rs. 4 lakhs (whichever is less).

Conclusion

The integration of AI and robotics in farm machinery represents a transformative shift in the field of precision agriculture. By harnessing the power of these technologies, farmers can achieve higher levels of productivity, profitability, and sustainability. The continued advancements in AI and robotics hold promise for the future of farming, ensuring a more efficient, precise, and environmentally conscious approach to agricultural practices. As we embrace these advancements, it is crucial to promote knowledge sharing, investment in research and development, and collaborations between industry stakeholders and agricultural professionals to unlock the full potential of precision agriculture.

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Grain Amaranth / Rajgira - Nutritional Importance, Improved Varieties and Cultivation Practices

S. R. Anand, A Mohan Rao and J. Ashwini Jain

Grain Amaranth plants are fast growing, dicotyledonous belonging to the genus *Amaranthus*. The genus has more than 60 species of which some are grown for leaf purpose seeds of which are black in colour. Four species are grown for grain purpose, pseudo seeds of which are golden yellow in colour. The seeds are very nutritious and popularly called as 'Dantina Beeja' in Kannada or 'Rajgira' in Hindi. Amaranth is native to the New World. Pre-Columbian civilizations grew thousands of hectares of this pseudo-cereal which was used along with maize and beans. The native Aztecs of South America relied on amaranth seeds as an important staple food. After Spanish invasion, maize crop with which amaranth co-evolved, was selected and developed into a major world crop. By the middle of 20th century, cultivation of Grain Amaranth had declined to the point where it was grown only in small plots in Mexico, the Andean highlands and in the Himalayan foothills of India and Nepal. After knowing the biochemistry of grain amaranth and its nutritional qualities, especially higher protein and lysine content, the crop started gaining importance and re-emerged as one of the Health Care crops in many countries including India.

How Grain Amaranth is nutritionally potential?

Amaranth grain contains 14-16% protein (Table 1) which no other commonly used cereals like Rice, Wheat and Maize have. The protein is of higher quality due to the presence of higher lysine, an essential amino acid (Table 2). Grain is also rich in Calcium, Phosphorous and Iron. The starch component of amaranth is distinctive has high swelling power with a distinctive gel characteristic which has interest in specialized food and industrial applications. Amaranth grain contains 6 to 10% oil, which is predominantly unsaturated oil (76%) and is high in linoleic acid which is necessary for human nutrition. Amaranth oil was found to have 7% Squalene, a high-priced material, used in cosmetics and pharmaceutical industries. Thus, Grain amaranth is a high potential crop for human health and industrial applications.

Table 1: Nutritional Value of Grain Amaranth in comparison with commonly used important cereals (per 100g)

Food grain	Protein (g)	Carbohydrates (g)	Lipid (g)	Crude fibre (g)	Mineral matter (g)	Calcium (mg)	P (mg)	Fe (mg)
Grain Amaranth	**16.0**	**62.0**	**8.0**	**2.43**	**3.0**	**490**	**600**	**17.5**
Rice	6.7	78.0	0.3	0.2	0.3	45	160	3.5
Wheat	12.0	69.0	1.7	1.2	2.7	41	306	5.3
Maize	11.0	66.0	3.5	2.7	1.1	10	348	2.3
Ragi	7.3	70.3	1.3	3.6	2.7	344	283	3.9

Varieties:

Suvarna: This variety was developed and released in 1996 from UAS, Bangalore. This variety is tall growing (5-6 feet) with well-developed stem and deep rooting capacity. Though, it grows tall it does not lodge. Earheads are light green in colour with 30-45 cm length. Seeds are golden yellow in colour. This variety matures in 85-90 days and yields about 12-15 quintals under rainfed and 15-18 quintals per hectare with protective irrigation.

Table 2: Essential amino acid composition (g/100g protein) of Grain Amaranth in comparison to other cereals

Food grain	Lysine	Methionine	Cystine	Isoleucine	Leucine
Grain Amaranth	**5.0**	**4.0**	**4.0**	**3.0**	**4.7**
Rice	3.8	2.3	1.4	3.8	3.2
Wheat	2.8	1.5	2.2	3.3	6.7
Maize	2.9	3.4	3.4	4.1	13.0

KBGA-1: Another variety from UAS, Bangalore which matures earlier to Suvarna by 5-10 days (80-85 days). The plant is medium tall with purple colour earheads which gives an attractive look to the crop. Yield potential of this variety is 14-16 quintals under rainfed and 18-20 quintals per hectare with protective irrigation.

KBGA-4: This variety has been developed as superior to KBGA-1 which was used as check variety for comparison. This is medium maturing with 85-90 days of duration. The leaves are reddish green. Plant height is medium (135-145 cm) with inflorescence is straight compact and purple in colour. Seeds are small and golden yellow in colour. Grain yield potential of this variety is 16-18 q/ha under rainfed and 20-22 q/ha with protective irrigation.

KBGA-15: Newly developed Grain Amaranth variety superior to the KBGA-4. It matures in 95-100 days with a good plant height (170-180 cm) and inflorescence has double colour with pink mixed green in colour. The variety is tolerant to leaf rust, phyllody, leaf spot diseases and insect pests. Yield potential is 18-20q/ha under rainfed condition and 22-24 q/ha under protective irrigation.

Selection of site: well drained soils with near neutral p^H (6.5-7.5) are best suited for cultivation of grain amaranth. Amaranth being susceptible to acidic and alkaline conditions, the soil and water affected by salts should be avoid for cultivation of grain amaranth.

Sowing time: Grain Amaranth can be grown in all the three seasons of the year, *Kharif* (June-July), *Rabi* (October - November) and in summer (January - February). However, crop sown during late *Kharif* (July –August) comes well compare to early *Kharif*.

Field preparation: Grain amaranth being a small seeded crop requires a fine seed bed to ensure proper seed soils contact and good germination. For this purpose, soil is turned with a mould board plough prior to onset of rains. This is followed by two to three ploughings and plankings on receipt of soaking rains. At the time of sowing, the filed must have fine grain structure, adequate moisture and should be free from weeds.

Seeds and sowing methods: 1.5 kg/ha seed is adequate for obtaining desired plant stand. As the seed is very small, it cannot be sown directly. Seeds are mixed with fine sand in 1:5 ratio sown in 45 cm rows. Care should be taken that seeds are not sown very deep to ensure better germination.

Manures & Fertilizers: Approximately 7.5 tons of farm yard manure is applied per hectare just three weeks before sowing of the seeds. Recommended fertilizer dose is 60: 40: 40 NPK kg per hectare. At the time of sowing, 50% of recommended dose of nitrogen and entire dose of phosphorous and potash is applied. The remaining 50% of Nitrogen fertilizer is applied 30-40 days after sowing. In Zinc deficit soils, application of Zinc sulphate at the rate of 12.5 kg per hectare or foliar application at the rate of 0.5% at 30 and 60 DAS increases grain yield by 15-20%. Substitution of 50% N equivalent FYM + 50% N equivalent Bio-digester Liquid Organic Manure (BDLM) results in higher grain yield as compared to application of chemical fertilizer alone.

Thinning of seedlings: It is compulsory to maintain spacing of 15cm between plants within the row. For this, thinning of the excess seedlings at 25 - 30 days after sowing is critical. The seedlings removed through this thinning process can be used as green leafy

vegetable which would fetch some income to the farmer.

Inter-cultivation & Earthling up: Inter-cultivation operation between rows should be completed before 25-30 days of sowing. Later, earthing up should be provided to put more soil to the base of the plant to ensure crop does not lodge at grain filling stage and maturity stage.

Weed Control: weeds compete with the crop for space, light, nutrients, and moisture and can cause considerable loss if not controlled in time. The period between 20-50 days after sowing has been observed to be critical for crop weed competition in grain amaranth. Weed control at early stage i.e. before earthing up should be done for better crop growth. Therefore, one hand weeding at 25 DAS followed by intercultural operations is recommended for effective weed control.

Water management: Grain Amaranth is mostly grown as rainfed crop during Kharif season. However, when grown during *Rabi* season, it has been found to respond favourably to application of irrigation. Depending upon soil conditions about 3-4 irrigations are adequate for realize potentiality of crop.

Plant Protection: Pest and disease are not serious in grain amaranth. As a precautionary measure, neem oil or Dimethoate at 2.0 ml per litre water to control sucking pests. Similarly, Chlorpyriphos at 2ml per litre of water is suggested to control defoliators.

Suitable intercropping systems: Amaranth is usually grown in crop mixtures. Simply mixing seeds of different crops and broadcasting may not give desired results. However, intercropping amaranth with finger millet (6:2), groundnut (6:1) and pigeon pea (2:1) have been found profitable.

How to use Grain Amaranth?

Grain Amaranth cannot be used directly, needs processing before use. There are four types of using grain amaranth which are briefly described below. Four different processing types are as follows

1. **Milling**: The grains can be milled and the flour can be mixed/ blended at 10-15%with any other commonly used flours like wheat, ragi, rice and dhal etc.
2. **Popping**: By popping the palatability and flavour of the seeds will increase. For popping, the grains are placed in the hot pan heated at 175-190^{0}C for 15-20 seconds. By this process, the grains loose water rapidly and will pop up and become light. These popped grains can be used for preparation of laddus, chikkis, biscuits and other bakery products.
3. **Roasting**: Seeds are roasted at 70 - 80 ^{0}C for 10 minutes. Roasted seeds known to have more flavour and high digestibility.
4. **Sprouting:** Seeds are soaked in water for one hour and later water is drained off. Such soaked seeds are allowed to sprout and used for malt preparation.

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Nocturnal Pollinators and Pollination Services

Priyanka Rani, Vaishali, Veenu and Diksha Devi

(Source: www.pollinatorprojectroguevallry.com)

The length and breadth of essential pollinating species and their flower-visiting interactions have been examined and reported, demonstrating how closely plants and pollinators have evolved over the past century. In order to diversify floral features, increase reproductive success, and maintain gene flow, plants must be able to draw in, reward, and exploit efficient pollinators. One of this discipline's most intriguing aspects, nocturnal pollination, is likely understudied. This is unexpected considering that plants need complex adaptations to make floral signals visible to nocturnal pollen-vector. Insect diversity and abundance have been damaged by anthropogenic ecological change, and insect pollinators in particular are commonly believed to be experiencing a global decline. This is a major problem because culturally significant or endangered wild plant species as well as more than one-third of the volume of world agricultural output, rely on animal pollination. Research priorities include figuring out the main ecological, social, and economic effects of the current pollinator reductions as well as the possibly underappreciated contribution of wild pollinator taxa to the supply of pollination services (Mayer et al. 2011). The bulk of pollination services are provided by wild pollinators, such as wild bees, syrphid and non-syrphid flies, and other taxa; in contrast to popular belief, farmed honey bees only serve a supporting function. Even though not all taxa have seen reductions, change may vary regionally and through time, according to climate change, habitat loss and fragmentation, agrochemical use, nighttime artificial lighting, changing biotic interactions with pathogens, invasive non-native species, and wild plant resources are all hypothesised to be drivers of these declines, with interactions between combinations of drivers likely.

However, it is not clear how pollination services and wild pollinator diversity relate to one another. Understanding the variety of wild pollinators that can contribute to pollination services and the relative significance of each service provider is therefore now of the utmost importance.

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Nocturnal pollinators and their importance

Nocturnal pollinators play a crucial role in pollination services, especially in ecosystems where there are plant species that rely on them for their reproductive success. While diurnal pollinators such as bees, butterflies, and birds are more well-known, several nocturnal creatures actively participate in pollination, including moths, bats, and some beetles. Moths are one of the most significant groups of nocturnal pollinators (Fleming and Muchhala, 2008). They are attracted to flowers that emit a strong fragrance at night and often have pale or white petals that are easier to spot in low-light conditions. Moths have specialized mouthparts that allow them to reach deep into flowers to access nectar. As they feed, they inadvertently transfer pollen from one flower to another, facilitating cross-pollination. Bats are vital nocturnal pollinators, particularly in tropical and desert regions. They are attracted to flowers that produce copious amounts of nectar and often have long tubular shapes.

(Source: www.pollinatorprojectroguevallry.com)

Bats have a unique method of pollination known as chiropterophily. They hover in front of flowers, extend their long tongues into the flower to access nectar, and inadvertently pick up and transfer pollen in the process. This interaction is critical for the reproduction of numerous plant species, including many cacti and fruit trees. While beetles are primarily associated with diurnal pollination, some species are active at night and contribute to pollination services. Many nocturnal beetles are attracted to flowers that emit strong, fruity, or carrion-like odours. They tend to be robust and have chewing mouthparts, allowing them to gnaw through floral structures to access nectar and pollen. As they move from flower to flower, they assist in pollen transfer (Ollerton, 2017). The pollination services provided by these nocturnal pollinators are essential for maintaining plant diversity, ecosystem stability, and food production. They enable the reproduction of various plant species, ensuring genetic diversity and the production of fruits, seeds, and other plant products that support both wildlife and human populations.

Mechanisms in nocturnal pollination services

Pollination is an individual level interaction between plants and their pollen agencies especially biotic agents. So, plants have various mechanisms to attract the pollinator so that they can detect and decipher plant cues to obtain the food reward from flowers. Some of the mechanisms are described as follows:

Floral scent

Floral fragrance is crucial to numerous nighttime plant-pollinator mutualisms. For taxa pollinated by moths, beetles, nocturnal bees, and to a lesser extent by tiny and crepuscular pollinators like mosquitoes and thrips, the floral volatilized chemistry has been characterised. Flowers pollinated by moths produce a mixture of acyclic terpene alcohols, aromatic alcohols, derived esters, and trace nitrogen-containing elements, which are related with nocturnal

pollinator species. Numerous nocturnal taxa, including moths, bees, mosquitoes, thrips, and other insects, are drawn to some substances, such as linalool. However, this might not be visible until the quantification of the timing of the release of volatile component emissions from scents, since floral scent emissions are often rhythmic for example, in Petunia spp. (Solanaceae) pollinated by hawk-moths (Sphingidae), diurnal volatile emissions are significantly less attractive to pollinators than nocturnal emissions. Volatiles released during circadian rhythms may be an adaptation to the behaviour of nocturnal pollinators, however certain species may have selected for nocturnal fragrance emissions in order to avoid attracting (or repelling) diurnal herbivorous insects.

Night vision

Nighttime insects can move around and between flowering plants thanks to their highly developed visual systems, which include scotopic colour vision. Compound eyes that are used at night are well-adapted to generate optical stimuli from enough light while minimising physiological noise that could compromise the purity of visual information. Some nocturnal Hymenoptera have kept and adapted the apposition eyes of their day-active relatives, but fully nocturnal species (such as moths) often have superposition compound eyes with complicated adaptations to boost sensitivity. Many species that have evolved to nocturnal pollination (particularly by moths) are pale or white in colour from the perspective of the plants, which is probably to boost visibility in low light.

Thermogenic sensitivity

In addition to reduced light, the nocturnal environment is characterised by decreased ambient temperatures. Ectotherms make up the majority of pollination insects, so being able to recognise flowers with floral warmth would be helpful. Flowers have the ability to absorb heat from the environment or make their own. Plants that produce heat, particularly those that grow in cooler climates, may attract ectothermic pollinators more frequently. Thermogenesis improves the volatilization of floral smell in addition to providing a warm refuge. Nocturnal thermal attraction has not yet been proven to occur, although plants do appear to use pre-existing stimuli in other, comparable ways to draw their pollinators. For instance, they may produce volatiles that are chemically similar to pheromones.

Impact of disturbances to nocturnal pollination

Because nighttime pollination systems depend so heavily on intricate interspecific plant-insect signalling pathways, they are extremely susceptible to the effects of their particular abiotic and biotic environments. Pollinator reductions are attributed to anthropogenic environmental change factors, particularly widespread habitat loss and global temperature change, which have negative effects on plants that rely on insect pollination. Such drivers could, however, have the unsettling effect of directly upsetting the delicate balance of mutualisms between plants and pollinators on a local level.

Artificial Light at Night

For nocturnal pollinators, artificial light at night (ALAN) may affect both visual and floral fragrance cues. ALAN is being more recognised as a significant and growing source of ecological disruption. ALAN sources that are bright can quickly reduce ocular sensitivity, impairing night time vision away from the light source. When compared to natural nighttime light spectra, such light sources may also change the nocturnal colour environment, making some flowers stand out more from their surroundings while masking others. As a result, ALAN directly alters the behaviour of pollinators, which is

likely to result in less time spent foraging (and consequently, fewer flowers visited).

Climate change

The general effects of elevated global temperature on plant-pollinator interactions are diverse, and are reviewed in detail elsewhere in this issue. One of the primary ways climate changes affects nocturnal pollinators is through shifts in phenology, which is the timing of life cycle events. As temperatures and weather patterns change, the timing of flowering and the emergence of pollinators may become mismatched. For example, if plants bloom earlier due to warmer springs, but the emergence of nocturnal pollinators does not shift correspondingly, the pollinators may miss the opportunity to feed on nectar and pollen. This can result in reduced reproductive success for both the plants and the pollinators.

Additionally, climate change can alter the availability of suitable habitats for nocturnal pollinators. Rising temperatures and changes in precipitation patterns can lead to shifts in vegetation composition and distribution, affecting the availability of food sources and shelter for these pollinators. Loss of suitable habitat can result in population declines and even local extinctions of nocturnal pollinator species. Rising temperatures and changes in precipitation patterns can lead to shifts in vegetation composition and distribution, affecting the availability of food sources and shelter for these pollinators. Loss of suitable habitat can result in population declines and even local extinctions of nocturnal pollinator species.

Conclusion

In conclusion, nocturnal pollinators, such as moths and bats, play a vital role in pollination services, contributing to the reproductive success of various plant species. However, climate change poses significant challenges to these nocturnal pollinators and their interactions with plants. The shifting phenology, habitat loss, and disruptions in ecological relationships due to climate change can have negative impacts on both the pollinators and the plants they depend on. Preserving and restoring habitats, maintaining diverse and connected ecosystems, and minimizing light pollution are essential conservation strategies to protect nocturnal pollinators. Additionally, mitigating climate change through sustainable practices and reducing greenhouse gas emissions is crucial for ensuring the long-term survival and resilience of these pollinators and the critical pollination services they provide. Recognizing the importance of nocturnal pollinators and taking action to safeguard their habitats and mitigate climate change not only benefits these fascinating creatures but also contributes to the preservation of biodiversity, food security, and the overall health of ecosystems. By nurturing the delicate balance between nocturnal pollinators and plants, we can help sustain the natural world upon which we all depend.

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Bacillus subtilis: A Potential Plant Growth Promoting Rhizobacteria that Impacts Plant Disease

Deepak Kumari, N. K. Yadav, Rakesh Punia and Garima

Bacillus subtilis is a gram-positive, rod shaped, spore-forming bacterium which is extensively present in the environment. B. subtilis develops endospores that can withstand stress. Its sequenced genome have 4 214 630 base pairs which encoded about 4100 proteins. It is used as a model organism for research on sporulation and the behaviour of Gram-positive bacteria with low GC levels. It is not infectious. Proteases and amylases are two of the products it produces. Due to its commercial importance and simplicity for genetic manipulation B. subtilis has undergone extensive research. It has low GC content of 43.5%. It lacks an exterior membrane, as is typical of Gram-positive organisms, but it does have a cytoplasmic membrane and a strong cell wall.

Domain: Bacteria

Phylum: Firmicute

Class: Bacilli

Order: Bacillales

Family: Bacilliaceae

Genus: Bacillus

Species: Subtilis

Mechanism of B. subtilis in plant disease control

Competition for nutritients and colonizing sites

Root exudates such as amino acids, fatty acids, polyamines, sterols, phenolics, organic acids, nucleotides, organic acids and vitamins. Competition for these nutrients is fundamental key of B. subtilis for management of plant disease. Chemotaxis was suggested as the essential characteristic for colonisation. Colonization of plant roots by B. subtilis directly contributes to plant disease management. On

Table 1: List of antibiotics produced by several strains of *B. subtilis*

B. subtilis strains	Plant pathogen	Disease in plant	Antibiotics produced
B. subtilis RB14	*Rhizoctonia solani*	Damping off of tomato	Iturin A and surfactin
B. subtilis	*F. oxysporum* f.sp. *ciceris*	Fusarium wilt of chickpea	Subtilin
B. subtilis AU195	*Aspergillus flavus*	Aflatoxin contamination	Bacillomycin D
B. subtilis QST713	*Botrytis cinerea* and *R. solani*	Damping off	Iturin A
B. subtilis BBG100	*Pythium aphanidermatum*	Damping off	Mycosubtili
B. subtilis UW85	*Phytophthora medicagins*	Damping off	Zwittermycin A, kanosamine
B. subtils fmbj	*Aspergillus flavous*	Aflatoxin contamination	Bacillomycin D
B. subtilis B47	*Bipolaris maydis*	Southern corn leaf blight	Iturin A2
B. subtilis SQR9	*F. oxysporum* f.sp. *cucumerinum*	Wilt disease of cucurbits	Fengycin and Bacillomycin
B. subtilis CMB 32	*Colletotrichum gleosporioides*	Anthracnose	Iturin A, Fengycin and surfactin A
B. subtilis PCL1608	*Fusarium oxysporum*	Wilt	Iturin A
B. subtilis PCL1612	*Rosellinia necatrix*	White root rot	Iturin A

Systemic position of the bacterium

The genus was first discovered as Vibrio subtilis by Christian Gottfried Ehrenberg in 1835. It was renamed by Ferdinand Cohn in 1872. The Bacillus genus was first reported by Cohn in 1872. Currently, the genus includes over 377 species.

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chir pine seedlings, B. subtilis BN1 showed excellent root colonization.

Plant growth promotion

B. subtilis produce several phytohormones including auxins, cytokinins, gibberellins and ethylene as well as enzymes like 1-aminocyclopropane-1-carboxylic acid (ACC) deaminase that helps to regulate the growth and development of plants. Additionally, this encourages nitrogen fixation, enhanced root growth, nutrient mineralization (such as phosphate, potassium, and zinc solubilization) and enhance absorption ability of roots. Application of B. subtilis GB03 and B. amyloliquefaciens IN937 mixture helps to enhance the growth of Arabidopsis mutants deficient in IAA. Cucumber seedling growth was stimulated by B. subtilis B579 through phosphate solubilization, IAA and siderophore production.

Production of cell wall hydrolytic enzymes

Various strains of B. subtilis synthesize a wide range of hydrolytic enzymes i.e. cellulases, proteases, and β-glucanases. The diminished growth of the Rhizopus stolonifer fungus on B. cereus AR156 and B. subtilis SM21 treated peach fruit was due to over expression of the genes for 1,3-glucanase, chitinase, and phenylalanine-ammonium-protein lyases.

Antibiotics production

B. subtilis produces several antibiotics that are very helpful in suppressing the growth and multiplication of the pathogens.

Induction of plant disease resistance

The use of PGPR such as B. subtilis may activate host defense mechanisms which results changes in ultrastructure and cytochemical alteration (ISR) against the pathogen. One of the main mechanisms of B. subtilis was the elicitation of ISR for controlling plant diseases. It is well accepted that signal transduction pathways elicited by B. subtilis are dependent on production of Jasmonic acid (JA), ethylene, and the regulatory gene NPR1, but independent of salicylic acid (SA), a signal of systemic acquired resistance elicited by pathogens.

Table 2: Commercially available formulations of B. subtilis

Commercial product	Active biological agent
Kodiak	B. subtilis GB03
Gallipro	B. subtilis DSM 17299
Calsporin	B. subtilis C-3102
Clostat	B. subtilis PB6
Biotop	B. subtilis CCT 7611
Natto powder- 710	B. subtilis Natto
Fertitacto	B. subtilis PBRS-1
Fertitacto	B. subtilis PBRS-2
Serenade	B. subtilis QST 713
Integral	B. subtilis MBI 600
Companion	B. subtilis GB03
Green Dual	B. subtilis
Quantum-400	B. subtilis GB03
YIB	B. subtilis QST 713

Production of Bacteriocins

Ribosomal synthesized peptides which are produced by numerous bacteria and might be useful against pathogenic bacteria are known as Bacteriocins (Zou et al., 2018). Bacteriocins interfere with the cell wall synthesis or by forming pores in the cell membrane acts against target pathogen. Bacillus spp. exhibits a broad-spectrum of antibacterial activity due to the production of bacteriocins. Some bacteriocins and bacteriocin-like substances (BLSs) such as amylolysin, amysin, subtilin, subtilosin A, subtilosin B and thuricin were isolated from various Bacillus spp.

Production of siderophores

Siderophores are Fe-chelating, low molecular weight, non-ribosomal peptides which are produced by some microorganisms and plants under iron starvation conditions. Siderophores chelate with Fe, allowing its solubilization and extraction from

minerals and organic compounds by making Fe unavailable for pathogens., Bacillus spp. produce a wide variety of siderophores such as bacillibactin, pyoverdine, pyochelin, schizokinen, petrobactin etc. For example, B. subtilis acts as promising biological control agent against Bipolaris sorokiniana due to siderophores, chitinase and cellulase production of (Villa-Rodríguez et al., 2019).

Some of commercially available products are listed along with their Trade name and biologically active strain of B. subtilis.

Conclusion

B. subtilis represent an eco-friendly approach to improving crop productivity through various mechanisms of biological control, biofertilization and biostimulation processes. Although it helps to boost crop output and reduce disease incidence. The interaction of bacteria with plants, potential pathogens, and the environment determines whether B. subtilis can display advantageous characteristics. B. subtilis play a significant role in both economic and ecological processes, so more practically significant species must be discovered together with advanced approaches for rapid and comprehensive study and effective application.

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Millet Cookies - A successful Venture in Salem District, Tamil Nadu

Malathi G., P.Kalaiselvi, R. Jegathambal and M. Ravi

ICAR-Krishi Vigyan Kendra, Salem was established in the year 1994 for disseminating location specific technological modules at district level through technology assessment, refinement and demonstration and training the farmers, farm women and rural youth on agricultural production technologies and post-harvest technologies. KVK acts as a knowledge resource centre for agricultural technology by supporting initiatives of public, private and voluntary sector for improving the agricultural economy of the district.

Millets are traditional grains grown and consumed in the Indian Sub-Continent from the past more than 5000 years. Millets are highly tolerant to drought and other extreme weather conditions. They are popularly known as Nutricereals as they provide most of the nutrients required for normal functioning of human beings.

Salem District is well known for its millet production in an area of 1,09,927 ha and sorghum in an area of 50349 ha. The other millet crops grown in Salem are finger millet (1933 ha), ragi (8141 ha), maize (33447 ha), samai (780 ha) and other minor millets (1233 ha) with total production of about 4,07,692 metric tonnes per year.

Now a days, renewed interest among farmers and consumers on millets increased the are under millet cultivation.

Millets are highly nutritious with high calcium, iron, potassium, magnesium, and zinc contents, besides other essential molecules such as vitamins, amino acids, and fatty acids. Government of India has declared 10 crops as 'Nutri Cereals' for production and consumption which include three major millets i.e., pearl millet, sorghum and finger millet; five minor millets i.e., foxtail millet, proso millet, kodo millet, barnyard millet, little millet; and two pseudo millets i.e., kuttu (buckwheat) and amaranthus.

Since millets have in-built tolerance to water stress and environmental stresses due to their morpho-physiological, molecular and biochemical characteristics, they are considered climate smart crops. Moreover, as millets are largely produced with low external inputs especially chemicals, they are considered as nature friendly. Several traits such as short stature, small leaf area, thickened cell walls, and dense root system also contribute to circumventing the stresses. Thirdly, being C4 crops, millets have greater potential to utilize atmospheric CO_2 in the accumulation of biomass per unit of water used and thus are recognized as crops with low carbon- and water-footprints. The short life cycle of millets (10–12 weeks) as compared to other major crops (20–24 weeks) also helps in stress mitigation. Because of these attributes millets are

Millets play a vital role in the livelihood of the poor and malnourished population, provide food and nutritional security, and help in achieving the first three sustainable development goals of the United

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Nations i.e. reducing poverty, zero hunger and good health and well-being. However, despite such positive attributes and qualities of millets for the present and future agriculture, their cultivation in India has been on decline over the last few decades, which has attracted the attention of policy makers and India celebrated 2018 as the 'National Year of Millets' to create greater awareness about unparalleled attributes of millets.

The farmers growing millets in Salem district are only small and marginal farmers and are getting only marginal income because of the involvement of middleman in the supply chain of millets. Hence, the millet growers are motivated by KVK by conducting frequent trainings and demonstrations, entrepreneurship development programmes on value addition to make aware of farmers to increase their income.

Several hands-on trainings on production of millet cookies without including wheat or maida were conducted. Since 2019, the demonstrations and trainings on value addition of millets were regularly conducted at KVK for the benefit of farmers, farm women, rural youth and Farmer Producer Organizations.

Millet cookies are prepared with 100 percent ragi, pearl millet and tenai flour without addition of any preservatives. Multi grain cookies and millet cookies blended with flour of tapioca and banana preparation were also demonstrated to the stakeholders.

The post-harvest processing and value addition facilities available with KVK for post-harvest processing and value addition of millets was shared to farmers on minimal cost basis. Tribal groups of Shervaroy hills were got benefitted and they utilized processing machineries and baking units at KVK.

Moreover, KVK is regularly conducting the awareness programmes in collaboration with Integrated Child Development Scheme, Salem during every September months for creating awareness to famers, school and college students, anganwadi workers etc., by organising Mela and Exhibitions to

showcase the importance of millets in balanced diet of the children, women especially pregnant women as a part of Poshan Abhiyan and Poshan Maah Programmes.

Since 2018, the millet cookies produced by KVK, Salem is given as refreshment to the participants during all the training programmes and farmer melas and sold through sales counter to create awareness among different stakeholders about the nutritional aspects of the Nutri cereals.

Awareness creation as well as sale of millet cookies has been done in collaboration with Forest Department too by selling KVK prepared millet cookies at Kurumbapatti Park of Salem which is one of the important tourist places in Salem District

functioning under the Department of Forests. By this way Salem KVK is not only creating awareness but also demonstrated the successful venture of value addition of millets through preparation of millet cookies to not only to farmers of Salem District but also to farmers of other districts too.

Profitable venture

- Input Cost – Approximately Rs. 200/-
- TNAU KVK Sale Price for Millet Cookies - Rs. 350 – 400 /- per kg,
- KVK, Salem sold millet cookies worth Rs.2,42,980 /- with BCR is 3.5 to 4.0.

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Peasantry in Punjab: Major Concerns and their Solutions

Raj Kumar

Punjab, with only 1.53 per cent of the total geographical area of the country produces about 16% wheat, 11% rice, 3.4% cotton and 7% milk of the country. State produces about 2.5% rice, 2.3% wheat and 0.7% cotton of the world. During the last decade, the state has contributed 35-40% of wheat and 25-30% of rice to the Central Pool. If we look back over the last seven decades, Punjab's agrarian economy and culture have continued to thrive, signaling a reach much beyond its demographic and geographical boundaries. The state possesses best agriculture infrastructure in the entire country. The state's average monthly income for agricultural households has consistently been increasing.

Table 1: Average monthly income of agricultural households

State	2012-13 (NSSO)	2016-17 (NABARD)	2018-19 (NSSO)
Punjab	18059	23133	26701
Haryana	14434	18496	22841
Bihar	3558	7175	7542
India	6426	8931	10218

(Rs./household)

However, the state continues to face a number of issues, including depletion of underground water, mounting debts, and a lack of alternative employment opportunities. The alternatives advocated by the experts and well-wishers, such as agricultural diversification, have proven to be non-starters. Approximately 67 per cent of farmers in Punjab cultivate less than 4 hectares of land, although their portion of total cultivable land is only 34.6 per cent. On the other hand, only 5.3 per cent farmers having more than 10 hectares of operational holding with a share of 21.7 per cent total cultivable land of the state. The average size of operational holding in Punjab is 3.62 hectares.

The heavy investment on about 4.7 lakh tractors, 15 lakh tube wells, 0.9 lakh threshers and 19 thousand combines harvesters in the state, which have made the agricultural production process capital intensive. Heavy farm investment and low level of savings in agriculture is leading to indebtedness. It is not economically viable to acquire even the smallest 25 HP tractor on 67% of holdings with less than 4 hectares of land. The small farmers could not afford farm investment on land, irrigation and farm machinery from their own savings in order to enhance productive capacity of farms and realize the benefits of precision farming. Therefore, cooperative farming needs to be promoted in order to alleviate the financial burden associated with the purchase of expensive machinery and tools. Hiring farming equipment is a significant cost-cutting measure for farmers. Such machinery can be maintained at the village level cooperative organization and made available to farmers on custom-hire basis, avoiding them from making large investments. This type of experiment should be conducted on a wider scale in the state. Collectively, the farmers themselves can also pool their resources and start cooperative farming. To initiate cooperative farming, well-run Primary Agricultural Cooperative Societies (PACSs) can prove to be a lifeline for small and marginal farmers. These societies should not stop at fertilizer providers; they should also promote co-operative farming, mechanization and marketing of agricultural produce. Such a strategy can help farmers increase their profits. Thus, small farmers must form groups and FPOs to strengthen their bargaining power, which will enable them to not only purchase quality inputs in bulk at relatively lower prices, but also sell their produce at higher prices. Besides, the farmers can choose crop rotations that require more labour and yield higher

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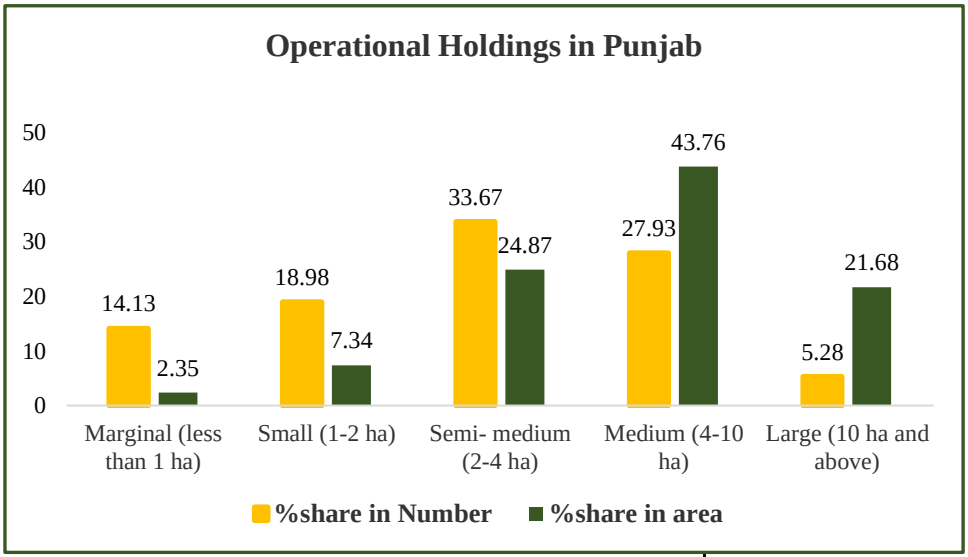

returns than wheat-paddy cycle, such as horticultural crops. This will also result in increased employment hours in the fields. Contract farming, likewise, may also assist small farmers in ensuring their returns. However, it requires government intervention to establish strict rules and regulations to protect both parties, as contract farming has a checkered history in the past.

The state's infrastructure for produce storage must be improved. Farmers can obtain credit against their stored produce using the warehouse receipts system. Additionally, this will assist them in avoiding distress sales immediately after harvest. Around 36% of farmers rely on non-institutional sources of funding (private dealers, corporate agents, commission agents, and money lenders) to meet their household and agricultural needs at a high rate of interest ranging from 24 to 36% per annum. The government should exert a firm check on the un-regulated operations of non-institutional sources, and secondly, the farming community, particularly small and tenant farmers, should have increased access to institutional financing.

Moreover, many farmers usually acquire agricultural supplies such as seeds, fertilisers, and pesticides from private dealers, and often utilise these inputs according to their recommendations. The agricultural problems can only be resolved through progressive dialogue with experts rather than relying solely on private traders and fellow farmers.

The reduced working hours of the agricultural labour force is another rising issue in today's agricultural scenario. The mode of production in Punjab agriculture has become capital intensive over time and the demand for human labour has diminished since the late 1980's. Such idle agricultural labour is often unable to find new employment in the non-farm sector. According to the recent cost of cultivation data, a one-acre paddy-wheat crop rotation requires only 20-25 man days of labour. Crop rotation or a supplementary occupation that generates additional work throughout the year is necessary. Farmers can visit Punjab Agricultural University (PAU) or district-level Krishi Vigyan Kendras (KVKs) to explore new supplementary occupations of their choice. With the addition of new occupations, farmers' effective working hours can be increased, resulting in a higher revenue. Apart from diversification within agriculture, the surplus agricultural labour force must also be redirected to non-agricultural sectors in order to maintain a subsistence level of living. The farming business should be planned in such a way that each member of the family has a work. Farmers should stay current on agricultural information in order to increase their farm income by maintaining contact with PAU and its KVKs.

Farmers must adhere to the latest agricultural techniques recommended by Punjab Agricultural University in order to reduce production costs and ensure the sustainability of their profession. Additionally, it has been noticed that the majority of farmers lack the practice of keeping proper records of

expenses and returns from farming. By keeping accurate records of returns and expenses, one can quickly detect unnecessary expenditures that can be reduced. Unproductive expenses on conservative social values such as symbols of social status, expensive costs associated with marriages and other social rites, and so on, should be eliminated in order to alleviate the burden of debt. Individuals should live within and consume within their means.

Utilizing modern agricultural techniques, efficient farm planning, diversified agriculture through demand driven production, and better farmers' exposure to both local and distant markets can help the farmers in lowering crop production costs, increasing demand for their produce, exploring additional work hours, and ultimately turning agriculture into a profitable occupation. Within the confines of the Punjab economy's socio-economic and political framework, these approaches can be helpful to improve farm income and reduce the incidence of indebtedness.

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Small Millets: Super Food of the Future

Farooqkhan, Anusha M. Nayak, Ismayil M. M. S and Tharana Poonacha T.

In recent years, there has been a growing interest in small millets as a potential superfood. These humble grains, such as finger millet, foxtail millet, proso millet, little millet, and barnyard millet,

FINGER MILLET

FOXTAIL MILLET

PROSO MILLET

are packed with nutritional benefits, environmentally sustainable qualities, and adaptability to challenging growing conditions. In this article, we will delve into the reasons why small millets have the potential to become the superfood of the future, revolutionising our diets and contributing to a healthier, more sustainable world.

Nutritional Powerhouses

Small millets are often hailed as nutritional powerhouses due to their impressive nutrient profile. They are rich in dietary fiber, providing essential roughage for a healthy digestive system. These grains are abundant in minerals like iron, calcium, magnesium, and phosphorus, which are vital for maintaining strong bones and supporting various bodily functions. Small millets also contain a range of B-complex vitamins that play a crucial role in energy metabolism and brain health.

Health Benefits

In addition to their impressive nutrient content, small millets offer a host of health benefits. These grains have a low glycemic index, meaning they release glucose into the bloodstream slowly, helping to regulate blood sugar levels. This makes them a valuable addition to the diet of individuals with diabetes or those aiming to maintain stable blood sugar levels.

The high fiber content in small millets aids in digestion, prevents constipation, and promotes a healthy gut microbiome. The presence of antioxidants in these grains helps protect the body against oxidative stress, reducing the risk of chronic diseases such as heart disease, cancer, and neurodegenerative disorders.

Environmental Sustainability

As our planet faces the challenges of climate change and limited natural resources, small millets offer a sustainable solution. These crops are known for their resilience in diverse agro-climatic conditions, requiring fewer inputs like water, fertilizers, and pesticides compared to major staple crops. Their

KODO MILLET

BARNYARD MILLET

LITTLE MILLET

ability to thrive in harsh environments makes them an ideal choice for regions facing water scarcity and soil degradation.

Cultivating small millets promotes biodiversity conservation and reduces the pressure on land and water resources. These grains have a smaller carbon footprint and contribute to the sustainability of agricultural systems. By incorporating small millets into our diets, we can support environmentally friendly farming practices and contribute to a more sustainable food system.

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Culinary Versatility

Small millets offer a wide range of culinary possibilities. They can be cooked as rice substitutes, offering a nutritious and gluten-free alternative for individuals with dietary restrictions. Small millets can be used to make porridges, soups, and salads, providing a wholesome and filling meal. They can also be ground into flour for baking bread, making rotis, or creating innovative gluten-free recipes.

The versatility of small millets not only caters to diverse culinary preferences but also enhances the nutritional value of meals. By incorporating these grains into various dishes, we can add a healthy twist to our major recipes and explore new flavours and textures.

Conclusion

In conclusion, small millets have the potential to become the superfood of the future. Their impressive nutrient profile, health benefits, environmental sustainability, and culinary versatility make them an ideal choice for a healthier and more sustainable diet. By embracing small millets, we can improve our nutrition, promote sustainable agricultural practices, and contribute to a greener future. Let us embrace the power of small millets and unlock their potential as the superfood that will shape our diets and impact generations to come.

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Sustainable Income Through Integrated Sheep/Goat cum Poultry Farming

Jayashree Pattar, S A Biradar, Geeta Tamagale, Kalavathi Kambli and Shailaja Galagali

Shri. Ravi Dandin from Kallur village of Dharwad taluka owns 1.20 acres of land with good irrigation facility. He was getting an annual income of Rs. 44000/- and after lockdown he had financial crises and was unable to maintain the family with agriculture income. He thought of starting an subsidiary activity to compensate his family income and one of the idea suggested was Sheep/Goat farming. He visited KVK, Dharwad during 2020 for consultancy service and after that attended Sheep/Goat training. Constant suggestion from Scientists, regular consultations and field visits helped him to start his own Integrated Sheep/Goat cum Poultry farming unit.

Interventions

Process: During the initial visit of KVK scientists to his field, it was observed that he was growing maize as main crop, due to extreme agroclimatic changes and Covid outbreak in the district which affected his livelihood. KVK Scientists advised him to go for secondary agriculture practices mainly integrated sheep/goat with poultry farming as subsidiary income source. Later he attended the vocational training programme on scientific sheep/goat farming which was organized by ICAR-KVK, Dharwad and sponsored by ATRAI, Bengaluru. The training oriented him regarding the basics of sheep/goat farming, feed and fodder management along with exposure field visit to successful entrepreneurs. After completion of the training, he established sheep/goat farming in raised integrated stall-fed housing system with area of 60*30 feet to rear the sheep/goat and poultry birds.

Technology: KVK scientists made timely visit and guided the farmer in feed, fodder and disease management, established fodder cafeteria, followed vaccination protocol for sheep/goat and poultry. He had grown multi cut fodder sorghum (CoFS-29), fodder maize, lucerne, sesbania in 0.5 acre of land for feeding sheep and goat. Presently he is having 50 sheep mainly *Deccani*, *Nari suvarna*, *Yalaga* breeds and 50 goats mainly *Sirrohi*, *Osmanabadi*, *Beetal* breeds. He regularly rear the 400 local poultry birds in the underneath space of stall fed housing system both for meat and egg purpose. He uses the farm

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residues mainly groundnut, urd dal and Bengal gram husk, grains to prepare the concentrate balance feed ration to feed the animals.

Output and outcome: Impact

Horizontal Spread: With his experience and knowledge, he has become the master trainer for integrated sheep/goat cum poultry farming training programmes. The participants of sheep, goat and poultry farming training organized by KVK, Dharwad regularly visits his farm for practical experience. More than 80 farmers, 60 students and 10 extension officials visited his farm for consultancy and already 10 farmers/ rural youths started their own integrated sheep/goat cum poultry farming unit.

Economic gains: Presently with the integrated unit he is getting an annual gross income of Rs. 6.12 lakh. Major contribution is from sheep/goat farming, i.e Rs. 4.0 lakh from sale of sheep/goat and Rs. 2.16 lakh from sale of eggs and birds with the cost benefit ratio of 4.08.

Employment Generation: Adoption of integrated sheep/goat cum poultry farming provided regular employment for two labours throughout the season along with crop cultivation practices. Hence integrated sheep/goat cum poultry farming is an additional sustainable source of income for the farming community during the era of climate change.

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Indian Eagle Owl (*Bubo Bengalensis*) in Rat Management

R.K. Gokulakrishnaa and Selvamuthukumaran Thirunavukkarasu

In agriculture, rodents are one of the major pests across the globe (Singleton & Petch 1994; Singleton *et al.*, 2010). The reason is their rapid breeding, high species diversity and adaptations to wide spread geographic distribution. Rodents in agricultural ecosystems are solely management by chemical rodenticides. Even though the rodenticides are the better option, we have concern about the human as well as animal health and environment contamination. Ecologically Based Rodent Management (EBRM) is the alternate approach understanding rodent population biology, behaviour and natural predation that is both economically and ecologically viable. One of the nocturnal raptors that is exclusively found in the Indian subcontinent is the Indian Eagle Owl, or *Bubo bengalensis*.

Owls have undergone numerous adaptations during their evolution to occupy the top of the food chain in the ecological niche. Field rats, mice, shrews, bats, birds, reptiles, frogs, crabs, scorpions, and insects make up most of an owl's diet. India's eagle Owls build their nests on the ground in rocky outcrops, shrubs, and earthen depressions. Their hunting areas are made up of rural surroundings, water reservoirs, hills, and agricultural crop fields. Undigested portions of the prey, such as bones, vertebrate animal fur, and invertebrate animal exoskeletons, can be found in the owls' regurgitated pellets. These undigested food materials are dropped in the nesting and roosting/perching areas and are oval and greenish black or grey in colour.

Pellets are usually analysed to compile the prey composition of Indian eagle owl in varies habitats over the period. The diet of the owl constitutes 65.1% of rodent prey and remaining 34.15% of other groups of both vertebrate and invertebrate animals. It was recorded that *Bubo bengalensis* consumed more than one prey per day and chiefly foraged in agricultural crop fields and consumed both small mammals and insects of agricultural importance under crop ecosystems (Siva *et al.*, 2019).

Highlights of *Bubo bengalensis*

- ✓ Despite being a generalist feeder, its diet was dominated by agricultural pests, which contributed 88% of the total prey biomass
- ✓ Out of the 13 rodent prey species, which comprised a major part of the diet, seven were identified as major agricultural pests - Lesser Bandicoot Rat (*Bandicota bengalensis*), Large Bandicoot Rat (*B. indica*), Soft-furred Field Rat (*Millardia meltada*), House Mouse (*Mus*

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musculus), Field Mouse (*M. booduga*), House Rat (*Rattus rattus*), and Indian Gerbil (*Tatera indica*)

Table 1: Description of *Bubo bengalensis*

Morphological characters	Habit	Breeding	Habitat	Distribution	Haunting tactics	Life span
Length – 50 to 56 Cm Wing length – 35 to 43 Cm Tail length – 185 – 227 Mm Height – 48 – 50 Cm Average Weight of male – 1100 g Females larger than male	Nocturnal, flies' clock to ground Usually hunt from perches Low foraging flight dive on prey Primarily on rats/mice Small birds, reptiles, frog, crab and large insects	Oct to May 2 – 4 eggs, incubate for 35 days Chick depends on adults up to six months Chick to Adult in 10 Weeks	Rocky hills with bushes Old mango orchards Earth cuttings Prefer – agriculture land than grassland and scrub land	West Himalayans, Pakistan, Kashmir, Nepal, Assam, and Burma Except – arid desert, moist evergreen forest	It flies almost parallel to ground with near silent wing beat for capture the prey Tear up the prey Feeding capacity – 61 g/ Day	25 to 30 years in wild

- ✓ The dependence of the Indian eagle owl on rodent pests was further reflected by positive correlation between rodent biomass consumed and the breeding success of the owl
- ✓ This owl is still hunted due to superstitious beliefs, scientific evidence elucidating the importance of the Indian eagle owl in agricultural pest control can be used for its conservation by educating the farming community
- ✓ Owl perches at the rate of 40-50 per/hac to enhance predation

The diet constituted 65.1% of rodent prey and the remaining 34.83% of other groups of both vertebrate and invertebrate animals. The mean percentage of prey composition was 31.15% *Millardia meltada* (Soft-furred field rat), 12.95% *Bandicota bengalensis* (Lesser bandicoot rat), 10.25% *Mus booduga* (Indian field mouse), and 10.24% of other rodent species. Of the 34.83% of non-rodent prey, the owls ingested insects (Rhinoceros beetles, 9.58%), Arachnida (Solifugae or Sun spider, *Galeodes* sp., 9.58%), reptiles (*Calotes* sp., 3.7%), amphibians (3.56%), shrews (*Suncus murinus*, 2.84%), and others (5.57%).

Ramanujam (2006) studied the prey items of the Indian eagle owl; it was found that mammals accounted for an estimated biomass of 86.93% of which rodents occupied pride of place with 64.91%. *Tatera indica* (24.96%), *Rattus rattus* (20.43%), *Bandicota bengalensis* (12.28%), *Mus spp.* (4.67%), *Bandicota indica* (2.34%), and *Funambulus palmarum* (0.15%) featured prominently among rodent food, but *Millardia meltada* (0.06%) was conspicuous by its near absence. Birds (8.28%) were the most important non-mammal food, followed by batrachians (2.75%), both of which showed distinct seasonal fluctuations. *Varanus bengalensis* (1.64%) and a single *Amphiesma stolata* were the reptiles consumed. Arthropods accounted for 0.34%, of which Coleoptera dominated with 0.24%. The venomous *Heterometrus swammerdami* and *Scolopendra morsitans* also formed part of the prey spectrum, albeit in negligible quantities (a combined biomass of 0.022%).

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Agricultural Application of Fish Amino Acids

Elavarasan K

Organic inputs are much sought for sustainable agricultural due to reasons like protective effect on the soil fertility, promotion of plant health, cost-effective crop managament and enhanced productivity. Among the organic inputs, foliar inputs play a significant role in productivity. There is a growing interest in use of fish processing waste in the form of amino acids alone or in combination with other natural sources with specific functions. An attempt has been made in this article to briefly describe the research outputs recorded from various sources on variety of crops on the agricultural applications of fish amino acids.

Fish waste kept for fermentation

Terrace garden

Fish amino acid

Fish amino acid is a product often prepared from fish discards or trash fishes through fermentation assisted by the addition of carbon sources like molasses, sugar, fruit waste etc. The product is light to dark brown in colour with typical sweetish smell devoid of fishy smell. The process takes 15-21 days for breaking the proteins better in to the simple components like smaller amino acids and very low molecular weight peptides. Fish amino acid can simply be used as a source of nitrogen. In addition, the peptides and amino acids may exert specific biofunctional role.

Studies on Agricultural crops

Though the production and application of fish amino acid for agricultural crops are practiced in various parts of the country, the scientific studies are limited. There is lot of scope to conduct the study on various crops in different agro climatic zones in India. Such studies are required in order to explore the benefits of using fish amino acids. Some of the studies related to fish amino acids and the outputs are listed in Table 1. A study on use of fish based fertilizer in comparison with commercial organic fertilizer on chilli has concluded that the fish fertilizer has the potential but did not perform better than the commercial one. Thus the study recommended enriching the fish amino acid with the high nutrients (Khir, 2019). The watermelon crop was applied with fish amino acid and herbal nutrients increased the plant growth, productivity, lycopene content etc. The high dose of fish amino acid

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Table 1: Effect of fish amino acid on agricultural crops

S. No	Input	Fermentation period	Plant studied	Result	References
1	Fish waste, egg shell, molded white bread and molasses (4:1:1:4)	43 days	Chilli Plant (Capsicum annum)	Organic fish fertilizer has a good potential for plant growth.	Khir, 2019
2	Fish amino acid and Oriental Herbal Nutrients	30 days	Water melon (Citrullus lanatus)	Plant growth, production, lycopene content and soluble solids increased.	Gasana and Kim, 2020
3	Fish amino acid	-	Chinese Broccoli (Brassica oleracea var. alboglabra L.).	Enhanced the plant height, leaves number, branches, total leaf area and plant biomass	Amin (2021)
4	Amino fish AMI-16 with mycorrhizae and vermicompost	-	Sun flower (Oil seed crop)	Increased yield and its components.	Sarabi et al., 2022
5	Panchgavya @ 3%, and fish amino acid @ 0.5%, soil application of Farm Yard Manure @25 t/ha, Groundnut cake @ 100 kg/ha and Neem cake @ 200kg/ha recorded (25.55 t/ha)	-	Ash gourd	Higher fruit yield	Dhanushkodi and Nageswari; 2022.
6	Fish amino acid with FYM, Vermicompost and oil cake	-	African marigold (Tagetes erecta L.)	Yield and quality	Sivasankar et al., 2021
7	Fish amino acid fermented with bananas	-	GREEN CHILL	Yield increased (7.18 ton/ha)	Arani et al., 2023
8	Fish amino acid (1%)	10 days	Amaranthus	Enhanced the plant height, number of leaves per plant, fresh weight and dry weight of whole plant	Ramesh et al., 2020

found to negatively influence the soluble solid content but the lycopene content increased (Gasana and Kim 2020). Hence, in the application of fish amino acid one should be careful in the selection of application dose. The study on fish amino acid studied at different doses on the chinese broccoli concluded that 300 ml in 1 litre water and spraying resulted in enhanced the plant height, leaves number, branches, total leaf area and plant biomass (Amin 2021). In general, the growth and yield is enhanced by the application of fish amino acids. Research should focus on application of fish amino acid in combination with other nutrients and bioactive ingredients. As such as fish amino acid is abundant in nitrogen and phosphorous and also various types of amino acids. It is easily absorbable and stimulates the metabolic activity of microorganisms associated with the soil. Process modifications need to be explored.

In conventional practice, production of fish amino acid involves fermentation using molasses and jiggery. The process is time consuming and achieving the consistency in the end product quality is very difficult. Hence, the options like proteases assisted enzymatic hydrolysis, fermentation using specifically formulated microbial consortium, alternative carbon sources and their effect need to be explored.

Fish amino acid – Market status

Due to growth witnessed in on line selling platforms, products like fish amino acid has a huge commercial and industrial potential in India. In general, the fish amino acid cost around Rupees 90 to 120/100 ml. The actual production cost is cheaper and the major cost incurred is towards the packaging material and carbon source used. Some of the popular brands which are selling fish amino acid are Abtec, Cleanom, My own garden, C-garden,Probio, Seed2plant, Keralagro, Amino Pearl, Sivalakshmi Organic farms, SAS enterpises, Aadaval, Bucket garden, Seamag etc. The competition in the market is growing day by day due to process simplicity, ease of manufacturing at any quantity.

Conclusion

Fish and shellfish processing waste are rich in nutrients like proteins, lipids, and minerals. These valuable nutrients converted into their simpler molecules through fermentation. Particularly as fish based raw materials are rich in proteins, their conversion leads to the formation of amino acids. It serve as the source of nitrogen, in addition certain biological functions are also modulated in a beneficial way when it is up taken by the plants through various route including foliar applications. As an organic input in agricultural practices, fish amino acid can play a major role towards developing sustainable inputs and improved resource utilization.

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Industrial Castor Crop Cultivation in Kharif Season

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Castor oil plant, or castor bean plant (*Ricinus communis*) of the Euphorbiaceae family is one of the world's most useful and economically important plant as it's seed contains 30-50% of oil, the highest among cultivated oilseeds. Castor oil has more than 700 industrial uses (eg. hydraulic fluid, artificial leather, rubber, printing ink, soaps, recinol, lubricating and heavy duty automotive greases, telecom engineering plastics, production of nylon 11, nylon 6-10 and medicines, source of fuel for aeroplanes etc.). India is the major producer in the world, castor seed with a production of 17.95 lakh tonnes (lt) during 2021-22 season, against 17.89 lt in 2020-21. (Anon, 2022). . Among states, Gujarat is leading with 6.52 lakh ha (13.45 lakh tonnes) under castor followed by Rajasthan 1.77lakh ha (2.76 lakh tonnes), Andhra Pradesh 0.16 lakh ha (0.064 lakh tonnes), and Telangana 0.022 lakh ha (0.037 lakh tonnes). According to government 2nd advance estimates, all India castor production in 2022-23 is at area 8.917 lakh ha, production 18.82 lakh tonnes. [Source: Directorate of Economics and Statistics (DES) , 2nd Advance estimates].

Table 1: Recommended varieties/hybrids:

S.No	Variety/ Hybrid	Days to maturity for first picking	Special characters	Mean seed yield (kg/ha)
1	DCH-519	105-110 Days	Resistance to wilt	1500-1750
2	ICH-66	94-97 DAS	Resistance to wilt, root rot and leaf hopper	1560 (Rainfed) 1450-1750
3	PCH-111	85-90 DAS	Resistance to wilt	1400-1500 (Rainfed) 2200-2500 (Irrigated)

Season and Time of sowing

Castor is mainly raised as *kharif* crop. The time of sowing varies from place to place depending on the onset of rains. Sowing is June 15th to July 15th for getting higher yields. Early crop suffers from severe incidence of semi-looper. In case of late sown crop, reduce spacing to 60 x 45-60 cm, soak the seed in water for 12 hours followed by shade drying. Apply 25 % more N than recommended dose.

Table 2: Intercropping: some of the profitable intercropping combinations involving castor followed in the Telangana:

Feasible intercropping systems
Castor + groundnut (1:3)
Castor + cowpea (1:2)
Castor + red gram (1:1 or 1:5)
Castor + black gram (1:2)
Castor + green gram (1:3)

Seed treatment

Seed treatment with Thiram or Captan @ 3g/kg seed or Carbendazim 3 g/kg protects plants from seed borne diseases like *Alternaria* leaf blight, seedling blight and wilt. Treating the seed with *Trichoderma viride* @ 10 g/kg seed and soil application of 2.5 kg incubated in 125 kg FYM/ha help in managing wilt.

Nutrient management

Application of 5-7.5 tonnes FYM/ha helps in moisture retention and provides nutrition to the crop. The recommended dose of fertilizer for a crop of 150 to 180 days duration is 60 kg N, 40 kg P205 and 30 kg K20/ha under rainfed conditions.

Nitrogen is normally used in split doses under irrigated condition and also under rainfed conditions

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subject to receipt of rains while phosphorus and potash applied ad basal dose.

Table 3: Seed rate and Spacing:

Season	Varity/Hybrid	Seed rate (kg/ha)	Spacing (cm)
Rainfed conditions			
Black Soils	Hybrids	5.0-6.25	90 x 60 (or) 120 x 45
Light textured Soils	Variety	8.75-10.0	90 x 45
	Hybrids	5.0-6.25	90 x 60 (or) 120 x 45

Irrigation

Castor is a drought resistant crop and found to thrive well in 400 mm rainfall also. Castor is grown as rainfed crop during *kharif* season. Hence, irrigation will not be given. However, in case of long dry spell during mid/terminal stages, give one or two lifesaving irrigations either from farm ponds or other source.

Make conservation furrows at an interval of 2.4 to 3.6 m interval across the slope for moisture conservation especially in slopy lands.

Harvesting

- Castor which is essentially a branching type in India produces five to six spikes on sequential branches at different intervals.
- The main spike gets ready for harvest within 90 to 100 days followed by other at 30days interval in case of the popular short duration varieties and hybrids .
- Premature harvesting result in low oil content and poor quality of oil. Since the problem of shattering is completely eliminated in the present varieties and hybrid harvesting can be delayed until the capsules are fully dry.
- The harvested spikes are allowed to dry in the sun for about six to eight days before threshing either by beating with sticks in case of limited quantities or by trampling by bullocks or tractor as per the availability when large quantities are to be hulled. Power operated mechanical threshers are available which are easier, faster and more efficient.

Table 4: Castor pests and Diseases Management

Name of Insect/ Disease	Symptoms	Favorable climatic conditions	Chemical / Biological control
Semiloop er	The caterpillar feeds sparingly at initial and feeds voraciously during later stages leaving only mid rib and veins i.e. *Defoliated leaves. *In severe cases only mid rib and veins of the leaves.	August to January	➢ Collection and destruction of the infested material from the field. ➢ Plucking of leaves harbouring egg masses / gregarious larvae and destroying. ➢ Setting up of pheromone traps @ 4-8/acre ➢ Application of *Azadirectin* 1500 ppm i.e. neem oil 5 ml/L for management of early instars larvae. ➢ Natural enemie (*Snellenius maculipennis*) acts as larval parasite whose cocoons may be seen attached to the ventral aspect of the posterior end of the host caterpillar. Avoid chemical
Tobacco caterpillar	In early stages, the caterpillars are gregarious and scrape the chlorophyll content of leaf lamina giving it a papery white appearance. Later they become voracious feeders	During September to January	

	making irregular holes on the leaves and finally leaving only veins and petioles and cause complete defoliation or skeletonised leaves.		spray when 1-2 larval parasitoids are observed per plant. ➢ Spray of Acephate 1.5 g/L or Thiodicarb 1.5g/L of water(if <25% defoliation) ➢ Spray Profenophos @ 2ml/ L or Flubendamide 0.2ml/L or Spinosad 0.3ml/L of water (if >25% defoliation).
Shoot and capsule Borer	Initially the larvae bores into the tender shoots and later it enters into capsule and causes holes. Damaged capsules webbed together. Peduncle and capsules showing galleries made of larval silk and frass.	September to February	➢ Collection and destruction the shoots and capsules infested by capsule borer. ➢ Sprayings should be commenced from the time of formation of inflorescence and again after 20 days. ➢ Spray Profenofos @ 2ml/L or Novaluraon @ 1ml/L of water, if at least 10% capsules are damaged.
Leafhopper	Leaf margins become yellow. Curling of leaf edges and leaves turn red or brown. Under severe infestation hopper burn symptoms are also noticed.	Peak infestation is during November to January	➢ When 10% of leaves in a plant show curling, spray Profenophos 2 ml/L of water. ➢ Under severe infested conditions spray Acetamirpide @ 0.2g/L or Clothionidin 0.1g/L of water. ➢ Atleast two sprays required at 15 days intervals based on severity.
Seedling blight - *Phytophthora parasitica*	The disease appears circular, dull green patch on both the surface of the cotyledon leaves. It later spreads and causes rotting. In mature plants, the infection initially appears on the young leaves and spreads to petiole and stem causing black discoloration and severe defoliation.	Continuous rainy weather. Low temperature (20-25°C). Low lying and ill drained soils.	➢ Remove and destroy infected plant residues. ➢ Avoid low-lying and ill drained fields for sowing. ➢ Treat the seeds with Thiram or Captan at 3g/kg. ➢ Drenching with metalaxyl @ 2.5 to 3 g/L or Copper oxy chloride 3g/Lof water.
Wilt –	When seedlings are attacked cotyledonary leaves turn to dull green colour, wither and die subsequently. ➢ In matures plants the leaves becomes yellow and brittle, droop and drop off leaving behind only top leaves. Diseased	Monocropping of castor in same field. Infected seed	➢ Crop rotation with non host plants ➢ Seed treatment with thiram @ 3g/ kg or carbendiazim @ 2g/ kg seed. ➢ Seed treatment with biocontrol agent *Trichoderma viride* @10g /kg. ➢ Soil application of *T. viride* @2kg of talc formulation mixed in 100kg farm yard manure and incubate it for 15 days and apply to the soil before ploughing. ➢ Drenching with Copper Oxy Chloride @ 3 g/L of water.

	plants are sickly in appearance. ➢ Cut opened stems will show discolouration of the vascular bundles and presence of white mycelium on infected portion.		
Gray Mold	Symptoms can be seen on all plant parts, being prominent on spike. Infected flowers rot and are covered by characteristic gray or ash coloured growth of the fungus. Subsequently the disease spreads upward infecting all flowers and capsules which are covered by the fungus. This is followed by development of cottony white growth which later converts into gray colour due to sporulation. Yellowish drops of liquid exude from these portions Infected spikes become sterile without capsules. Infected capsules rot and shed off.	Continuous rains, Night temperatures below 22° C and high relative humidity favours the disease spread	➢ Adjust sowing time in such a way that crop maturation occurs during dry season ➢ Adopt wider spacing (90 x 60cm) ➢ Remove diseased spikes and destroy them ➢ Grow varieties with non-spiny capsules and less compact inflorescence. ➢ Seed treatment with carbendazim @2g/kg ➢ Spray Carbendazim@ 1g/L or Propiconozole @ 1ml/L or thiophenate methyl @ 1g./L before onset of cyclonic weather based on weather forecast and another spray after cyclonic rains. ➢ Application of 20kg urea and 10kg of murate of potash after removal of diseased panicles may be useful for the growth of panicles that subsequently develop.

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Value Addition and Marketing of Millets – A Success Story of an Entrepreneur

Malathi G., P. Kalaiselvi, R. Jegathambal, L. Subha and N. Chandra Sekaran

Krishi Vigyan Kendra, Salem District established in the year 1994 disseminates agricultural technology by supporting initiatives of public, private and voluntary sector for improving the agricultural economy of the district.

KVK, Salem conducted hands on trainings on millets processing and value addition for the benefit of farmers, farm women and rural youth, students and anganwadi workers and other extension officials too.

Mrs. Dhivya, a young software engineer of Salem got instigation and inspiration after attending millets processing and value addition training, started a venture in procuring few chemical free farms produces and supplying the same to the needy consumers in small through online. She became incubate of Entrepreneurship Development and Innovation Institute (*EDII*), , Horticultural College and Research Institute, Periyakulam, TNAU and got several ideas on product development and marketing. Technological backstopping was given to her regularly by KVK, Salem.

To supply chemical free natural quality farm

produces to the consumers continuously that too directly from the farmers, she started Ana Foods in 2020. Initially she started marketing of jaggery and ghee only and now she markets millets as whole grains, millet flour, value added products of millet, ready to cook products, ready to eat products and health drinks *etc.*, through the marketing platform of her brand "Ana Foods".

Unpolished millets as such like ragi, *cumbu, tenai, varagu, pani varagu, Kuthiraivali*, red and white sorghum, flours of ragi, *cumbu, tenai, varagu, pani varagu, Kuthiraivali* etc., millet instant health mixes along with carrot and beetroot for improving nutritional status as well as adding natural colour to the products, instant sprouted health mix, heath mix for weight loss, noodles, semiya, vermicelli, pasta from millets are also available in the basket of Ana Foods Start Up Company.

By this way, she encouraged the farmers to go for producing the millets in natural way and supporting them by procuring their products directly from them for her business venture. There are more

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than 25 food products in her basket to spread over the earth through online marketing. She has registered her brand "Ana Foods: in FSSAI and MSME too. She used Facebook, WhatsApp, Instagram etc., to market the food products of Ana Foods. Now she created a web site too to do online marketing of products in a better manner. She planned to do marketing in collaboration with online marketing platforms like Amazon, Flipkart, Meso etc., Within a short period of time, she was encouraged with many awards too as an encouragement from the society. Grow Local, Eat Local and Support Local Farmers is the motto of Ana Foods.

Through the references made by domestic customers to their friends and relatives living in abroad, the variety of Ana Foods reached USA and UK too. Hence the Motto of Ana Foods is changed into Grow Local, Get Local and Spread throughout the World.

* * * * * * * *

Thar Kiran: Anthocyanin Rich High Yielding Variety of Indian Bean

Gangadhara K, Lalu Prasad Yadav, V.V. Appa Rao and A.K. Singh

Indian bean (*Lablab purpureus* L., 2n=22, Family- Fabaceae) is one of the most ancient crops among cultivated plants and an important prime leguminous vegetable crop cultivated by poor masses of tribal areas of our country. It is an agro-morphologically diverse, domesticated and versatile legume vegetable crop owing to its multiple uses as fresh vegetable (pod, tender seed), pulse, forage crop/ green manure, ornamental and industrial use. It is commonly called as Indian bean, hyacinth bean, lablab bean, country bean, Egyptian bean, Tonga bean, field bean. In India, major Indian bean growing states are Karnataka, Gujarat, Tamil Nadu, Andhra Pradesh, Madhya Pradesh and Maharashtra. In India its locally called by different names viz., Hindi-Sem; Bengali-Shim, Gujarati-Val, Marathi-Pavta, Telugu-Chikkudu, Tamil-Avarai, Kannada-Chapparadavare and Malayalam-Avara. Two types of *Dolichos* bean are recognized, i.e., *purpureus* var. *typicus*, which is a garden type with soft edible pods having less fibre in their pod walls. The second type is *purpureus* var. *lignosus*, which is a field bean grown for dry seeds generally used as a pulse. Its pods have a characteristic aroma and the pod walls have high fibre content.

Thar Kiran is new high yielding and anthocyanin rich variety (pole type) of Indian bean developed by Central Horticultural Experiment Station (ICAR-CIAH), Godhra, Gujarat. The Silent features of variety Thar Kiran and its cultivation practices are given below

Thar Kiran

It is a high yielding and anthocyanin rich variety of dolichos bean having attractive shining purple colour pods. It is in vigorous in growth having dark green leaves with purple veins. The whole plant

has purple pigmentation in their stem, petiole, flower, leaf veins and pod. The plants have climbing (pole type) growth habit and grow up to 3.5-4.0 m and they require stacking or support for higher yield and better-quality pod production. The pods are medium having an average pod length, pod girth and pod weight of 10.8cm,5.33cm and 8.4g respectively. It is performing well under rainfed semi-arid conditions and showed resistance to dolichos bean yellow mosaic virus disease under field conditions. The variety 'Thar Kiran' has higher nutritional value in terms of antioxidants, proteins, vitamins, micro nutrients and minerals. It is rich source of anthocyanins (190 mg/100g), proteins (5.4g/100g) and other antioxidants like total phenols (376.5 mg GAE/100g), flavonoids (42.6 mg cat.equi/100g), total antioxidants (662.5 mg AAE/100g), β-carotene (5.4

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mg/100g), vitamin-C (89.34mg/100g) and lycopene (1.5mg/100g).

Cultivation practices for variety Thar Kiran

Soil and climate

It is remarkably adaptable to wide areas under diverse climatic conditions such as arid, semiarid, Subtropical and humid regions where temperatures

vary between 22°C–35°C and is fairly tolerant to high temperatures. Low lands and uplands and many types of soils with pH varying from 4.4 to 7.8. Being a legume, it can fix atmospheric nitrogen besides leaving enough crop residues to enrich the soils with organic matter.

Sowing, Seed rate, Spacing and Manure and Fertilizer

The seeds are dibbled or drilled behind the plough. Thar Kiran is climbing/pole type variety hence it needs 5-6 kg/ha of seeds with a spacing of 75 cm X 1-1.5 m is followed for commercial cultivation. About 25t/ha of well decomposed FYM should be applied to the soil at the time of land preparation. Application of NPK 20:60:60 kg/ha is recommended. Half of N along with entire dose of P and K fertilizer should be applied at sowing time. The remaining half dose of N should be top dressed 30 days after sowing.

Intercultural Operations

Timely weeding is required to improve the growth of the crop and to keep the plot free from sucking insects. Weeds may be controlled mechanically or by using weedicides.

Pole type dolichos bean needs support, since the plants have climbing growth habit. The plants should be trained on thin bamboo stakes or small iron poles for better growth and fruit set. Over-crowding of plant vines due to non-staking affects formation of pods and yield adversely. Staking improves plant spread and photosynthetic activity and color development in pods. As a result, there is higher yield due to higher number of pods per plant.

Irrigation

Light irrigation is given when required. For higher yield the crop should be irrigated regularly at 7 -10 days interval. Flowering and pod development period are the critical stages.

Harvesting and Yield

Thar Kiran takes totally 12-15 pickings at 8-10 days interval. Fully grown immature pods are harvested for vegetable purpose. The fresh purple pods are harvested between 100 to 110 days after sowing. A total of 1100-1600 pods per plant with on an average yield of 7-9 kg/plant of fresh purple pods can be harvested under rainfed semi-arid conditions with yield potential of 60-63 t/ha.

Conclusion

Thar Kiran is wrapped with anthocyanins (190 mg/100g), (antioxidants), protein, vitamins, micronutrients and minerals indicating its nutritional importance. It is a high yielding variety and found dolichos bean yellow mosaic virus disease resistant under field conditions. The varieties have greater adoptability, high nutritional value and with minimum agronomical inputs will fetches higher yield under rainfed areas.

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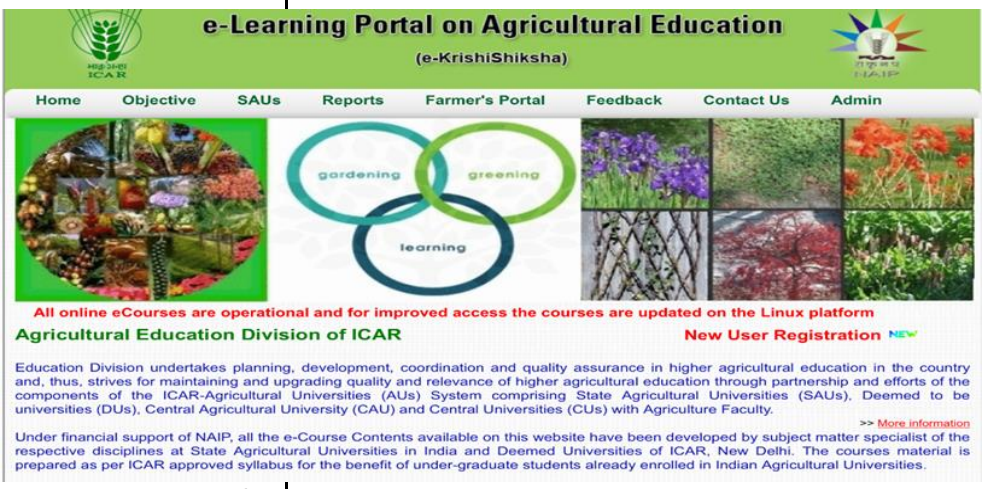
Online Learning in Agriculture: Providing Path to An Agri-Literate India

Sampriti Guha, Debabrata Basu and Swadhin Priyadarsinee

Agriculture not only means growing into a farmer. It is a blended perusal of learning food systems, natural resources, technology usage, marketing and developing organizations both public and private sectors.

Learning agriculture provide us with an opportunity to handle our future food system by ensuring food security and encouraging healthy environment. Up-skilling in agriculture has become necessary for matching pace with progressive technologies. Moreover, agriculture is also a promising career. So interested folks from other sectors are shifting to agriculture. But, gaining access to learning agriculture is scattered. ICT and digitalization have made learning concise. The bewitched people, both from farming as well as non-farming sector can get access to learn agriculture and allied practices of their choice through various online courses from different e-learning platforms. Government organizations, EdTech companies, Universities round the globe, research institutes are developing and delivering e-courses which can help the farming stakeholders, students and inquisitive mankind.

This article discusses about the online courses in agriculture and allied sectors that are easily accessible by the people from different corners of the country; their development, benefits and importance. Here, we have categorized the courses according to organizations offering them.



Source: www.ecourses.icar.gov.in

COURSES FROM GOVERNMENT INSTITUTIONS

e- Courseware on Agricultural Education (e-KrishiShiksha):

The Agricultural Education Division of ICAR with a joint partnership with its component institutes; ICAR-Agricultural Universities, State Agricultural Universities, Deemed-to-be universities, Central Agricultural Universities and Central Universities with

Source: www.ecourses.icar.gov.in

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Agricultural faculty has developed UG level interactive online course contents under NAIP's learning and capacity building programme. This portal allows round the clock access to content for teachers and students. The link to access the website is www.ecourses.icar.gov.in

Fig 1: Organizational Structure Network of e-KrishiShiksha

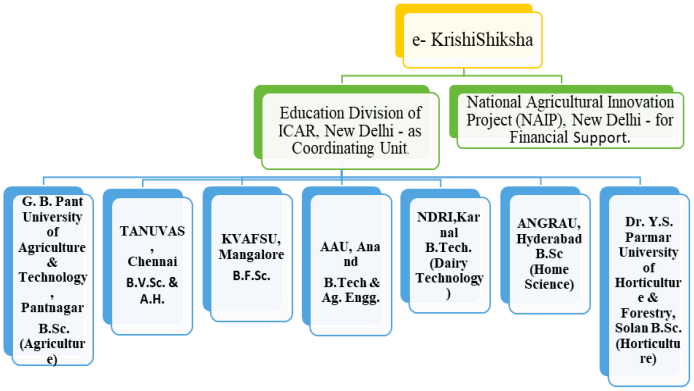

Table 1. Online UG courses offered by Agricultural Education Division of ICAR

S.No	Online e-Courses
1	B.Sc.(Agriculture)
2	B.V.Sc.(Veterinary & AH)
3	B.F.Sc.(Fisheries Science)
4	B.Tech. (Dairy Technology)
5	B.Sc.(Home Science)
6	B.Tech.(Agricultural Engineering)
7	B. Sc. (Horticulture)

Source: www.ecourses.icar.gov.in

Farmers e-World:

The Farmers e-world portal compiles e-resources generated at ICAR and SAUs, connecting farmers with the existing community. Interested person can use the e-learning platform for free. The new user needs to register on the portal, providing basic personal information for establishing Portal usage records. The link to access the portal is: (https://ecourses.icar.gov.in)

Digital Training programmes offered by NDDB (National Dairy Development Board):

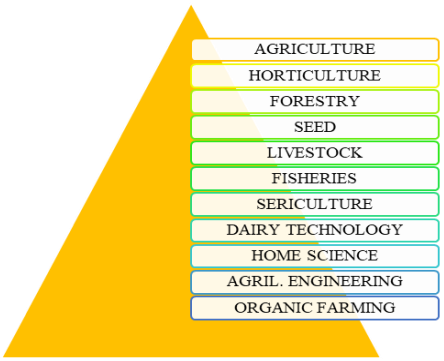

Fig. 2. Disciplines covered by Farmers e- World portal

Source: www.ecourses.icar.gov.in

NDDB has conceived to metamorphose capacity building and knowledge dissemination through digital platform to provide assistance and reach out to stakeholders in Indian dairy sector. The NDDB YouTube channel (www.youtube.com/c/NationalDairyDevelopmentBoard/videos), Dairy Knowledge Portal (www.dairyknowledge.in) and e-learning portal (www.nddb.coop) are to be accessed by users for receiving online content.

Online Course from Directorate of Open and Distance Learning, TNAU

Fig 3. Certificate Courses provided by Directorate of Open and Distance Learning, TNAU.

Source: https://tnau.ac.in/

Digital certificate courses conducted fully in English are offered to interested folks from any sector for a duration of 2 months and course fee of Rs. 3000, by the Directorate of Open and Distance Learning, TNAU, Coimbatore. The link of the portal is https://tnau.ac.in/ .

COURSES OFFERED THROUGH DIFFERENT MOOCS PLATFORM

MOOCs provide a flexible and economical way to osmose a new skill for career advancement and conceive good quality education, where anyone can register to access the e-courses.

agMOOCs

agMOOCs under NPTEL is pivoted towards training and capacity building of students and professionals indulged in different arenas of agricultural education. It is delivered by the Commonwealth of Learning and a Consortium of leading institutes of India; IIT Kanpur, IIM Calcutta and UAS- Raichur. It intends to deliver knowledge on critical topics to agricultural professionals in English and Hindi. Certificates are awarded to learners with good test scores.

Table 2. List of popular agMOOCs courses

Title of the MOOCs	URL of the course
Agricultural Value Chain Management	https://www.agmoocs.in/course/ag243-agricultural-value-chain-management
Fundamentals of ICT for Agriculture	http://hdl.handle.net/11599/2982
Basics of Entrepreneurship	https://www.agmoocs.in/course/ag393a-basics-entrepreneurship-development-agriculture
Fundamentals of Agricultural Extension	https://www.agmoocs.in/course/fage2021sept
GIS in Ag-essentials and Applications	https://www.agmoocs.in/course/gis-ag-essentials-and-applications
Integrated Disease Management	https://www.agmoocs.in/course/ag364b-integrated-disease-management
Integrated Pest Management	https://www.agmoocs.in/course/ipm2020
Weather forecast in Agriculture and Agro-advisory	https://www.agmoocs.in/course/ag212-weather-forecast-agriculture-and-agro-advisory

EdX platform

An American based MOOCs, developed jointly by Harvard University and MIT, hosts numerable online courses in agriculture for free. These courses can be accessed by students worldwide. The courses offered are enlisted below. The link of the website is: www.edx.org

Table 3. List of courses based on Agriculture and allied topics on EdX platform

Course Name	Offered by
Drainage in Agriculture: controlling water and salt levels in the soil	Wageningen University and Research
Feeding a Hungry Planet: Agriculture, Nutrition and Sustainability	SDG Academy
Drones for Agriculture: Prepare and Design Your Drone (UAV) Mission	Wageningen University and Research
Understanding Agribusiness, Value Chains, and Consumers	The University of Adelaide
Sustainable Agribusiness	Doanex
Sustainable Food Systems: A Mediterranean Percept	SDGAcademy
Sustainable Food Security: Crop Production	Wageningen University and Research
Agricultural Economic Modeling Tools	Doanex
Sustainable Agri-food Marketing	Doanex
Sustainable Agribusiness Comprehensive Exam	Doanex
Sustainable Global Food Systems	The University of Edinburgh
Global Food Futures and Agri-food Systems Solutions	Doanex
Innovative Environmental Management Models: Case Studies and Application	UMCES, USMx
e-Learning on Digital Agriculture	Open Learning Campus, The World Bank Group
Animal Breeding and Genetics	Wageningen University and Research

Irrigation Efficiency: more food with less water	KU LEUVEN
Sustainable Business Models: Guidance for Future Farmers	KU LEUVEN

Source: www.edx.org

Coursera

USA based MOOCs founded in 2012 by the Stanford University. It works in collaboration with universities and other organisations to deliver online courses with proper certifications. The link of the platform is: www.coursera.org

Table 4. List of popular courses in agriculture provided by Coursera

Course Topic	Offered by
Agriculture, Economics and Nature	University of Western Australia
Global Post harvest Loss Prevention: Fundamentals, Technologies and Actor	University of Illinois at Urbana-Champaign
Discover Best Practice Farming for a Sustainable 2050	University of Western Australia
Sustainable Agriculture Land Management	University of Florida
Challenges of Agribusiness Management	University of Bocconi
Geographic Information Systems (GIS)	University of California, Davis
Transformation of Global Food System	University of Copenhagen

Source: www.coursera.org

Udemy

A MOOCs platform founded in 2010; headquartered at San Francisco, California, providing professional courses to improve job- oriented skills with valid certifications being accepted world-wide. Some courses related to agriculture available at Udemy are listed below.

Table 5. List of popular courses in agriculture provided by Udemy

Course topic	Offered by
Growing Mushrooms Indoors for Business and Pleasure	Alex Field (Urban Farming Consultant, Entrepreneur)
Introduction to Precision Agriculture	Derek Arbeiter (Instructor, Technical Precision Technologies)
Bio-Organic Farming and Gardening: GROW Your Own FOOD	im Simpl (Environmental Engineer/ Organic Farmer/ Builder/ Designer)
Modern Farming Techniques	Dionisio Gonzalez (Project Engineer)
Agriculture Business Technology	Eric Yeboah (MBA/ Chief Executive Officer)
Aquaponic Farming. Design your own Aquaponics System	Dr. Gowhar Ali
Farming Business Finances	Eric Yeboah (MBA/ Chief Executive Officer)

SWAYAM (Study Webs of Active-Learning for Young Aspiring Minds)

This Indian MOOCs launched by MHRD, GOI and AICTE under Digital India, in 2017 providing a coordinated platform to web courses for free, covering advance education and skill enhancement in agriculture.

Table 6. List of popular courses in agriculture provided by SWAYAM portal

Course Name	Course Level	Course Duration
Indian Agricultural Development (MNR 001)	PG	15 weeks
Entrepreneurship Development	UG	12 weeks
Research Methodology	PG	12 weeks

Source: SWAYAM portal

Online courses from global universities

The digital courses from global universities awarding diploma and certifications in various domains of agriculture are mentioned below:

Table 7. List of popular courses in agriculture provided by global universities

Course Name	Offered By	Accredited By	Course Type
Agriculture Systems Management Technical Diploma	Madison Area Technical College	Higher Learning Commission	Diploma
Organic Agriculture	Washington State University	Northwest Commission on Colleges and Universities	Certificate
Professional Development in Urban Agriculture	University of Illinois at Urbana-Champaign	Higher Learning Commission	Certificate
Agricultural Technician Certificate	Lakeshore Technical College	Higher Learning Commission	Certificate

Source: onlineschoolcenter.com

Benefits of Online Learning

More Fun: Designing a course to make it fun and interactive by using multimedia or newly developed gamification methods, increases the lifetime and engrossment factor of courseware.

No restriction: Time and locational constraints are the significant threats faced by learners and teachers in learning. Online learning is flexible for everyone ready to attend a course.

Fairly priced: While books frequently become obsolete after certain time, online courses do not require the accession of new editions on a regular basis.

Befitting into context: Internet is a necessity now, as the learning organisations employ technologies enhancing efficiency. Transnational organisations face difficulty in working with people from other countries. Online learning tackles all challenges in training all such parties together.

Drawbacks of Online Learning

Sense of isolation: Despite the convenience, flexibility and opportunity of attending classes from anywhere at any time, learners may feel isolated. The course developers and coordinators should integrate with students by using video conferencing platforms and discussion forums.

Health related issues: Learners faces eye problems and physical issues due to more screen time. Therefore, it is important to deliver instructions on proper sitting posture and resting patterns.

Technical issues: The online lessons are mostly disrupted due to lack of good quality internet connection and access to advance smart gadgets all over the globe.

Training programmes for instructors: Lack of expertise of teachers in handling online courses disrupts learning. Hence they must be trained properly to tackle the technical issues, lecture capture software and LMS.

Conclusion

The 21st century Agriculture is mainly concerned with food security and sustainability due to the climatic changes and natural disasters. The changes in the natural resources and the mistakes of 20th century agriculture have made mankind to focus

on attaining sustainability. Technological advancement has even cropped into this sector. The use of Artificial Intelligence (AI) to combat nature's unpredictability is gaining popularity in agriculture.

The urge to up-skilling the agricultural practices is at hype with rapid development of agricultural sector. Both farming and non-farming communities are keenly interested in gaining knowledge about various aspects of agriculture. With the aura of digitalisation of education, e-learning approach is getting popular in agriculture. The Governmental organisations, Ed-Tech companies and MOOCs platforms deliver several online courses in agriculture and allied sectors, enabling learners to access from anywhere, anytime. The crucial time of COVID-19 has shown the importance of online learning. Despite the limitations, the benefits outweigh the pitfalls. These e-courses reaching interested pupils globally, blended with traditional education is committed to bring a smarter learning approach to agriculture.

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Success Story: Application of Waste Decomposer for Paddy Straw Management

J Vijay

Name: Rupireddy Laxmi w/o Thirupathi reddy
Age: 43
Education: 5th Class
Land holding: 14 acres
Address: Village - Kondapalkala
Taluk - Manukondur
District - Karimnagar
State - Telangana

India is an agriculturally based country. Farmers are the back bones of our nation. In early days farmers were using locally available natural materials like after harvest trashes, weeds, cow dung etc. as manure. Later on they started using chemical fertilizers in view of fast growth and good yield. Though they got good results in early days, after 10-15 years of continuous use agricultural land becomes barren, crops become less resistant to environmental conditions. To dispose the agriculture waste, they started burning it and digest anaerobically in the land itself, which leads to soil and environment pollution.

Problem identified

In Karimnagar district every year in late October and November, most of the farmers have been using burning method to dispose paddy straw after harvesting of paddy crop in their fields as a low-cost straw-disposal practice to reduce the turnaround time between harvesting and sowing for the second (winter) crop.

This situation leads to

- ✓ Release of soot particles and smoke causing human health problems such as asthma or other respiratory problems
- ✓ Emission of greenhouse gases such as carbon dioxide, methane, and nitrous oxide (N_2O) causing global warming
- ✓ Loss of plant nutrients such as N, P, K, and S
- ✓ When the straw is burned on the ground, the soil loses nutrients and becomes less fertile. It generates heat that penetrates the soil, increasing erosion and resulting in the loss of moisture and beneficial microbes.

Almost entire amounts of C and N, 25% of P, 50% of S, and 20% of K present in straw are lost due to burning. The gaseous emissions from the burning of rice straw were 70% CO2, 7% CO, 0.7% CH4,

and 2.1% N2O. Therefore, the burning of crop residues should be avoided, and alternate measures of disposal of residues should be found out.

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Farmer intervention

The waste decomposer developed by National Centre of Organic Farming (NCOF) helps in avoiding the burning of paddy straw, as it makes enzymes that break down paddy straw's cellulose, lignin and pectin. It is a low-cost and efficient method for managing crop residue and other agricultural waste as it can be decomposed in the process without causing any pollution. In general, normal composting takes about 60 days but decomposer converts the paddy straw into compost in just 15-25 days.

Key Features of the Technology (Process)

After harvesting the paddy crop, the left-over paddy straw will be collected and piled nearly maintaining thickness from 18-20 cm at the corner of the field. Then wet the straw with the solution of waste decomposer and again pile the paddy straw (by maintaining thickness 18-20 cm) on top of the already prepared bed. Again, wet the layer with the solution of waste decomposer. And on the same way, repeat the process till the piling goes up to 30-45 cm. While decomposing the straw, maintain adequate moisture levels during entire period for proper composting. The compost will be ready to use as manure after 30-40 days. The process is basically simple and reliable.

Outcome

Rice residue management through incorporation of rice straw is associated with certain problems such as immobilization of plant nutrients particularly Nitrogen, residues impede seed bed preparation and contribute to reduced germination of subsequent crops.

So, composting arises a safe opinion which results in reusability of the nutrients contained in the residue. Production of compost from straw is a alternative to burning and direct incorporation in soil. By composting paddy straw, can avoid air pollution, enhances soil organic matter content.

Economic benefits of the crop

Generally, most of the farmers follows conventional method paddy cultivation (raising nursery and transplantation). But here Smt. R. Lakshmi adopted & implemented broadcasting method in her field i.e., of paddy seed for 24 hrs in water & soaked paddy grains were broadcasted in her puddled field. Due to

Table 1: Soil organic carbon and other characteristics before and after treatments

Soil Health card no	pH	EC	Organic Carbon	Nitrogen (kg/ha)	Phosphorous (kg/ha)	Potassium (kg/ha)
Initial (05/05/2020) KVK/STL/21-48	**6.92**	0.67	**0.26**	189.12	30.74	298.82
Present (02/06/2023) KVK/STL/23-271	**7.31**	0.43	**0.39**	198.4	55.1	323.21

this she is able to save the time and labour when compared with conventional method.

With this practice, the total cost of cultivation is Rs 22,750/- per acre under normal method of rice transplantation against Rs 18,950/- per acre with the practice of Broadcasting method of rice cultivation. Even though the yields are less, an amount of 3800/- per acre was saved and in comparison, to the existing method, this technique saves labour and time to a great extent. She started this compost preparation technique from Kharif -2021, during these two seasons (kharif,2022 and kharif, 2023) the minor changes were observed in soil characteristics. The application of compost to soil caused a slight increase in soil pH, OC and decrease in EC which is ideal for crop growth.

Table 2: Economics of paddy cultivation

Sl. No.	Name of the parameter	Normal Rice Transplantation	Broadcasting method
1	Seed Rate (Kg/ac)	20-25 Kg/ac	10 Kg/ac
2	Seed Cost (Rs/Ac)	900/-	400/-
3	Land preparation cost (Rs/ac)	6000/-	6000/-
4	Transplanting cost (Rs/ac)	5500/-	1000/-
5	Herbicide cost (Rs/ac)	450/-	1650/-
6	Manual weeding (Rs/ac)	1800/-	1800/-
7	Fertilizer cost (Rs/ac)	2100/-	2100/-
8	Pesticide Cost (Rs/ac)	1800/-	1800/-
9	Labour cost for fertilizer & pesticide application (Rs/ac)	1000/-	1000/-
10	Cost of Harvesting (Rs/ac)	2200/-	2200/-
11	Cost of Transport & others	1000/-	1000/-
12	**Cost of Cultivation**	**22,750/-**	**18,950/-**
13	**Yield (Qt/ac)**	**26.40**	**24.65**
14	Market Rate (Rs/qt)	2040/-	2040/-
15	Gross Income (Rs)	53,856/-	50,286/-
16	**Net Income (Rs)**	31,106/-	31,336/-
17	**C:B Ratio**	**1:2.37**	**1:2.65**

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Value Addition of Flowers

G. Jyothi and D. Saritha

Due to change in lifestyle the demand for flowers is increasing day by day especially in urban areas. During the peak season may be festivals, religious ceremonies, valentine day, marriages etc., there is a great demand of flowers and farmer get a good price, but in case of glut or off season the demand is less and supply is more, farmers do not get remunerative price. Due to highly perishable nature, most of these flowers are being wasted, therefore, value addition is a very good alternative to avoid wastage and utilize glut. Value addition means increasing the value of a raw product anytime between harvesting and sale of the final product through changes by processing. Any product can be considered value added if it is grown by farmer and increased in value by labour and creativity. The consumers are willing to pay more for the value-added products compared to raw ones.

Value addition includes preparation of products from fresh flowers like cut flower arrangements, bouquets, garlands, corasage, wreaths, buttonholes, floral jewellery; petal embedded handmade paper, dried flower arrangements like wreaths and wall swatches, painted gourds, sachets, pot pourris; products made up of press dried flowers like greeting cards, wall hangings, sceneries, table tops, book marks, paper weights etc. Value addition also offers an opportunity of making processed flowers products like jam, jelly, beverages, rose water, gulkand, gulroban, floral dyes, floral tea (rose, chrysanthemum, jasmine, hibiscus) etc. Besides this a number of products like essential oil, perfumes, insect repellants, cosmetics, pigments like xanthophylls, carotenoids, luteins, anthocyanins, etc. which have neutraceutical properties and pharmaceutical compounds can be prepared from the flowers. For successful value-addition it is recommended that carefully identify goods that utilize local resources and fulfill the gap in the market. Adding value adds to the cost of production, but careful planning and test marketing can significantly increase the net return of a small-scale floriculture enterprise. Value-addition ensures high premium to the grower, while providing more acceptable quality products for the domestic

and export market, and encourage the customers to buy such products.

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There are three main reasons for value addition:

- Utilization of excess produce and elimination of waste
- Stabilizing farm income by adding profits
- Affording an outlet for creativity

There are different modes of value addition Fresh Flower Products: It includes two types of flower arrangements; firstly, cut flower arrangements like bouquets, baskets, bunch, buttonaire, corsage etc.; secondly loose flower products like garland, floral strings, pomanders, wreaths, floral jewellery etc. Recently, the floral jewellery concept has become very popular among brides especially in metropolitan cities on mehandi event of marriage, as the floral jewellery will be matching to dress and light in weight, convenient to use and there are no chances of jewellery theft. Since the fresh flower have limited shelf life so these can be enjoyed from 2- 15 days depending upon the prevailing climatic conditions and species used.

Dry Flower products: Dried flowers have been exported for the last 40 years USA and Asian countries. The dry flower export from India has a share of around 70 percent of total export; therefore, there is a great scope of drying the flowers grown in local area and to convert them into everlasting value-added products like dry flower arrangements, baskets, bouquets, table arrangements etc. Among different dry flower products out pot pourri is a major dry flower export item. Besides this there are press dried flower products including greeting cards, bookmarks, swaths, paper weights, wall hangings, table tops, table mats, etc. Most of these dry flower products have a shelf life of 6- 9 months therefore, consumer can enjoy these flower products for comparatively longer time and utilize maximum benefit of the money spent.

Processed products: Processed products include essential oils, absolutes, concrete, petal jam (rose, rhododendron), jelly, ready to serve beverages, wine, floral tea, rose hip juice, poultry feed, insect repellent, floral dyes, petal embedded handmade paper, cosmetics like calendula cream, rose water, rose cream etc.

Pharmaceutical and nutraceutical compounds: Due to globalization international competition is increasing, people are becoming more conscious, therefore use of natural ingredients is increasing in food and pharmaceutical industry. Therefore, the flowers pigments like carotenoid, xanthophyll, anthocyanin etc. are being used in food industry and compounds like lutein, vincristine, catharanthine, vitamin C extracted from rose hips are being used in pharmaceutical industry. Carotenoids are the major source of pigment for poultry feed. The pigment is used in feed for intensification of yellow colour of egg yolk and broiler skin and increase the lutein content which is good for health. There is a tremendous scope of converting the flowers into different value-added products depending upon the need, desire and condition of the flowers. Moreover, the fresh and dried flower products can be used even for interior

decoration. By making use of value addition technology, wastage can be avoided during the glut period and farmers involved in the flower cultivation can earn better remuneration. n Value-addition ensures high premium to the grower, while providing more acceptable quality products for the domestic and export market. There are three main reasons for value addition: utilization of excess produce and elimination of waste; stabilizing farm income by adding profits; and finally affording an outlet for creativity Value Addition and still dried flower industry is rapidly expanding; and adds enriched value to the flourishing industry. India is one of the leading countries in the dry flower exports and major export destinations of Indian floriculture products are Europe.

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WORLD MILK DAY 2023

Hemanth Gowda K., Jagadeeswary V. and Devaraja Naik H

Day	World Milk Day
Observed	June 1 (every year)
Established in	2001
Established by	FAO, United Nations
World Milk Day 2023 Theme	"Enjoy Dairy"
Focus	Showcasing how dairy is reducing its environmental footprint, while also providing nutritious foods and livelihoods

As an important global event, World Milk Day is observed on June 1st each year to raise awareness about the benefits of milk as a nutritious food source. World Milk Day aims to raise awareness about the nutritional value of milk, support dairy farmers, and encourage individuals to make informed choices for a healthy and balanced diet. India plans to produce about 300 million tonnes of milk by 2024. Such growth has positioned India as a global leader in milk production. This upward trend has also been supported by the increasing per capita milk consumption in the country, which rose from 107 grams per person in 1970 to 427 grams per person in 2020-21.

Table 1: Proximate Composition of Milk

Component	Average Content percentage (w/w)	Range Percentage (w/w)	Average % of Dry matter
Water	87.3	85.5 -88.7	
Solids not fat	8.8	7.9-10.0	69
Lactose	4.6	3.8-5.3	36
Fat	3.9	2.4-5.5	31
Protein	3.25	2.3-4.4	26
Casein	2.6	1.7-3.5	20
Mineral substances	0.65	0.53-0.80	5.1
Organic acids	0.18	--	1.4
Miscellaneous	0.14	--	1.1

(Source: Dairy Chemistry and Physics, Walstra and Jenness, 1984)

TOP 5 MILK PRODCUING STATES IN INDIA (2022)

Rajasthan 15.05 %

Uttar Pradesh 14.93 %

Madhya Pradesh 9.60 %

Gujarat 7.56 %

Andhra Pradesh 6.97 %

All other states 53.11 %

History of World Milk Day

World Milk Day was established in 2001 by the Food and Agriculture Organisation (FAO) of the United Nations to acknowledge the vital role of milk in our diets and to celebrate the dairy sector as a whole. Since then, it has become an annual celebration recognized by millions of people worldwide.

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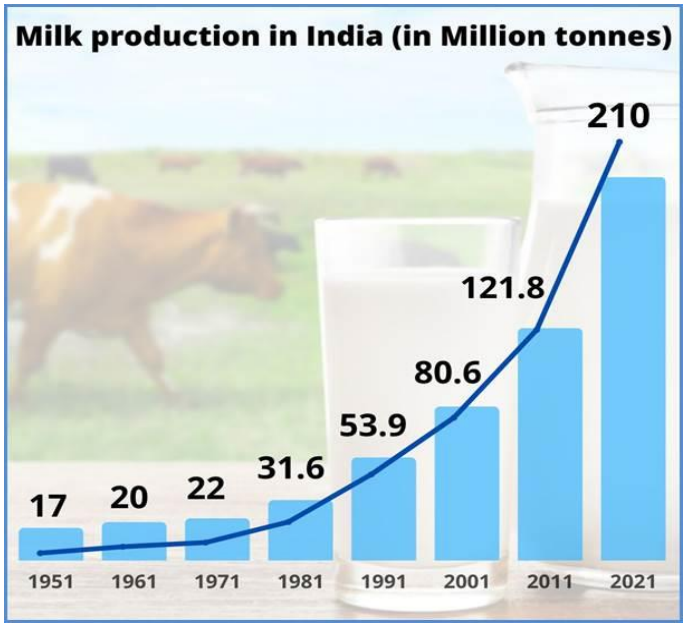
World Milk Day 2023

The theme for the year 2023 is focused on various aspects of the dairy sector. The themes aim to highlight the efforts made by the dairy industry to reduce its environmental impact, provide nutritious



foods, and support livelihoods. Additionally, the celebration emphasizes the integration of the environmental, nutritional, and societal impacts of the sector. The specific focus areas of the 2023 World Milk Day include:

Reducing Environmental Footprint

The dairy industry aims to showcase how it is actively working towards reducing its environmental impact. This may involve implementing sustainable practices and initiatives that promote conservation and minimize resource consumption. The focus on reducing carbon footprints emphasizes the importance of mitigating greenhouse gas emissions associated with dairy production. Efforts are being made to implement innovative technologies, such as methane capture systems and energy-efficient processes, to minimize the environmental impact of dairy farms. By adopting sustainable practices, the dairy sector can contribute to the global fight against climate change.

Providing Nutritious Foods

World Milk Day emphasizes the nutritional value of milk and dairy products. The focus is on promoting the consumption of dairy as part of a healthy diet, highlighting the essential nutrients, vitamins, and minerals that milk provides for overall well-being. Dairy products, such as milk, cheese, and yogurt, are excellent sources of calcium, protein, vitamins, and minerals essential for healthy development and well-being. Recognizing the nutritional value of dairy promotes the consumption of these products as part of a balanced diet.

Livelihoods and Economic Development

The celebration acknowledges the contribution of the dairy sector to economic development and livelihoods. It recognizes the role of dairy farmers and their responsibility towards their communities, land, and animals. It aims to raise awareness about the socio-economic significance of the dairy industry. The day emphasizes the responsibility of farmers toward their communities and the land they cultivate. Dairy farming is not only

a source of income for many families but also a means of sustenance for local economies. By practicing sustainable agriculture, farmers can ensure the long-

term viability of their livelihoods while preserving the surrounding environment and benefiting the communities they serve.

Celebrating World Milk Day

The day is marked by various events, campaigns, and initiatives organized by governments, non-profit organizations, dairy associations, and individuals. These activities aim to educate the public about the nutritional value of milk, sustainable dairy practices, and the role of dairy farming in local economies.

Promoting Milk Consumption

One of the key objectives of World Milk Day is to promote the consumption of milk and dairy products. This is achieved through campaigns that highlight the benefits of incorporating dairy into daily diets, especially for children, adolescents, and pregnant women. By increasing awareness about the nutritional advantages of milk, World Milk Day encourages individuals to make informed dietary choices.

Engaging the Community

World Milk Day celebrations provide an opportunity to engage communities in various activities related to dairy farming and milk production. These activities may include farm visits, educational programs, workshops, cooking demonstrations, and competitions. Such initiatives aim to bridge the gap between consumers and dairy producers, fostering a better understanding of the processes involved in bringing milk from the farm to the table.

Supporting Local Dairy Industry

World Milk Day serves as a platform to support and recognize the efforts of dairy farmers, processors, and all those involved in the dairy industry. It highlights the importance of their work in ensuring a steady supply of safe and high-quality dairy products. By promoting local dairy industries, World Milk Day contributes to the economic growth and development of farming communities worldwide.

Nutritional Value of Milk

Milk is a nutrient-dense beverage that contains a wide range of essential nutrients necessary for maintaining good health. It is an excellent source of high-quality protein, which plays a vital role in building and repairing tissues in the body. Additionally, milk is rich in calcium, phosphorus, and vitamin D, all of which are essential for strong bones and teeth.

- Strengthen Bones and Teeth - Milk is a rich source of calcium, which is crucial for building and maintaining strong bones and teeth. It also contains vitamin D, which aids in calcium absorption. Regular consumption of milk and milk products can help prevent conditions like osteoporosis and reduce the risk of fractures, especially in older adults.

- Promote Muscle Growth and Repair - Milk contains high-quality proteins, including casein and whey protein, which are easily digestible and provide essential amino acids needed for muscle development and recovery. Including milk as part of a balanced diet can be particularly beneficial for individuals engaged in regular physical activity or those looking to build lean muscle mass.

- Support Weight Management - Contrary to popular belief, milk can be a part of a healthy diet for weight management. The protein and fat content in milk provide a feeling of fullness, helping to curb appetite and reduce overall calorie intake. Additionally, studies have shown

that a diet rich in dairy products, including milk, may aid in weight loss, especially in combination with a reduced-calorie diet and exercise.

- Boost Cardiovascular Health - Regular consumption of milk and milk products may have a positive impact on cardiovascular health. Lower blood pressure in adults and reduce the risk of cardiovascular diseases. The presence of bioactive compounds like peptides, calcium, potassium, and magnesium in milk contributes to its potential cardiovascular benefits.

- Reduce the Risk of Type 2 Diabetes - Incorporating milk into your diet may also have a protective effect against type 2 diabetes. Research suggests that individuals who consume higher amounts of dairy products, such as milk and yogurt, have a lower risk of developing type 2 diabetes. The exact mechanisms behind this relationship are still being studied, but it is believed that the bioactive components found in milk, such as peptides and minerals, may play a role in improving insulin sensitivity and glucose regulation.

- Enhance Hydration - Staying hydrated is essential for overall health, and milk can contribute to your daily fluid intake. While water is the primary source of hydration, milk can be a tasty and nutritious alternative. It contains high water content and provides electrolytes like potassium, which is important for maintaining proper fluid balance in the body.

- Provide Essential Vitamins and Minerals - Milk is a rich source of essential vitamins and minerals needed for optimal health. Along with calcium and vitamin D, milk contains vitamins A, B2, B12, and minerals like phosphorus, potassium, and magnesium. These nutrients play various roles in supporting immune function, energy metabolism, vision, and overall well-being.

- Support Brain Function and Development - The nutrients found in milk, particularly vitamin B12 and iodine, are crucial for brain function and development. Vitamin B12 is involved in the production of neurotransmitters, which are essential for proper cognitive function. Iodine is necessary for the synthesis of thyroid hormones, which play a vital role in brain development, especially during pregnancy and early childhood.

- Aids Digestive Health - Consuming milk and milk products can be beneficial for digestive health. Milk contains lactose, a natural sugar present in dairy, which is broken down by the enzyme lactase. Individuals who are lactose intolerant may experience digestive discomfort due to insufficient lactase production. However, lactose-free milk and lactase supplements are available to provide the benefits of milk without the discomfort.

- Alleviate Symptoms of PMS - For women experiencing premenstrual syndrome (PMS), incorporating milk into their diet may help alleviate symptoms. The calcium and vitamin D in milk have been shown to reduce mood swings, bloating, and other discomforts associated with PMS. Including milk as part of a balanced diet during the menstrual cycle may offer relief for some women.

- Boost Skin Health - The nutrients found in milk can contribute to healthy skin. Milk contains vitamins A and D, which are known to have positive effects on skin health. Vitamin A promotes skin cell growth and repair, while

vitamin D supports skin barrier function and helps prevent skin conditions like dryness and eczema. Including milk as part of a well-rounded diet can help nourish your skin from within.

- Helps in Post-Workout Recovery - After a strenuous workout, your body needs nutrients to recover and repair muscles. Milk, particularly chocolate milk, has gained popularity as a post-workout beverage due to its ideal combination of carbohydrates and protein. The carbohydrates replenish glycogen stores, while the protein aids in muscle repair and growth. Drinking milk after exercise can help enhance recovery and promote muscle adaptation. In comprehensive, World Milk Day 2023 celebrates the significance of milk as a global food source and highlights the dairy sector's commitment to sustainable practices. The chosen theme focuses on reducing carbon footprints, providing nutritious foods, and emphasizing farmers' responsibility towards their communities, land, and animals. By raising awareness, promoting milk consumption, and engaging communities, World Milk Day plays a vital role in educating the public about the nutritional benefits of milk and supporting sustainable dairy practices worldwide.

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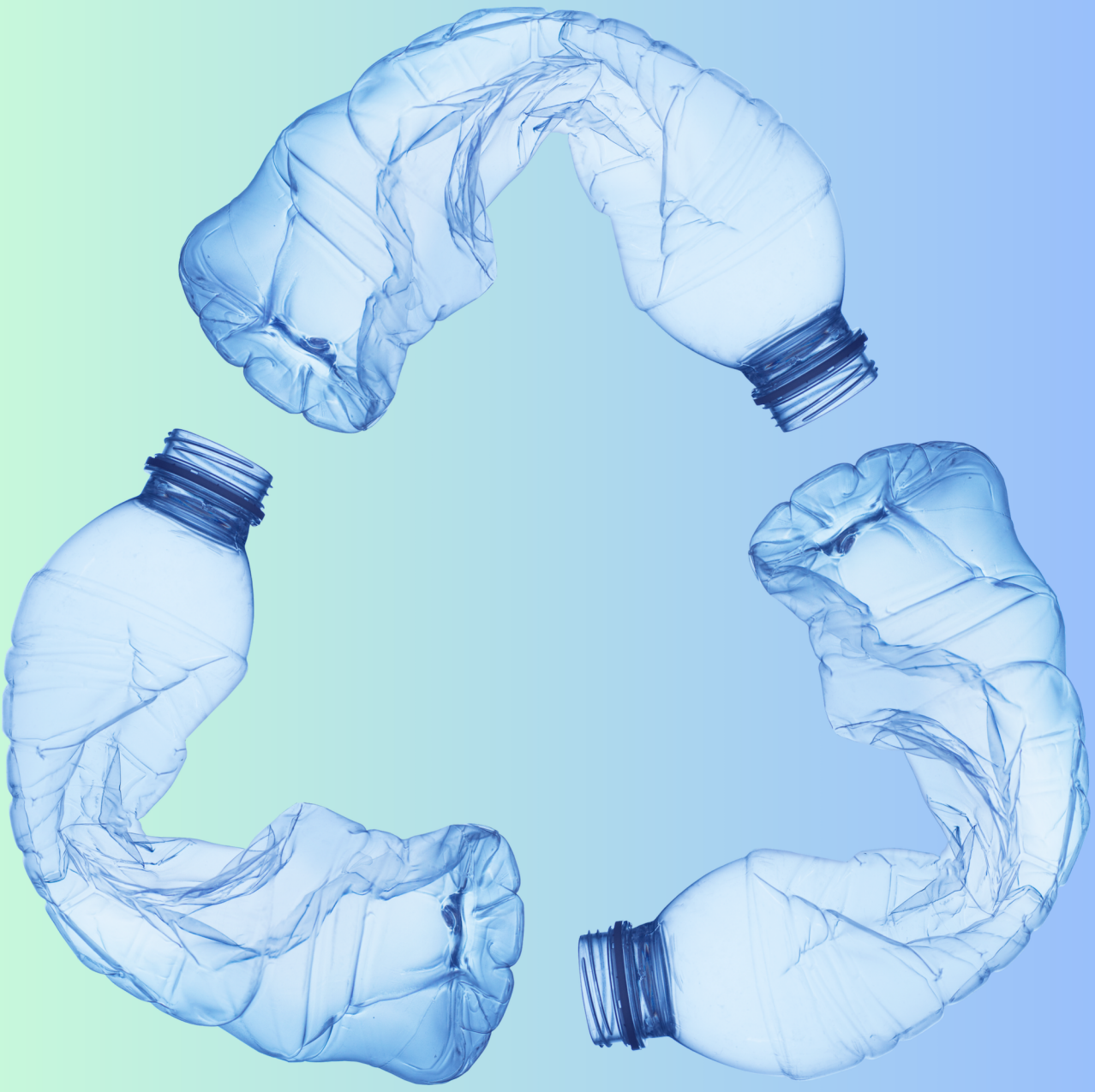

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