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"Transforming agriculture in Bundelkhand through rainbow revolution....."

"Integration of modern technologies in natural and organic farming"

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Contents

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From Vice Chancellor's Desk.....

Modern farming is characterised and aided by continuous improvements in digital tools as well as collaborations among farmers and researchers across all sectors. Let us remember the Green Revolution of the 1960s, when India achieved self-sufficiency in food grain production by using modern methods of agriculture, quality seeds, irrigationmethods, chemical fertilisers and pesticides. However the achievements in the field of self sufficiency in food productios were at the expense of ecology and environment and to the detriment of the well-being of the people. The agriculture system adopted from the west has started showing increasing unsustainability and once again the need for an appropriate method suitable to our requirements is being felt.

The necessity of having an alternative agriculture method which can function in a friendly eco-system while sustaining and increasing the crop productivity is realized now. The best known alternative to the conventional agriculture is Organic farming and natural farming. Over the years several technological advances have lent a helping hand to agriculture and farmers. It is now possible for farmers to utilise digital technology, data science and artificial Intelligence enabled farming methods, upgraded tools and well- researched technology to improve crop yield.

Organic farming has become the new ideology. Organic and natural farming are natives of India and both denote a holistic system where farming is optimised to increase productivity in a sustainable manner. There is a need to enable a smooth integration of technologies with modern farming. The organic farming practices are said to the best known alternative over the conventional methods, which suffered from the ill effects of chemical agriculture. However, principles underlying organic farming are based on our traditional agriculture. Organic agriculture aims at the human welfare without any harm to the environment which is the foundation of human life itself. New technologies will have to be developed specifically for agriculture, while existing technologies developed in other areas have to be modified to suit the agricultural scenario. To achieve precision farming, technological advances have to be integrated at all points.

Natural farming is a system where the laws of nature are applied to agricultural practices. This method works along with the natural biodiversity of each farmed area, encouraging the complexity of living organisms, both plants, and animals that shape each particular ecosystem to thrive along with food plants. Both natural and organic farming systems discourage farmers from using any chemical fertilizers, pesticides on plants and in all agricultural practices.Both farming methods encourage farmers to use local breeds of seeds, and native varieties of vegetables, grains, pulses and other crops. In natural farming there no plowing, no tilting of soil and no fertilizers, and no weeding is done just the way it would be in natural ecosystems. Organic farming is still expensive due to the requirement of bulk manures, and it has an ecological impact on surrounding environments; whereas, natural agriculture is an extremely low-cost farming method, completely molding with local biodiversity.

The present issue of Agri- Life, entitled, "Integrated technologies for natural and organic farming" is an endeavour to invite scientists and researchers to showcase their works dealing with natural and organic farming with a technological approach. I hope this issue of Agri-Life would answer some of the critical questions about natural and organic farming and will open new vistas for research with many key researchable questions that need to be systematically investigated to understand the causality, sustainability, and long-term impact of natural and organic farming.

(Arvind Kumar)
ViceChancellor

Editorial

Agriculture is the main source of livelihood for 67% of India's population and 55% of its labour force. The Indian economy is largely driven by agriculture, which provides 30% of total income to the fastest-growing population in the world. Indian rural communities have been practicing organic farming for millennia as an ancient indigenous practice. Increasing population and arrival of modern technologies have led to a preference for conventional farming, which utilizes synthetic fertilizers, pesticides, and genetic modification techniques. Organic produce is more popular even in developing countries like India because people are more aware now about food safety and quality. The organic process also improves soil health because no chemical pesticides are used. India is currently the largest organic producer in the world and ranks eighth with 1.78 million ha of organic agriculture land.

Traditional Indian farmers are well versed in soil fertility maintenance and pest management, values that are effective for strengthening organic production in India and enhancing economic growth. They possess a vast collection of knowledge, extensive observation, perseverance, and special practices.

Agriculture's main objectives are to achieve food sufficiency as well as to conserve the environment. This task has been hampered by limited land and water resources, as well as the harmful effects of excessive use of chemicals in agriculture for nutrition and pest management. The negative effects of anthropogenic activities for development have been causing environmental degradation and has accelerated due to climate change.

In recent years, global efforts have been undertaken to reduce the impacts of climate change on earth in general and agriculture in particular. In addition to these steps, innovation in agricultural production techniques and scientific application of indigenous knowledge, proven to be more sustainable, should also be undertaken. Organic farming is gaining popularity among people lately, whether they are concerned with health and environmental issues, or seeking out new culinary experiences. It offers both environmental and food diversity benefits to switch to organic farming. In addition to having a higher nutritional value than a crop grown with chemical additives, organic farming offers another significant benefit: food grown organically is much healthier for long term perspectives.

It is possible to implement the different methods of agriculture elaborated above easily and on a global scale. Due to expanding urbanization and the increasing per capita income of developing nations, technologies for organic farming, has great potential considering the declining land resources for agriculture. It is a novel concept for the developing nation, but it offers great promise and can efficiently meet the challenge of providing quantity, quality, and variety of goods. The concept of organic farming is well known, but it requires further exploration and integration of scientific knowledge for it to be integrated into mainstream agriculture to feed the growing population.

Despite their differences in principles, both methodologies are promising avenues for global agriculture, however further research in both areas is necessary to integrate them into mainstream agriculture for a healthier environment and well-fed world.

Agricultural innovations are being driven by changing demographic trends and technological advancements. To meet the growing demands of modern agriculture, these emerging technologies need to be used judiciously. In order to meet the changing demands and needs of mankind, vertical farming and organic farming are viable alternatives. Researchers and farmers must also work together to establish links to address the constraints to adoption of these practices.

Organic farms can be helped by new technologies, whether explicitly green or not, by increasing crop yields, reducing the time required to grow, and making organic produce more affordable. In the end, organic farming has the greatest environmental impact when practiced widely. Environmental science makes it possible for organic farmers to connect with cutting-edge technology, and it's one reason why so many are hooked up with green technology.

We may discover new ways for green tech to support sustainable growth, such as extending organic farming to new places, as we continue to learn about the environment and proper agricultural management. I am very pleased that this sixth issue of Agrilife- with theme "Integration of Modern Technologies in Natural and Organic Farming" will present an overview to the readers about the technological up-gradation in the field of organic and natural farming.

(Anil Kumar)
Editor in Chief

Table of contents

Organic farming: Status, issues and looking ahead

Artika Singh, S. K. Chaturvedi and Anil Kumar Rai

The growing concern about the health and growing demand of chemical free food stuff such as vegetables, fruits, cereals, pulses, oilseeds etc. the ancient concept of producing food organically becoming popular worldwide including India. The cultivation of crops and vegetables without application of chemical fertilizers and other agro-chemical is gaining importance day by day. There are many bio-pesticides and botanicals are known for management of insect pests and diseases. The Government of India has also announced a number of policy supports to promote organic farming and established mechanisms to create required market linkages. The organic products are getting premium price therefore will help in increasing farmers' income as well. In present article, an attempt has been made to discuss current status, issues and perspectives besides enabling policies for the promotion of organic farming to provide chemical free food. Government of India is committed to promote organic farming in big way. Prime Minister Narendra Modi also said *"The Government is constantly trying to provide new solutions and new options in farming. Promoting organic farming is also one of such efforts. Organic farming delivers more profit and is now being practiced across the nation by young farmers."*

Introduction

Indian farmers grow a variety of crops under varying agro-ecological conditions in different seasons. The country has achieved self sufficiency in cereals which is now termed as '*Green Revolution*' during late sixties with the use of quality seeds of dwarf varieties of wheat and rice supported with use of high amount of chemical fertilizers and water etc. Later, development of hybrids in case of maize, sorghum and pearlmillet paved the way for further increase in production of food grains. The ever highest production of food grains (316.66 million tonnes) could be achieved during 2021-22 with the use of quality seeds of high yielding varieties insulated against major biotic and abiotic stresses well supported with good agronomic practices and integrated crop protection technologies. More recently during 2017-18 India attained self sufficiency in indigenous production of pulses and country witnessed '*Pulses Revolution*' and achieved ever highest production of pulses (26.96 million tonnes) during 2021-22 (https://eands.dacnet.nic.in/Advance_Estimate/Time%20Series%202%20AE%202021-22%20 (English).pdf).

However, extensive use of fertilizers, pesticides, agricultural machinery and irrigation high input agriculture impacted negatively on environment causing ecological and economic imbalance. This includes declining soil fertility and food diversity, increase in farmers' debt, dependence on agro-chemicals, and pest resistance. In addition, chemical-intensive agriculture adversely affects the health of humans and animals. The reduced total factor productivity has been widely spread in areas like Punjab, Haryana and western Uttar Pradesh from where we realized 'Green Revolution'.

Food quality and safety are two important issues those are attracting attention of the common people worldwide.With the growing environmental concerns and awareness about the use of food hazards like dioxins, bovine spongiform encephalopathy, and bacterial contamination have substantially decreased the consumer's trust towards food quality during last few years. High input agriculture is also adding to contamination in food chain. Therefore, there is increasing demand for safer and better quality everywhere including urban, peri-urban and rural areas. Organically grown food and food products are believed to meet such demands. In recent years, organic farming as a crop production process is gaining popularity among cultivators as they are getting higher return from per unit of production. Many people those are health and environment cautious are adopting 'Go Green' lifestyle.

Organic farming means

Organic farming (OF) is a set of farming practices where environmental friendly methods of managing weed, pest, and diseases are adopted. The principles and practices of have been explained in details in the standards of International Federation of Organic Agriculture Movements (IFOAM) based on the principle of health, ecology, fairness, and care. The organic movement began after 1920, as a reaction by individual agricultural scientists, activists and farmers against intensive or industrialized agriculture. Three important movements' viz., biodynamic, organic and biological agriculture received attention within first half of the twentieth century. IFOAM adopted basic standards for OF and processing in 1998 after a number of

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Table 1. Historical aspects of organic farming

Initiated research on traditional and conventional farming practices for the purpose of comparison	Albert Howard (1905-1924)
Biodynamic Agriculture	Rudolf Steiner (1924)
Natural Farming	Masanobu Fukuoka (1938)
Organic farming term	Lord Northbourne (1940)
Haughley' experiment	Lady Eve Balfour (1943)
Organic farming- as an international campaign was launched	1944
Sustainable agriculture words became common	1950s
Organic farming started at few farmers' field	1970s
IFOAM established	1972
Legislation and certification of organic produce formulated and implemented	1980s
The retail marketing of organic produce started	1990s

consolations with the stakeholders. Organic production methods are those where at least 95% of the ingredients of agricultural origin are organic. The term 'organic' was first coined in 1940 by Northbourne in his book entitled 'Look to the Land'. He stated that 'the farm itself should have biological completeness; it must be a living entity; it must Organic farming is a method of farming system which primarily aimed at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment. The chronology of promotion of organic movement has been listed in Table 1.

The organic agriculture is a production system which largely excludes the use of chemical fertilizers, agro-chemicals (fungicides, insecticides, herbicides, etc.) and growth regulators. The carbon sequestration was suggested through crop rotations, incorporation of crop residues, animal manure, growing legume crops, green manuring and adding off-farm organic waste. It can also reduce carbon emissions by avoiding the use of fossil fuels used to manufacture synthetic materials for use in crops' cultivation. As per FAO organic agriculture is a unique production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity, and this is accomplished by using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs.

Status

In India, during 2020-21 more than 4.34 m ha area had been registered under organic certification process which includes 2.65 m ha cultivable area and another 1.68 m ha for wild harvest collection.As per records available, approximately 2.78 million hectare area (about 2% of the net sown area) was covered with organic farming during as of March 2020 in our country as per data available with Ministry of Agriculture and Farmers' Welfare, Government of India. Among various states Madhya Pradesh has covered largest area under organic certification followed by Rajasthan, Maharashtra, Chhattisgarh, Himachal Pradesh, Jammu, Kashmir and Karnataka. Further, during 2016 Sikkim has achieved a remarkable distinction of converting its entire cultivable land (more than 75000 ha) under organic certification. Our country is producing about 3.49 mt (2020-21) of certified organic products annually which includes oilseeds, pulses, fibre, sugarcane, millets, cereals, cotton, aromatic and medicinal plants, tea, coffee, spices, dry fruits, fruits, vegetables, processed foods etc. (Table 2). Various reports indicate that about 172 countries of the world are practising organic farming now establishing relevance of the farming practice.

Considering the demand for healthy and safer food and food products, Govt. of India promoted export and as a result during 2020-21, about 8.88 lakh metric tonnes of organic products worth Rs. 7078 crores were exported to USA, European Union, Canada, Great Britain, Korea Republic, Israel, Switzerland, Ecuador, Vietnam, Australia etc. These processed foods include soya meal (57%) followed by oilseeds (9%), cereals and millets (7%), tea and coffee (6%), spices and condiments (5%), medicinal plants(5%), dry fruits (3%) and sugar (3%) etc.

Issues

There are several issues in mainstreaming of organic farming. These includes researchable, developmental, institutional and policy issues. The researchable issues mainly includes lack of suitable varieties with higher nutrients acquisition efficiency, multi-adversities (diseases, insect pests, nematodes etc.) resistant varieties, lack of organic input responsive varieties, quality manure, low yields during field conversion period, etc. The crop specific efficient

Table 2. States and crops under organic farming

State*	Crops
Arunachal Pradesh	Maize, Sorghum, Pulses, Oilseeds
Andhra Pradesh & Telangana	Cotton, maize, pulses, oilseeds
Assam	Pulses (lentil, mungbean)
Chhattisgarh	Rice, Wheat
Gujarat	Cotton, pulses, oilseeds
Haryana	Basmati rice, wheat, maize
H.P., Jammu region, Nagaland	Rajmash
Karnataka	Wheat, maize, sorghum, pulses
Maharashtra	rice, wheat, pulses, oilseeds,
Madhya Pradesh	Soybean, wheat
Punjab	Basmati rice, wheat
Sikkim	Maize, rice, buckwheat, finger millet,
Rajasthan	Cotton, wheat
Uttar Pradesh	Rice, wheat, maize, vegetables
Uttarakhand	Basmati rice, maize, sorghum

*Many states grow vegetables organically

Source (Table Extracted): Avasthe, R.K.; Singh, Raghvendra and Babu, Subhash.2016. Organic pulses production in India: perspectives and opportunities. Indian Journal of Agronomy 61 (Special issue): 93-101

microbes are not available for large scale adoption to improve soil properties, mineralization of nutrients available in soil, protect crops from diseases and insect pests etc. Among various developmental issues shortage of natural manures and decomposed bio-waste, livestock rearing, lack of awareness, shortage of trained human resources, high input cost, small holdings etc. restricting further expansion of organic farming at the required rate. Among various, institutional and policy issues availability of assured market for organic inputs and produce, lack of supporting infrastructure, lack of suitable agriculture policy in terms of incentives during soil conversion period, lack of financial support, complex certification procedures and institutional mechanisms, supply chain linkages etc. are most common.

How the technology could contribute to socio-economic development and environmental protection?

Organic agriculture requires 28% to 32% less energy compared to conventional systems. Costs of agri-inputs are approximately 20% lower in a rotation that includes a legume compared with a conventional rotation system. Annual global sequestration potential of organic agriculture amounts to 2.4-4Gt $CO_2e\ yr^{-1}$, and it can be improved tremendously (6.5-11.7Gt $CO_2e\ yr^{-1}$) by adoption of innovative organic farming technologies. Further, it has been noticed that organic agriculture has lower methane and nitrous oxide emissions of 0.6-0.7Gt $CO_2e\ yr^{-1}$ in comparison to conventional agriculture, which includes the burning of the crops' residue (Smith et al., 2007). Organic agriculture has a significant potential to provide on-farm energy by biogas production from slurry and compost. If all agriculture were organic, the elimination of nitrogen fertilizers would save substantial emissions.

Characteristics of Organic Farming

It Protects long-term fertility of soils, also provides nutrients indirectly through insoluble nutrient sources. Nitrogen self-sufficiency is attained through the use of legumes (biological nitrogen fixation), as well as effective recycling of organic materials occurs i.e. crop residue and animal waste.Biotic stresses such as weeds, diseases and insect pests control rely on crop rotations, natural predators, diversity, resistant varieties and biological (botanicals and micro-organisms) and mechanical interventions which are intervened by organic farming components.

Is organic farming a new concept?

The organic farming is an age old concept and remains under practice from time immemorial. Organic farming in India remain in practice from last 10,000 years dating back to Neolithic age and practiced by ancient civilization like Mesopotamia. Ramayana stated that the cycling of all dead and rotten things returned is to nourish the earth. Kamadhenu cow has beenmentioned in Mahabharata (5500 BC) for its role in agricultural practices. Likewise, Kautilya (300 BC) mentioned about use of oil cake and animal excreta in Kautilya Arthashastra. Varahmihir in Brihad-Sanhita mentions different types of manures and manuring methods for a Varun Dhiman. The Rigveda and Atharva Veda-II have also mentioned organic and green manure.

(https://des.uk.gov.in/files/Comparative_Profit-Cost_Analysis_of_Organic_and_Conventional_Farming.pdf.).

Pillars of organic farming: The main pillars of organic farming are development of threshold standards, reliable mechanisms for organic certification and institutional mechanism to manage regulatory affairs beside technology packages for higher productivity, efficient and strong market network for sale of organic produce etc.

Components of Organic Farming: The major components of organic farming are use of organic manures, adoption of bio-pesticides for insect pests and diseases management, adoption of non-chemical methods of weed control, good agronomic practices without use of chemicals an alley cropping etc.

Potential niche areas for organic agriculture

India holds a unique position among 172 countries practicing organic agriculture as it has 6.50 lakh organic producers, 699 processors, 669 exporters and 7.20 lakh hectares area under cultivation. According to International Fund for Agriculture and Development (IFAD), India has more than 15 thousand certified organic farms. Sikkim, India's North-Eastern State, with 75 thousand hectares of land under organic cultivation is an organic state. By 2030, Meghalaya, another northeast state of India also eyes to convert 2.00 lakh hectares of land into organic cultivation. In Kerala, more than one lakh farmers are adopting the organic farming practices.

Policy

The Government of India is fully aware of its responsibility and has launched dedicated scheme 'Paramparagat Krishi Vikas Yojana (PKVY)' which promotes organic farming following cluster approach. The assistance of INR 50000 per hectare per 3 years is provide and out of this INR 31000 is provided as incentive to the farmer towards organic farming inputs. Mission Organic Value Chain Development for North Eastern Region (MOVCDNER) is another scheme that was in operation since 2015-16 to cater to the needs of domestic and export markets, respectively. Both the schemes (PKVY and MOVCDNER) are for end-to-end support to the farmers practicing organic agriculture i.e. from production to certification and marketing. Post-harvest management support including processing, packing, and marketing has been made as an integral part of these schemes to encourage organic farmers.

Looking ahead

India has achieved self sufficiency in food grains production long back and more recently attained self sufficiency in pulses production through technologies developed by the National Agriculture Research and Education System (NARES). There is huge demand for organic and chemical free food due to increasing awareness about health and environment. Ample scope exists to bring sufficient large area that can be to the tune of 10-12 m ha under organic or natural farming to produce chemical free quality food stuff. The market opportunities are there for export of organic produce as well. As an empirical estimated of the WHO, the total global organic food market presently is around $37 billion. Of this $14 billion is for herbals and medicines, which is expected to reach $5 trillion by the year 2050. Organic agriculture in India will prosper as there is large domestic market and export potential exists for organic produce. According to *ASSOCHAM TechSci Research*, the organic farming market in our countrymay grow at an appreciable rate of 25-30% per annum.

Organic agriculture seems to be a viable and sustainable alternative because it improves soil, strengthens the natural resource base and sustains biological production. Effective residue management conserves Soil, Water and Biodiversity, improves nutrient cycling with reduced energy input- Thus protects the environment. Growing varieties with multiple resistances to stresses, improved yield and quality- plant protection chemicals are not required. Bio-pesticides are environmentally safe and economical viable. Low cost technology: Seed treatment with *rhizobium* and PSB along with *Trichoderma viride* for enhancing N_2-fixation, P availability, and controlling seed and seedling borne diseases, respectively.Efficient nutrient management through organic manures, natural sources of nutrients, biofertilizers, mulches and green manuring. Efficient moisture management shall be achieved through effective rain water harvesting, tillage and residue management, suitable land configurations, mulches, weed management, etc. Crop sequences to sustain population of PGPR in the rhizosphere.Export market may be effectively tapped by the prospective farmers by growing organic food. Organic production system has potential to sustain the production systems. Govt. of India has also launched several schemes to promote organic farming and some of pockets and states are being delineated for organic production.

Neo-natural farming: A way-out for sustainable and quality food production system

Ram Prakash Yadav, M. J. Dobriyal, Prabhat Tiwari and Rakesh Kumar

Sustainable and quality food production is a challenge in the modern agriculture where indiscriminate use of fertilizers, pesticides and fertilizer industry's pollution has made spurious to soil, water and environment. In the present scenario nature friendly farming based onnatural ecological principles is the need of the hour. One of the options available which issustainable, ecologically sound and can produce quality food is natural farming. Neo-natural farming is human induced and managed interventions in accordance with natural principles directed towards targeted productivity and production of normal cultivated crops. It discouragesuse ofinorganic chemicals, external farm inputs, encourages use of native crop cultivar and seed material, and use of homemade bio-pesticides for plant protection. In this several plants (perennials and annuals) areplanted together and synergy is created that produces diversified quality food. There are manyvariation of natural farming like zero budget farming, Forest farming, ecological farming, carbon neutral farming etc., which produce quality grains & fruits based on natural ecological approach. Promotion of neo natural farming practices withmodern technological, policy&sensitization interventions to farmingcommunity is current imperative.

Introduction

In post era of green revolution, we reached to self-sufficiency in food production but at the cost of intensive agricultural practices especially application of inorganic fertilizer and pesticides.With realization of ill effects of these inputs and need for sustainable agri-production system we have to see measures for revolution for evergreen agriculture. There are several issues associated with fertilizer industry like pollution, health hazardous and poor water use efficiency. The air, water and solid waste pollution generated from fertilizer industry creates health problems.The fertilizer industry discharges air pollutants i.e.,gaseous ammonia, dust particulate matter, oxides of sulphur, nitrogen and carbon. The effect on vegetation and crop contribute to reduced growth and productivity. The industrial wastewater discharge which has pollutants likeammonical nitrogen, heavy metals, phosphates and fluorides has enhanced both surface and ground water pollution.Study of Bureau of Indian Standards (BIS) reported that ~78% drinking water samples and 57% fertiliser effluent discharge norms had deviated set by the Environment Ministry. The hazardous waste is also not properly managed by the industry. Reductions in excess usage of the inorganic fertilisers are needed. Excess fertilizer use have many adverse effects like expenditure wastage due to the additional input cost of fertilisers without increasing output, reduced productivity due to negative effects on soil health and environmental conditions.

The parliamentary standing committee on agriculture has observed that imbalance use of fertilizer and pesticides responsible for declining soil fertility and agricultural productivity. The committee has recommended balanced use of nitrogen, phosphorus and potassium (NPK) in their desirable ratio of 4:2:1 against present usage of 6.7:2.4:1 with 85% consumptions in 292 districts of the country to enhance food production to feed its growing population. Considering these problems one of the way-out for the agriculture is natural farming that discourages the use of inorganic fertilisers and simultaneously eradicated the ill effects of fertilizer industry and excess use of fertilisers.

What is Natural & Neo-natural farming?

System of farming in which natures principles are strictly adopted and managedthrough different agricultural practices is '***Natural farming'***. This farming method promotes biodiversity mimicking nature that encourages flora and fauna complexity which shapes itself in a flourishing ecosystem with food plants production. Hence, natural farming is nature friendly and an ecological approach of farming.'***Neo-natural farming'*** is human induced and managed interventions in accordance with natural principles directed towards targeted productivity and production of normal cultivated crops. In natural farming no farm inputs are supplied from outside these are managed from farm itself and from neighboring ecological system. Zero budget farming, Forest farming, Ecological farming, Carbon neutral farming etc are its synonyms and common variants.

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Is organic farming neo natural farming?

Several practice of organic farming are similar to the natural farming like no use of chemicals and pesticides, use of native crop varieties and seed, and homemade pest for insect and disease control. However, it differs in some method for example in organic farming purchased inputs to farm are supplied from outside like bio-fertilizers, verm-compost, etc. Besides, basic agricultural operations like ploughing, tilling, manure mixing and weeding are done. Organic farming is an expensive method of farming in which large quantity of manures and extensive weeding is required.

Features of neo natural farming

Natural farming is chemical free (fertilisers and pesticides), no ploughing and tilling operations, encourage local seed and native crop varieties, promotes homemade pest for insect disease control, allow organic matter decomposition at soil surface and improve biodiversity (plants and animals) of ecosystem.

Neo-natural farming & Agroforestry variants

Farming visualize the agricultural landscape which generally intensively managed, mechanized operation based. Agroforestry is one of the alternative land use system that works on the principles of natural farming. Therefore, neo-natural farming envisages the integration of agroforestry or perennial component to have a neo natural forest ecosystem where all biological, physical, biogeochemical and hydrological process are interlinked. The roots of leguminous tree fix atmospheric nitrogen that made available to plants either through litter fall or decaying of roots. Similarly, the leached out nutrients and nutrients from deeper soil layer/horizons also becomes available to the plants grown under the canopy of agroforestry trees through nutrient pumping and litter fall and their decomposition. This litter fall also acts as mulch for some time that helps in moisture conservation and weed suppression. Decomposition of the litter fall improves soil organic carbon that contributes to the soil structural, chemical and biological property improvement. Togetherthese processes generate synergy which make it sustainable and enhance production of different component of the system. There are several variants or types of agroforestry can be harmonized with neo natural farming models.

Pecan-based agri-horti

Litter fall from pecan in agri-horti

Peach-based agri-horti

Litter fall from peach in agri-horti

Alleycropping is the practice of growing agricultural cops in the alleys of the leguminous trees. These trees are maintained as hedge the pruning material is used as mulch therefore also known as hedgerow intercropping. The pruning ofhedgerow species benefits to agricultural crop as the litter fall and roots decompose nutrients enclosed in them are released to the soil and make available to the alley crops. Farmers also benefited due to reduced input cost and improvements in net returns. The organic matter layer on the soil surface inhibits weed seed germination by acting as mulch even if weed germinates it does not receive the proper sun light to survive. In simpler way the mulch generated from system itself need not to bring it from elsewhere. The pruning results in enhanced root die back and increase nutrient availability on decomposition of dead roots.

In neo natural farming the innovations are pre requisites for popularization of the practices. There are several traditional as well as neo traditional approaches to harness the potential of natural farming with amalgamation of on farm organics inputs quick utilization. The natural process nutrient cycle is climate parameters like temperature and moisture along with rhizosphere is time dependent which result slow process of degradation, can be enhanced with suitable interventions. The efficient nutrient cyclic process of farm waste utilization is basic concept to maximize the farm returns in shorter time. Similarly, the many trees/ shrubs like neem, karanj, custard apple, castor, calotropisetc parts can used for preparation of bio-pesticides be obtained from farm grown agroforestry trees.If the animal/ poultry components can be integrated for manure, cow urine, in situ manuring and other energy needs, the more benefits can be derived from the farm. The neo natural farming advocates the more use of trees to utilize the vertical space as stratification or multilayer cropping and crops suitability on par with homestead garden. This will help to create more complex web of on farm resource generation and utilization per unit basis. Further, agroforestry components diversity will not only maintain ecological balance but also provide diverse agri-inputs and products to the farming.

Food production and ecosystem services

Natural farming is sustainable, ecological sound and produces diversified quality food. It integrates many component crops together simultaneously and sequentially. Hence, farmer can obtain good quality diversified outputs due to natural management like ecological system and no application of fertilizers and pesticides. It also generates several ecosystem services like carbon sequestration both in perennial components and soil, soil conservation, water quality enhancement, nutrient cycling, cultural and aesthetic services. Hence, helps in climate change mitigation and adaptation. Neo natural farming approach can be linked to carbon credits, carbon finance and natural product/ organic certification for better returns to the farmers. The prioritization of the crops or plants like medicinal plants, flavour and fragrance, natural dyes and gums which are novel compound based nutriayur products will be more remunerative. Nutri- ayur products are one of demanded naturally grown produce required for health and boosting of immune system.

Thus there is need to promote the neo natural farming for a way-out for sustainable and quality food production system. The modern technologically driven farming coupled with natural system in principle with sustainable production approach is required. To promote this practice a value chain system for premium product with branding and pricing with strict quality standards adherence will give good market returns. Most of these neo natural farm produce especially health supplements, food additives, medicinal and aromatic products are to be processed on farm to avoid adulteration and pilferages. The natural produce thus can be assured with quality food production system and maintain the sustainability of agri production system. We must advocate the promotion of neo natural or ecological or forest farming practices with modern technological, policy & sensitization interventions to farming community in current imperative of climate justice in agricultural landscape.

The farmer works the soil, The agriculturist works the farmer.

Eugene F. Ware

Earth is here so kind, that just tickle her with a hoe and she laughs with a harvest.

Douglas Jerrold

It is impossible to have a healthy and sound society without a proper respect for the soil.

Peter Maurin

Possibilities of organic agriculture and certification in Uttar Pradesh

Rajesh Kumar Kanojia[1], Amit Kanawjia and Rakesh Kumar[3]

Organic farming is defined as a holistic management system that promotes and improves the health of the agro system related to biodiversity, nutrient bio-cycles, and soil microbial and biochemical activities. Organic farming practices improve the quality of the land, and at the same time, the fertility of the land remains for a long time. India has tremendous potential to grow crops organically and can emerge as a major supplier of organic products in the world's organic market. The total area underorganic cultivation in India is 4.33 m ha.Major organic produces in India include plantation crops, spices, cereals, pulses, oilseeds, fruits, and vegetables About 67442.61-hectare area is under organic certification in Uttar Pradesh. In terms of exported quantity, Uttar Pradesh exports 12141.77 (MT) of organic products of a total value of Rs 278.56 Crores. Farmers can increase their income by getting organic certification of their organic produce. Commercially, certified organic farming of crops like gram, lentil, mustard, linseed, wheat, basmati paddy, fruits, vegetables, medicinal and aromatic is being done in many districts of the state like Badaun, Azamgarh, Hamirpur, Bahraich, Pratapgarh, Lalitpur etc. Production and certification standards involve growing, storing, processing, packaging, and shipping organic products.Authenticated organic farming can be done by forming a group of farmers so that farmers can become their enterprise and increase their income through organic farming and at the same time can help maintain environmental balance.

Introduction

Organic farming is an age-old practice with the Indian farming community. Organic farming is that method of agriculture in which long-term and stable production are achieved without polluting the land, water and air while maintaining the natural balance of the environment. Under this farming system,chemical fertilizers, insecticides, and growth control chemicals areeither minimized or not used. Emphasis is given on crop residues, organic manures such as cow dung, earthworm manure, compost, green manure etc.and organic pest control.Due to this, the fertility of the land remains for a long time. At the same time, environmental pollution is also very less, the ecological balance is maintained, and high-quality products are also obtained.Organic farming management is a way in which all the components and systems of farming are related and work for each other. A biologically active land is a source of nutrition for the crop, and the field's biodiversity controls pests, whereas livestock ensures coordination, productivity, and sustainability. With the changing nature of time, organic farming has become more complex than in its earlier period, and many dimensions are now its central part.

Organic farming: Definition

According to USDA National Organic Standards Board, organic agriculture is "*An ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity*." Organic farming is also defined as a holistic management system that promotes and improves the health of the agro system related to biodiversity, nutrient bio-cycles, and soil microbial and biochemical activities. Organic farming is an environment and ecology-friendly food production system. As per IFOAM "*Organic farming emphasizes the use of any agricultural technique that relies on natural processes instead of artificial inputs, such as fertilizers and synthetic pesticides. Another important aspect of organic agriculture is an emphasis on maintaining the health and sustainability of the soil, which directly impacts agricultural communities' viability.*" This form of agriculture aims to maximise the health and productivity of the soil and plants and animals, and other people. It is based on the minimal cost of the off-farm inputs and management practices that restore, maintain and sustain ecological harmony (Munda, 2006).

Benefits of organic farming

- Organic farming practices improve the quality of the land, and at the same time, the fertility of the land remains for a long time.
- The cost of doing organic farming comes down. In this type of farming, organic manures like farm yard manure, green manure, vermicomposts NADEP, CPP and organic pesticides, etc., are used, which are much cheaper than this typeof chemical fertilizers.

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- Water holding capacity of the soil increases.
- There is no air, water, and land pollution by doing organic farming.
- Reduces the evaporation of water from the land. At the same time, there is an increase in the water level.
- Environmental and ecological balance is maintained.
- Organic farming helps in getting safer, residue-free and chemical-free food items.

Organic farming in India

In India, only 30% of the total cultivable land area is covered with fertilizers, where irrigation facilities are available. In the remaining 70% of arable land, mainly rainfed, a negligible amount of fertilizers is being used. Farmer's in these areas often use organic manure as a source of nutrients readily available either in their farm or their locality (Thapa and Tripathy, 2013). With the sizeable acreage under naturally organic/default organic cultivation, India has tremendous potential to grow crops organically and emerge as a major supplier of organic products in the world's organic market. The North-Eastern region of India provides considerable opportunity for organic farming due to the least utilization of chemical inputs. The current scenario of organic farming in India is presented in Table 1.

Table 1: Current Scenario of Organic Agriculture in India

The total area under organic	4.33m Ha
Cultivated Area	2.65 m Ha
Wild area	1.68 m Ha
Total farmers	10.92 lakh
Cultivable Production	3.46 m MT
Total Exports (Quantity)	888179.69 MT
Total Export (Value)	Rs 7078.50 crore (1040 m USD)
Major Destinations	European Union, USA, Canada, Switzerland, Australia, Japan, S. Korea etc

Source: APEDA, 2021www.apeda.gov.in

In terms of export value realization, Processed foods, including soya meal (57%), lead among the products followed by Oilseeds (9%), Cereals and millets (7%), Plantation crop products such as Tea and Coffee (6%), Spices and condiments (5%), Medicinal plants (5%), Dry fruits (3%), Sugar (3%), and others.

Organic food market in India

As per the study prepared by industry body ASSOCHAM and Tech Sci Research, the Indian organic food market, which is highly unorganized, was $0.36 billion (2014), and organic pulses and food grains took the lion's share of the market. According to the study, the Indian organic food market stood at USD 849.5 million in 2020. The market is further expected to grow at a CAGR of about 20.5% in the forecast period of 2021 and 2026 to reach a value of approximately USD 2601 million by 2026, provided there is more awareness about these products and the government incentivizes region-specific organic farming to ensure consistent growth in future. Major organic produces in India include plantation crops, spices, cereals, pulses, oilseeds, fruits, and vegetables. Further, classifications under these product categories include:

Table 2: Major organic produce of India

Category	Products
Cereals	Wheat, Jowar, Rice, Bajra
Pulses	Chickpea, Pigeon-pea, Green Gram, Red Gram, Black Gram
Fruits	Banana, Custard Apple, Papaya
Vegetables	Tomato, Brinjal
Spices	Ginger, Turmeric, Chillies, Cumin
Plantation crops	Tea, Coffee, Cardamom
Oilseeds	Groundnut, Castor, Mustard, Sesame
Other crops	Honey, Cotton, Sugarcane, Medicinal plants

Source: APEDA 2021, www.apeda.gov.in

Present scenario of agriculture in Uttar Pradesh

Agriculture is the mainstay of Uttar Pradesh's economy, and the agriculture sector plays an essential role in the state's economic development. About 65 percent of the population of Uttar Pradesh is based on agriculture. According to the data received for 2014-15, about 165.98 lakh hectares (68.7 percent) area is cultivated in the State. Various types of crops are cultivated in the state, in which along with food crops, vegetable, fruit and spice category crops are cultivated on a large scale.In 2015-16, 439.47 lakh metric tonnes of food grains were produced, out of which 159.12 lakh metric tonnes were obtained in Kharif and 280.35 lakh metric tonnes in Rabi.

Similarly, in oilseed crops, production was 8.47 lakh metric tonnes (net) against 13.03 lakh metric tonnes. Industrial crops are grown on a large scale in Uttar Pradesh. According to data from 2014-15, the area under vegetable production in Uttar Pradesh is 11.45 lakh hectares, and the total production is about 235.23 lakh

metric tonnes. The fruit production area is 3.1 lakh hectares, and production is 75.17 lakh metric tonnes. Flower production is done in about 0.84lakh hectares. Spices category crops are also cultivated in Uttar Pradesh, under which the area is about 72,211 hectares, and the production is 2.73 lakh metric tonnes. The state contributes 21 percent to the total food grain production of the country. There are 08 agro-climatic zones in the state, and 83 percent area of the state is irrigated.

According to the agricultural census year 2010-11, there are 233.25 lakh farmers in Uttar Pradesh, and the average holding size is 0.76 hectares. Smallholdings, low use of certified seeds in pulses/oilseeds crops, weak soil health, unbalanced fertilizer use, soil erosion, lack of water resources, slow process of mechanization, lack of marketing infrastructure and low credit flow are the main reasons for the weak economic condition of the farmers.

Current status of organic farming in Uttar Pradesh

At present, organic farming is being done on a large scale in Uttar Pradesh. Uttar Pradesh ranks in the cultivated farm area under organic in the country. The area under the status of certified organic farming is about 53194.79 hectares, whereas the area under organic conversion is about 14247.83 hectares. Including these two areas, the about 67442.61-hectare area is under organic certification in Uttar Pradesh. In terms of exported quantity, Uttar Pradesh exports 12141.77 (MT) of organic products totalling Rs 278.56 Crores. Commercially, certified organic farming of crops like gram, lentil, mustard, linseed, wheat, basmati paddy, vegetables, medicinal and aromatic is being done in many districts of the state like Badaun, Azamgarh, Hamirpur, Bahraich, Pratapgarh, Lalitpur, Mahoba, etc. Many private companies are doing contract farming with the farmers, buying the products directly from the farmers' fields and selling them in the country and abroad, and giving the farmer a premium price.

Organic Certification

Organic certification is a process by which a certification agency gives written approval that the product grown or processed meets the analyzed and meets the requirements of organic standards. It is a certification process for producers of organic food and other organic agricultural products. In general, any business directly involved in food/non-food items production can be certified as organic, including seed suppliers, farmers, food processors, retailers, restaurants, etc. The requirements of certification vary from country to country.

Purpose and Benefits of Organic Certification

- It is intended to assure quality, prevent fraud, and promote commerce.
- Creates trust among the consumers through the Organic label.
- Assures consumers about the product quality.
- Organic certified farmers get premium prices in the market and increase their income.
- It makes it easier to sell their products in the Indian and international markets like Japan, America, Europe, Gulf countries, etc.

Standards for Organic Certification

- NPOP - For the sale of organic agricultural products in the Indian market.
- NOP - For the sale of organic agricultural products in the US market.
- JAS - For the sale of organic agricultural products in Japan market.
- EU- For the sale of organic agricultural products in the European market.

Products that can be certified as organic

- Agriculture, wild collection, textile, food and pharmaceutical, cosmetic, aquaculture and inputs etc.
- The principal organic products sold in the global markets include dried fruits and nuts, cocoa, spices, herbs, oil, crops and derived products.
- Non-food items include cotton, cut flowers, livestock and potted plants

Organic Certification: Key issues

Certification is an annual process. A set of production and certification standards that are involved for growing, storage, processing, packaging and shipping of organic products includes:

- The minimum requirement for certification of crop far is the use of farmland that has been free from chemicals for at least three years.

- The certification body verifies the contents indicating organic farming practices in the Organic Management Plan (OMP) at the time of inspection.
- Avoidance of synthetic chemical inputs (e.g. fertilizer, pesticides, antibiotics, food additives, etc.) and genetically modified organisms;
- Maintenance of detailed production and sales records
- Physical separation of organic products from non-certified products
- On-site inspections periodically.
- If the project proponent fails to meet the minimum requirement, a Corrective Action Request (CAR) is issued by the certification body. In case of a serious lapse, the certification body issues a major corrective action. It could even debar a project from being certified until the proponent shows the measures taken to overcome it.

Constraints of organic farming and certification

- Lack of awareness among farmers and consumers about the benefits of organic food
- Insufficient incentives from the Govt. machinery to promote organic farming
- A social system of letting loose the animal during croppingseason thereby hindering crop rotation (*Anna Pratha*)
- Lack of awareness among the farmers regarding organic food production standards and its marketing regulation
- Lack of organized marketing structure for organic produce
- The lesser production during the conversion period (2-3 yrs) from conventional to organic farming
- There is no proper storage house to keep the organic farming produce.
- Lack of research and dissemination in organic farming.
- Organic certification costs more.
- The process of organic certification is quite complex.
- Lack of training by the government to the officers and employees of the Agriculture Department regarding the standards of organic farming.
- Lack of Farmer Self Help Groups.

Strategic Interventions

- Identify the potential areas suitable for organic farming in Uttar Pradesh
- Intensive training of farmers for maintaining organic standards.
- Promoting group certification of organic farming.
- Promotion of more Self Help Groups (SHG), FPO and cooperatives/societies in the region to take up organic farming and marketing organic products.
- Technical assistance to farmers in post-harvest handling, processing and value addition.
- Promotion of contract farming/buyback policy with the help of companies engaged in contract farming and export of organic produce.
- Development of package and practices and proper handling of produce for organic farming.

Farmers of Uttar Pradesh can enjoy several benefits from adopting organic farming. To prevent a decline in crop yieldsduring organic conversion, it may be suggested to switch to organic farming in a phased manner to minimise such risks during the initial years. In those parts of Uttar Pradesh, where there is no proper irrigation system and where rainfed farming is done, organic farming can be a good option. The Bundelkhand is a major pulses growing region of India. The importance of pulses in maintaining soil fertility is well known. In the Bundelkhand region of Uttar Pradesh, growing pulses can be gradually converted into organic farming.

Further, authenticated organic farming can be done by forming a group of farmers to become their enterprise and increase their income through organic agriculture. At the same time can help maintain environmental balance. Organic farmer markets can be organized weekly in urban centres for direct sales to consumers by producer groups. The state government should show strong political will and policy consistency, and well-defined targets and implementation plans thatother states can adopt.

The need of modern technology in organic farming

Yumnam Bijilaxmi Devi[1*] and Thounaojam Thomas Meetei[2]

Organic farming has gained importance in due time since sustaining natural resources for future use has become the priority. With advancement in technologies, modern way of living has created many consequences to the environment and natural resources have been exploited on a greater scale. With the overflowing human population in the world, increasing productivity is also an important aspect but sustaining the environment cannot be ignored. If modern technologies like crop monitoring, artificial intelligence is added in traditional organic farming, this will serve both the purpose of sustaining natural resources and increasing productivity from the same piece of land.

Introduction

Seeing the ongoing exploitation of natural resources in the name of intensive agriculture, organic farming plays an important role in sustaining the environment for future use. Nevertheless, population explosion cannot be neglected. So, there is a need to increase productivity by sustaining the resources. Organic farming provides the balance between ecosystem and natural resources and helps in conserving resources, this ensures the better availability and productivity of soil and water in the future. However, Organic farming totally depends on natural resources for production but its productivity is compromised due to slow action of natural products compared to inorganically manufactured alternatives. Therefore, the enhancement of productivity by applying some modern techniques like crop monitoring, artificial intelligence in organic farming is the need of hour.

Importance of technology in Agriculture

The need of integrating modern technology in agriculture is because of the benefits they provide, some of them include higher crop productivity, efficient use of resources (water, fertilizers, pesticides etc.), reduced impact on natural ecosystems, less damage to the soil because of conservation measures and improved safety while working.

Robotic technologies also create better reliable monitoring and management of resources. It can be used to increase efficiency and offer lower price and reduce environmental and ecological impact.

Feasibility of technology in Organic Farming

Overcoming the tradition of synthetic fertilizers and pesticides is also a barrier in adopting the organic farming besides low productivity and higher prices in the market. In order to make the adoption feasible, greater education among farmers and public needs to be done to show the worth of organic farming in sustaining the environment in long term.

Contribution of technology in developing socio-economic status and environmental Protection

Organic farming consumes 28 to 32% less energy compared to conventional farming. In terms of input cost for labour, seeds, fertilizers, machinery etc. are also low approximately by 20% where legume crop has been incorporated in crop rotation. It has been found that 4.1 return ratio carbon sequestration can be obtained by applying cattle manure in a recent study. Maize stover also helped in increasing the carbon sequestration in 1.3 return ratio. Overall, annual global carbon sequestration contribution from organic farming amounts to 2.4-4Gt CO_2e and can be improved to higher level of 6.5-11.7 Gt CO_2e yr^{-1} using new technologies in organic farming. Organic farming has lower methane and nitrous oxide emissions compared to conventional farming where residue burning is done. All these aspects will lead to a better socioeconomic status to farmers and offer eco-friendly environment.

Modern Technologies to be included in Organic Farming

1. Crop monitoring

It is an online facilitating tool which processes and helps in agricultural decision making. It gathers all the information from the last five years based on historical data and helps in assisting the organic farmers to compare the vegetation levels which will ultimately lead to reduced cost on soil testing as it will not be required to carry out frequently. The problem of erosion may

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also be identified through interpretation of the previous years data, which will help in combating the erosion at first stage of loss. Crop monitoring supports the measuring and determination of soil characteristics by providing productivity and vegetative maps from the previous data.

Key features of Crop monitoring

Zoning – It is an important feature of monitoring by providing the vegetation variations on the field. Zoning consists of two maps giving the information on productivity of the particular land/soil and different vegetations growing on a particular area known as productivity map and vegetation map respectively. This method can be well incorporated in organic farming to reduce resources needed. Farmers can plan on different sowing time, method of sowing etc. thus saving the excess charge on additional seeds.

2. Artificial Intelligence

AI is a part of computer science which focuses on the manufacturing of tangible and intangible systems resulting in intelligence and behaviour to level of human beings thinking using only the logical reasoning. From the word artificial intelligence, artificial is correlating to non-biological and the intelligence is correlating to ability to accomplish a complex task. AI is the cognitive process one can associate with human thinking like speech recognition, natural language understanding and translation, knowledge management, image analysis, decision making, learning etc. which will make systems powerful and useful.

Adaptation of AI in agriculture has been observed in various farming techniques. The cognitive computing concept is the reason which imitates human thought process in computer model. This will also help in enhancing the productivity in organic farming by managing the crop in advanced step of identification of any health issue.

Fig.1 Benefits of Artificial Intelligence

3. GIS

Biological Agriculture is nowadays gaining importance as it focusses on farming system without deteriorating the health of soil by maintaining the population of live organisms on soil. Application of chemical inputs have restricted the growth of beneficial organisms; therefore, it needs to be protected. Organic farming is one such approach which will help in bringing biological agriculture to near future. But for this, lots of information is required to prepare a model. Geographic Information System (GIS) plays an important role here in collecting, storing, analyzing and interpretating the data. It is a computerized system where all these functions are performed with an expert staff. GIS with appropriate data and models can help in interpretating the possible outcome and may be used in promoting organic agriculture. GIS based approach can be used to reorganize the development and promotion of Organic Farming.

4. Robotics

Agricultural robots have gained some importance in due course of time. In organic farming, labour requirement is too high as no chemicals are applied specially in case of weeding. Devices have been developed to automatically uproot the weeds from the field. An autonomous weeding robot has been designed for organic farming in Wageningen University and has received good result. This approach will increase the efficiency of labour.

The adoption of modern technologies is a challenging task in Indian agriculture but the present environmental scenario demands sustainable agriculture. Organic farming can only be performing better when integrated with some technologies developed.Organic farming has the ability to balance among different ecosystems and reduce the pressure on natural resources. This approach will ensure the availability of productive land for future and by incorporating modern technology, productivity of present condition will also be enhanced. Farmers, policy makers and other stake holders should be confident in sustainable technologies which can facilitate the dissemination and adoption of modern technologies in organic farming.

Conservation agriculture: Proven benefits and constraints in broad scale adoption

V. G. Bavalgave and N. N. Gudadhe

In conventional agriculture faulty practices like maximum tillage, burning of residues, barren soil with no cover for most of the period. Monocropping/fixed crop rotation, greater dependence on chemical fertilizer has decreased the use of organic manures/green manures. Flood irrigation, indiscriminate use of pesticide use etc. stagnated the productivity and reduced profitability, resource degradation and environmental problems. Conservation agriculture is the practice of minimum soil disturbance, diversified crop rotations, and maintenance of soil cover through a number of interrelated pathways. Conservation agriculture improves physical, chemical and biological properties of soil with high efficiency of nutrient, water, energy, labours and time. Ecological balance is attained with sustained yield and returns. Conservation agriculture is specific to site, crop and environment condition.Supporting/enabling elements-declining farmers income, labour shortages, degradation of natural resources (soil, water & environment), climate change & sustainability of agriculture. Despite some challenges associated with conservation agriculture, when done correctly, it could ensure current food security and nutrition for all without compromising the economic, social, and environmental bases for future generations.

Introduction

Green revolution has increased food grain production by four fold since 1950-51 with adoption of HYVs, intensive input use and extensive tillage. The intensive cultivation has lead to degradation of natural resources such as soil, water, vegetation etc. The problems associated with conventional agriculture are erratic rainfall distribution, delayed planting, reduction of soil fertility and physical structure, increased erosion and high labour/energy requirement

What is conservation agriculture

Conservation agriculture is the collective umbrella term commonly given to No-tillage, direct-drilling, minimum tillage and/or ridge tillage, a conservation goal of some nature. Usually, the retention of 30 per cent surface cover by residues, the practice include conservation of time, fuel, earthworms, soil-water, soil structure and nutrients.

Conservation Agriculture (CA) is a sustainable approach to agricultural production which aims to protect soil from erosion and degradation, improve its quality and biodiversity, contribute to the preservation of natural resources, water and air, whilst optimising yields.CA has emerged as an alternative strategies for conserving the natural resources.

Definition:

Conservation agriculture can be defined as "a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment" (FAO 2009)

Conservation agriculture is a set of practices that leave crop residues on the surface which increases water infiltration and reduces erosion.

Conservation agriculture is a minimal soil disturbance (no-till) and permanent soil cover (mulch) combined with rotations, is a recent agricultural management system that is gaining popularity in many parts of the world (FAO 2006).

Appropriate definition "A sustainable agriculture production system comprising a set of farming practices adapted to the requirements of crops and local condition of each region, whose farming and soil management techniques protect the soil from erosion and degradation, improve its quality and bio-diversity and contribute to the preservation of the natural resources, water and air, while optimizing yield".

Aims:

- To conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs
- It contributes to environmental conservation as well as to enhanced and sustained agricultural production

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Three principles of conservation agriculture:

CA is characterized by the practical application of three linked principles, along with other complementary good agricultural practices of crop production management.

- Principle 1: No till/minimum disturbance of soil/ Direct planting of crop seeds
- Principle 2: Permanent soil cover, especially by crop residues and cover crops
- Principle 3: Crop rotation

GAPS: Suitable modifications in stand establishment, fertilizers, weed control, irrigation and pest management

No till/minimum disturbance of soil/Direct planting of crop seeds:

- Direct seeding involves growing crops without mechanical seedbed preparation and with minimal soil disturbances since the harvest of the previous crop.
- The term direct seeding is understood in conservation agriculture system as synonymous with zero-tillage, no-tillage, direct drilling etc. Planting refers to the precise placing of large seeds (maize and beans); whereas seeding usually refers to a continuous flow of seed as in the case of small cereals (wheat and barley).
- Equipment penetrates the soil cover, opens a seeding slot and places the seed into that slot. Size of the seed slot and the associated movement of soil are to be kept at the absolute minimum possible. Ideally, the seed slot is completely covered by mulch again after seeding and no loose soil should be visible on the surface.
- Land preparation for seeding or planting under no-tillage involves slashing or rolling the weeds, previous crop residues or cover crops or spraying herbicides for weed control and seeding directly through the mulch. Crop residues are retained either completely or to a suitable amount to guarantee the complete soil cover and
- fertilizer and amendments are either broadcast on the soil surface or applied during seeding.

Permanent soil cover

A permanent soil cover is important to:

- Protect the soil against the deleterious effects of exposure to rain and sun
- Provide micro and macro-organisms in the soil with a constant supply of "food"
- Alter the microclimate in the soil for optimal growth and development of soil organisms, including plant roots

Cover crops need to be managed before planting the main crop. This can be done manually or with animal or tractor power. The important point is that the soil is always kept covered (FAO 2006).

The effect of soil cover includes:

1. Improved infiltration and retention of soil moisture resulting in less severe, less prolonged crop-water stress and increased availability of plant nutrients
2. Source of food and habitat for diverse soil life: creation of channels for air and water, biological tillage and substrate for biological activity through the recycling of organic matter and plant nutrients
3. Increased humus formation
4. Reduction of impact of raindrops on soil surface resulting in reduced crusting and surface sealing
5. Reduction of runoff and erosion
6. Soil regeneration is higher than soil degradation
7. Mitigation of temperature variations on and in the soil
8. Better conditions for the development of roots and seedling growth

Means and practices include:

- Use of appropriate/improved seeds for high yields as well as high residue production and good root development
- Integrated management and reduced competition with livestock or other uses
- Use of various cover crops, especially multipurpose crops, like nitrogen fixing, soil- porosity-restoring, pest repellent etc.
- Optimization of crop rotations in spatial, timing and economic terms
- Targeted use of herbicides for controlling cover crop and weed development

Crop Rotation

- Rotation of crops is not only necessary to offer a diverse "diet" to the soil micro-organisms, but as they root at different soil depths, they are capable of exploring different soil layers for nutrients
- Furthermore, a diversity of crops in rotation leads to a diverse soil flora and fauna, as the roots excrete different organic substances that attract different types of bacteria and fungi, which in turn, play an important role in the transformation of these substances into plant available nutrients
- Crop rotation also has an important phytosanitary function as it prevents the carryover of crop-specific pests and diseases from one crop to the next via crop residues

Effect of crop rotation include:

- Higher diversity in plant production and thus in human and livestock nutrition.
- Reduction and reduced risk of pest and weed infestations
- Greater distribution of channels or bio-pores created by diverse roots (various forms, sizes and depths)
- Better distribution of water and nutrients through the soil profile
- Exploration for nutrients and water of diverse strata of the soil profile by roots of Many different plant species resulting in a greater use of the available nutrients and water
- Increased nitrogen fixation through certain plant-soil biota symbionts and improved balance of N/P/K from both organic and mineral sources

Means and practices include:

1. Design and implementation of crop rotations according to the various objectives: food and fodder production (grain, leaf, stalks), residue production, pest and weed control, nutrient uptake and biological subsurface mixing/cultivation etc
2. Use of appropriate/improved seeds for high yields as well as high residue production of above-ground and below-ground parts, given the soil and climate conditions

Constraints for adopting conservation agriculture

A mental change of farmers, technicians, extensionists and researchers away from soil degrading tillage operations towards sustainable production system like no tillage is necessary to obtain changes in attitudes of farmers. The most important factor in the adoption of CA is overcoming the bias or mindset about tillage.

Proven benefits of research on conservation agriculture

Resource saving

Fuel consumption	:	Up to 80% fuel used is conserved by converting to CA
Time conservation	:	Only 1-3 trips over a field with CA compared with 5-10 trips in tillage-based farming
Labour consumption	:	Up to 60% fewer man days compared with conventional tillage
Time flexibility	:	CA allows late decision to be made about growing crops
Reduced irrigation requirements	:	Improved water holding capacity and reduced evaporation lessen the need for irrigation
Reduced germination of weeds	:	Absence of physical soil disturbance and retentation of surface residues under CA reduces new weed seed germination
Reduced fertilizer requirement	:	Adding crop residues and inclusion of cover crops over a period improves soil fertility

Soil health improvement: Physical properties

Preservation of soil structure	:	Tillage destroys natural soil structure while CA minimizes structural breakdown
Improved aeration	:	Improvement in earthworm numbers, organic matter and soil structure result in improved soil aeration and porosity over time
Improved infiltration	:	Residues reduce surface sealing by raindrop impact and slow down velocity of runoff water
Preventing soil erosion	:	Preserving soil structure, earthworms and organic matter, together with surface residues reduce wind and water erosion
Soil moisture conservation	:	Physical disturbance of soil exposes it to drying, whereas CA along with surface residues reduce drying
Moderating soil temperatures	:	Under CA soil temperature in summer is lower than under tillage, winter temperatures are usually higher when the crop residues are retained on soil surface.

Soil health improvement: Chemical properties

Increased soil organic matter	:	By leaving the previous crop residues on the soil surface to decay, soil organic matter near the surface is increased
Increased soil nitrogen	:	Tillage mineralizes soil N and provide a short term boost to plant growth, but such N is mined from the soil organic matter, further reducing total soil organic matter
Natural fixing of soil P and K	:	CA increases earthworms which mix large quantities of soil P and K in the root zone

Soil health improvement: Biological properties

Preservation of earthworms	:	Tillage destroys humans most valuable soil born ally, earthworms, while Ca encourages their multiplication
Microbial biomass and soil enzymes	:	CA favours microbial biomass growth and increased FDA, DHA, alkaline phosphatase

Environmental benefits

Reduced air pollution	:	Reduction in diesel consumption results in ;less emission of CO2 into the atmosphere
reduced pollution of waterways	:	Decreased runoff of water from soil and chemicals it transports reduces pollution of streams and rivers
Moderating canopy temperatures	:	Canopy temperature under ZT + crop residues has been observed to be lower than under CT. This avoids terminal heat stress in crops like wheat
Reduced emission of GHGs	:	CA involves a set of climate resilient technologies, which cause lower emission of GHGsw like CH_4, CO_2, N_2O

Higher productivity and economics

Increased crop yield	:	Al these factors are capable of improving crop yields to levels well above those attained by tillage- but only if the CA system and processes are fully practiced
Lower cost	:	Total capital and /or operating costs required to establish tillage crops are reduced by up to 50% when CA substitutes for tillage
Longer replacement intervals for machinery	:	Because of reduced hours per ha, tractors and advanced no till drills are replaced less often and reduce a capital costs over time
Future improvements expected over time	:	Modern advanced CA systems and equipments have removed earlier expectations of depressed crop yields in the short term to gain long term benefits of CA

Convincing the farmers that successful cultivation is possible even with reduced tillage or without tillage is a major hurdle in promoting CA on a large scale. It may be difficult to convince the farmers of potential benefits of CA beyond its potential to reduce production costs, mainly by tillage reductions. CA is now, considered a route to sustainable agriculture. Spread of conservation agriculture, therefore, will call for scientific research

A few important constraints which impede broad scale adoption:

Lack of appropriate seeders especially for small and medium scale farmers:

Although significant efforts have been made in developing and promoting machinery for seeding wheat inno till system, successful adoption will call for accelerated effort in developing, standardizing and promoting quality machinery aimed at a range of crop and cropping sequences. These would include the development of permanent bed and furrow planting system and harvest operations to manage crop residues.

Wide spread use of crop residues for livestock feed and fuel:

Especially under rainfed situations, farmers face a scarcity of crop residues due to less biomass production of different crops. There is competition between conservation agriculture practice and livestock feeding for crop residue. This is a major constraint for promotion of conservation agriculture under rainfed situations.

Burning of crop residues:

For timely sowing of the next crop and without machinery for sowing under conservation agriculture system, fanners prefer to sow the crop in time by burning the residue. This has become a common feature in the rice-wheat system in north India. This creates environmental problems for the region.

Lack of knowledge about the potential of* conservation agriculture *to agriculture leaders, extension agents and farmers:

This implies that the whole range of practices in conservation agriculture, including planting and harvesting, water and nutrient management, diseases and pest control etc need to be evolved, evaluated and matched in the context of new system.

Skilled and scientific manpower:

Managing conservation agriculture system, will call for enhanced capacity of scientists to address problems from a system perspective and to be able to work in close partnerships with farmers and other stakeholders. Strengthened knowledge and information sharing mechanisms are needed.

Conservation agriculture is known to improve physical, chemical and biological properties of soil. Nutrient, water, energy, labours and time saving was observed with high efficiency. Ecological balance is attained with sustained yield and returns. CA is specific to site, crop and environment condition.Supporting/ Enabling elements-Declining Farmers income, Labour Shortages, Degradation of Natural Resources (Soil, Water & Environment), Climate Change & Sustainability of Agriculture.

Conservation Agriculture
Agriculture of the Future
Future of the Agriculture

Agriculture was the first occupation of man, and as it embraces the whole earth, it is the foundation of all other industries.

Edward W. Stewart

If farm ecology and economics go wrong, nothing else will go right in agriculture.

M. S. Swaminathan

If agriculture goes wrong, nothing else will have a chance to go right in the country.

M. S. Swaminathan

Cultivators are the most valuable citizens…they are tied to their country.

Thomas Jefferson

Practical utility of conservation agriculture in India

V. David Chella Baskar and Amit Tomar

Agricultural technologies for conservation agriculture (CA) require minimum soil disturbance, permanent soil cover through crop residues or cover crops, and crop rotation for better productivity.Over the past two decades, conservation-based agricultural technologies have been developed, refined, and disseminated in India. However, despite several challenges, Conservation Agriculture is making progress.Both adopters and promoters are aware of the trade-offs and rewards associated with Conservation Agriculture adoption.Technology in conservation agriculture can reduce production costs, save water, nutrients, increase yields, increase crop diversification, improve efficiency in resource use, and benefit the environment which can be coped up with present scenario.Even so, there remains some challenges to the promotion of Conservation Agriculture technologies, such as the lack of suitable seeders, especially for small and medium farmers, the competition for crop residues between Conservation Agriculture and livestock feed, crop residues burning, having qualified and scientific personnel, and the bias against tillage. Promoting Conservation Agriculture in the region requires the development of a policy framework and strategies. As conventional agriculture systems are steadily adopted, there are emerging concerns about their sustainability, policy issues and research need for conservation agriculture in India.

Introduction

Conservation agriculture definition and goals

The conservation agriculture (CA) system is used to prevent losses of arable land and regenerate land that has been degraded. In addition, it promotes plant diversity by ensuring a permanent soil cover and minimal soil disturbance. It enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production (FAO). Conservation agriculture (CA) is not business as usual, since it maximizes yields while exploiting soil and ecosystem resources, as stated by Dumanski *et al*. (2006). Study says that the combined economic and social benefits of production and environmental protection, including lower input and labour costs, are greater than those from production alone.

From a conventional agriculture perspective, conservation agriculture systems require a complete paradigm shift with respect to managing crops, soil, water, nutrients, weeds, and farm machinery.

Utilities of Conservation Agriculture:

1. Environmental Utility:

The two main factors responsible for soil moisture loss are evaporation and runoff. Agriculturally, 60% to 70% of rainfall evaporates, 10% to 20% runs off and only 10% to 20% filters into the soil. Conservation Agriculture reduces soil erosion as well as improves infiltration by maintaining residue on the surface of the land and it is also considered as carbon sequestration. Due to this, the integration of this technology into practice can help reduce greenhouse gas emissions and reduce the pace of climate change.

2. Economic Utility:

The greatest economic benefits of Conservation Agriculture are time savings and reduced costs (labour, fuel, machine operation and maintenance). For farmers, whose main source of income is family labour, it is a major driver. A culture that is used to cultivate the field under conventional agriculture requires special measures to change its mindset. It is essential to explain the advantages of Conservation Agriculture technology along with government support, NGOs, and extension service

Table 1: Difference between Conventional farming and Conservation Agriculture

S. No.	Title	Conventional Farming	Conservation Agriculture
1.	Tillage	Ploughing is done to increase the soil structure and control of weeds.	Direct planting is done.
2.	Crop Residue	Removal or burning is done.	Crop residue is left on the as it is and planting is done over it.
3.	Crop Rotation	Monoculture is practised and soil is inverted with mould board or with similar ploughs.	Intercropping is permanent feature in Conservation Agriculture.

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agencies to overcome such difficulties.As part of their national agrarian programs, some Asian countries, including China, India, and Kazakhstan, urge farmers to implement Conservation Agriculture technology.

3. Social Utility:

Conservation Agriculture will increase yield, soil organic matter (SOM), as well as soil biological health in the long run.Those goals are connected to building a global partnership for sustainable development as well as ensuring environmental sustainability by 2015.As a non-profit organization dedicated to conservation agriculture and sponsored by FAO, the European Conservation Agriculture Federation (ECAF) held its first World Congress on Conservation Agriculture in Madrid in 2001.More international, regional, and national support as well as grants and projects are needed to promote the Conservation Agriculture technology around the world. These should be directed towards scientists, scholars, extension workers, and farmers.

4. Policy issues:

Traditional agriculture has been transformed by conservation agriculture.Analysis of policy instruments and institutional arrangements and their impact on CA technologies are both essential to understanding how the technology integrates with other technologies. The following were some of the suggested policies for promotion of conservation agriculture

- Upscaling of conservation agriculture
- Transition from Food security to livelihood security
- Diversified cropping system
- Capacity building on Conservation Agriculture.

Conservation Agriculture technology can improve livelihoods and productivity for millions of farmers who rely on climate change for survival and sustenance. Developing sustainable agricultural practices includes environmental, economic, and social values, and this technology encourages them.Although Conservation Agriculture has grown rapidly in the Americas, its adoption levels are low globally. Support from international, regional, and national sources is necessary to popularize the Conservation Agriculture technology. As there is a potential future for establishing Conservation Agriculture in Europe, Asia, and Africa, government policy, and extension agencies 162 play an important role in adopting the technology.

Agriculture is our wisest pursuit, because it will in the end contribute most to real wealth, good morals, and happiness.

Thomas Jefferson

Agriculture is a fundamental source of national prosperity.

J. J. Mapes

A fertile soil alone does not carry agriculture to perfection.

Elias Hasket Derby

Agriculture is at the core of the state.

Dave Cook

Non chemical approaches for plant disease management for sustainable organic farming

Prashant P. Jambhulkar and Shubha Trivedi

Organic growers commonly rely on cultural plant protection methods. When soil-borne diseases and pests are threatening plant establishment and survival, elimination of the pathogens and pests can be attempted by sanitation and soil dis-infestation. Soil dis-infestation will change the soil ecosystem with the aim of reducing a broad spectrum of fungi, bacteria, nematodes and weeds. Sanitation is an essential pre-plant measure to reduce the initial inoculum of a wide array of plant pathogens. Other sustainable approaches for disease management in organic fields are physical or mechanical control, biopesticides, plant extracts, biocontrol agents, and induced defense reaction. In organic fields, crop stubble is treasured and will never be burned to prevent loss of organic carbon in the form of CO_2. Better alternatives to burning are shallow incorporation of the debris to provide substrate to the soil food web, or leaving it on the surface for slower decomposition to prevent erosion. Lack of awareness is the key factor and is the stumbling block to limited applicability of organic farming practices. Thus a scientific approach is needed to establish a rapidly expanding demand of organic products by following organic plant protection measures.

Introduction

Organic farming (OF) can be defined as 'an ecologically, economically and socially responsible way of farming, providing an enduring supply of safe and healthy food and fibers,with the least possible losses of nutrients and energy, and the least negative impacts on the environment, as regulated by certification agencies'. Worldwide, OF has increased tremendously in importance over the past 20 years, including in developing countries, and the global market for organic products reached a value of almost $US 72 billion in 2013. OF is governed by the idea that all natural processes within an agro-ecosystem are mutually dependent on each other, and that management should aim at achieving and supporting self-regulation through natural processes. In an organic farming system, it is appropriate to develop disease control strategies that have an ecological basis. Organic farming should encourage the growth and diversity of soil inhabiting and epiphytic microorganisms that have the potential to exert beneficial and pathogen antagonistic influences. An increase in genetic diversity of the crop host rotation is another management step that incorporates ecological considerations. Organic farming involves a comprehensive approach to soil health, crop health and maintenance of dynamic agro ecosystem. Disease management of cereals, pulses and oil seed crops is a year round endeavour. Typically, disease management for the upcoming crop season begins immediately after harvest of previous crop. Cropping system based on monocropping favours epidemic development of many crop diseases caused by fungi, bacteria, nematodes and viruses. The degradation of soil structure and soil quality by loss of soil organic matter favours root diseases. Pest and disease control in organic farming is to a large extent based on the maintenance of soil fertility by balanced crop rotations, including nitrogen-fixing crops, winter cover crops, intercrops, additions of manure and compost and reductions in soil tillage. Disease management in organic farming is not directed at controlling possible pathogens directly, but at management of the environment such that plants are able to withstand potential attacks.

Approach for organic disease management

1. Cultural Control

Cultural control is the first line of defence. It promotes healthy soils and healthy plants. Healthy soil is the hallmark of organic agriculture. An unhealthy plant is very attractive to diseases. Soils rich in organic matter are shown to increase soil biodiversity and help to create and abundance of beneficial soil microorganisms. Using compost has been shown to increase the suppressiveness of the soil by encouraging beneficial microorganisms, as well as inducing disease resistance in plants by simply having healthier plants. The major approaches of cultural methods for organic disease management are:

a) Exclusion :

- Disease-free seeds, transplants or plant stock
- Prevent introduction of diseased plants or soil

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- Disease free water source
- Control insects that can carry disease
- Soil solarization
- Disease resistant varieties
- Good sanitation from the prior season.
- Remove diseased plants or weeds from the field.

b) Always work infested fields last and clean off equipment.

c) Plant on raised beds. Not only helps with avoidance of pathogen, but also good moisture drainage is key.

d) Crop rotation

> 3 yrs between crops in the same family

Some pathogens cause disease among multiple plant families

e) Use only thoroughly composted material

f) Improve air circulation by staking, trellis or pruning

g) Water in the morning. Avoid overhead irrigation if possible

h) Make life difficult for the pathogen

i) Create an unfavorable environment for pathogens

j) Increase air movement, Increase soil drainage, Avoid low-lying areas, Row orientation, Maximize air movement, Minimize leaf wetness periods,

k) Irrigation management, Drip Irrigation, Mulches (Plastic or plant-based),

2. Physical/ Mechanical Controls

Physical and Mechanical controls are very important in insect management on organic farms. They are also very important for disease control, especially in perennial cropping systems like fruit trees, small fruits and tree nurseries. Some options for physical/ mechanical management of plant disease include:

• Hand-picking • Pruning • Mulches • Soil solarization • Prune out diseased plant parts

• Increase light into canopy • Increase airflow • Helps spray penetrate all surfaces

• Proper pruning for proper plant health!

3. Material Control

Materials include:

• Elemental fungicides

– Copper and sulfur

• Biofungicides/Microorganisms

– Ex. *Trichoderma, Pseudomonas, Bacillus, Metarhizium*

• Particle Film Barriers

– Ex. kaolin clay

• Peroxides and Bicarbonates

• Compost Teas

Sulfur

• Used effectively for powdery mildew on most crops

• Labeled for rusts (grape and bean), botrytis (onions), black spot (rose)

• pH adjustment

• Component of Bordeaux mixture

Sulfur is only fungicidal, but Bordeaux mixture also is bactericidal, which means that it can be effective against disease caused both by fungi (such as powdery mildew, downy mildew, and various anthracnose pathogens) and by bacteria (such as bacterial leaf spots and fire blight).

Copper

Controls some fungi and bacteria

– Free Cu - Copper sulfate: Bordeaux mixture

– Fixed Cu - copper hydroxide, copper oxide, copper oxychloride, copper octanoate

– Safer Garden fungicide – Cu 12% or 0.4% : rust, scab, brown spot, black spot,

Biocarbonates and Peroxides

• Bicarbonates - Potassium Bicarbonate (baking soda)

– disrupts cell membrane K balance

– Powdery Mildew, Black spot, leaf spots, rusts for seed, transplants or established plants

4. Biopesticides

A biopesticide is a pesticide derived from natural materials. The most commonly used biopesticides are living organisms, which are pathogenic for the pest of interest. These include biofungicides (Trichoderma), bioherbicides (Phytopthora) and bioinsecticides (*Bacillus thuringiensis*). Bio-control methods like the neem based pesticides to Trichoderma are available in the country. Indigenous technological products such as Panchagavya (five products of cow origin) which was experimented at the University of Agricultural Sciences, Bangalore found to control effectively wilt disease in tomato. Biopesticides categorised as: biochemical pesticides, microbial pesticides, and plants containing added genetic material.

1. Biochemical pesticides contain naturally occurring substances that control pests. Substances that control diseases in this category include potassium bicarbonate, hydrogen dioxide, phosphorous acids, plant extracts, and botanical oils.
2. Microbial biopesticides contain microorganisms as the main active ingredient that function as biological control agents, affecting the pathogen directly or indirectly through the compounds they produce or by stimulating specific plant responses.
3. Plant-incorporated protectants (PIPs) are the least common type of biopesticide. These are pesticidal substances produced by plants that contain genetic material added to the plant often through genetic engineering. Biopesticides also exist for the management of weeds, insects, and nematodes.

- Biopesticides can be used in a preventative and not a curative manner, as they typically lack the breadth of activity, efficacy, or residual activity of conventional fungicides.
- Apply biopesticides soon after initiation of first symptoms of disease
- Repeated application of biopesticides is required because due to loss of product from degradation or rain/irrigation washing materials off foliage and fruit, or with the growth of new foliage.
- Biopesticides is generally targeted to specific pests and closely related organisms, and they are usually inherently less toxic to non-target organisms

5. Role of plant extracts in disease management

Plants have ability to synthesize aromatic secondary metabolites, like phenols, phenolic acids, quinones, flavones, flavonoids, flavonols, tannins and coumarins. The components with phenolic structures, like carvacrol, eugenol, and thymol, were highly active against the pathogen. These groups of compounds show antimicrobial effect and serves as plant defence mechanisms against pathogenic microorganisms. The volatile antimicrobial substance allicin (diallyl thio sulphinate) is synthesized in garlic when the tissues are damaged and the substrate alliin (S-allyl-L-cysteine Sulphoxide) mixes with the enzyme alliin-lyase. Allicin is readily membrane-permeable and undergoes thiol-disulphide exchange reactions with free thiol groups in proteins. Allicin effectively controlled seed-borne *Alternaria* spp. in carrot, Phytophthora leaf blight of tomato and tuber blight of potato as well as *Magnaporthe oryzae* on rice and downy mildew of *Arabidopsis thaliana*. Application of plant products especially essential oils is a very attractive method for controlling post harvest diseases. Essential oil extracted from lemon grass (Cymbopogon spp.) post harvest anthracnose of mango fruit . The anti viral protein (AVP) extracts from *Bougainvillea spectabilis* and *Prosopis chilinesis* were found to be effective in reducing the sunflower necrosis virus (SFNV) infection both in cowpea and sunflower plants.

Some plant contains components that are toxic to pathogens. When extracted from the plant and applied on infested crops, these components are called botanical pesticides or botanicals. Commonly used botanicals:

Plant extracts: Neem (*Azadirachta indica*, A. Juss), Garlic (*Allium sativum*, Linn., Eucalyptus (*Eucalyptus globulus*, Turmeric (*Curcuma longa*, Linn., Tobacco (*Nicotiana tabacum*, Linn., Ginger (*Zingiber officinale*, Rosc.

Essential oils: Nettle oil (Urtica spp.), Thyme oil (*Thymus vulgaris*, Linn.), Eucalyptus oil Eucalyptus globulus, Labill. Rue oil (*Ruta graveolens*, Linn.), Lemon grass oil (*Cymbopogon flexuosus* (Steud.) Wats. and Tea tree oil (*Melaleuca alternifolia*).

Gel and latex: *Aloe vera* (Tourn. Ex Linn.).

6. Biocontrol agents

Trichoderma spp.

Trichoderma belongs to genus hymenomycetes is characterized for their rapid growth, capability of utilizing

diverse substrates and resistance to noxious chemicals. Trichoderma present in soils (rhizosphere as well as non-rhizosphere and rhizoplane), decaying organic matter, manure heaps and crop residues. The production and secretion of fungal cell wall degrading enzymes (CWDES) and compounds affecting the integrity of fungal membrane and cell walls are considered as the key steps in antagonistic process by Trichoderma. The enzymes involved in cell wall degradation are chitinase, â 1,3-glucanases and proteases. Trichoderma can be multiplied using three types of substrates namely (i) liquid media (potato jaggery medium) (ii) Cheap grains (sorghum) and (iii) agricultural by products (Rice bran, wheat bran). *Trichoderma* grown in liquid media will be used to make talc formulation of Trichoderma which can be used for seed treatment, seedling root dip and soil application through FYM for disease control.

Pseudomonas fluorescens

Pseudomonas spp are the most extensively studied plant growth-promoting rhizobacteria (PGPR), and are known to protect the plant from many deleterious soil and foliar plant pathogenic microorganisms. The beneficial effects of P. fluorescens have been attributed to: (i) their ability to produce various compounds including phytohormones, siderophores, antibiotics, chitinase, b-1, 3 glucanase, and hydrogen cyanide (HCN), phosphate solubilization and (ii) induced systemic resistance against a broad diversity of pathogens. Fluorescent pseudomonades are often grouped under PGPR because of their ability to promote the plant growth and suppress plant diseases.

Bacillus subtilis

Bacillus subtilis is plant growth promoting rhizobacterium shown to synthesize antifungal peptides. It persists in the environment and protects the crops effectively from fungal and bacterial pathogen in soybean, peanuts, wheat, barley, cotton and vegetables.

Consortia application of biocontrol agents

Judicious use of microbial inoculants as biocontrol agent (BCA) is a potentially important component of sustainable agriculture. The principal biocontrol mechanism involved include mycoparasitism, antibiosis, competition and induced resistance; additional mechanisms are hypovirulence mediated through fungal viruses and inhibition of enzymes involved in plant pathogenicity. Individual biocontrol mechanism could be predominant for some BCAs but there are also many instances where more than one mechanism may operate in a given BCA isolate. The ecological processes determining the fate of such biological control are complex.

Use of mixtures of or fungicides has been successfully adopted in many crops to increase and maintain disease control efficacy when individual cultivars or fungicides may not be able to control disease effectively. To improve biocontrol efficacies achieved through use of a single BCA, there has been increasing interest recently among researchers in using mixtures of BCAs to exploit potential synergistic effect among them.

Compatible strains of *P. fluorescens* (Pf1,Py15 and Fp7) and Bacillus subtilis strains (EPCO 16 and EPC 5) were found effectively inhibited the growth of Alternaria solani in tomato crop. Similarly, experiments for the biological control of the bacterial blight pathogen revealed that different species of Bacillus applied to rice plants as a seed treatment before sowing, a root dip prior to transplantation, and two foliar sprays prior to inoculation could afford up to 59% suppression of the disease. Efforts are in progress including formulation of synergy hypothesis in relation to biocontrol mechanism to exploit microbial mixture for uses in biocontrol of plant diseases. Jambhulkar et al., 2018 determined synergism in application of *Trichoderma harzianum* and *Pseudomonas fluorescens* against rice blast and bacterial leaf blight of rice. They determined synergism among biocontrol agents by using Bliss independence a numerical hypothesis to asses synergism.

7. Enhancing plant defence for disease management

Plants have developed a wide range of defense mechanisms to survive different stress factors including diseases. Resistance genes confer genetic protection. What is coming to be understood now is that susceptible species also stand a good chance of defending themselves through activating a series of metabolic pathways that allow a rapid expression of a broad set of defences upon infection by a pathogen.Several fungal diseases can be controlled by mustard and related plants. After harvest, if the plants are mulched into the soil, microbes act upon the sulphur containing peptides in the mustard plants to release isothiocyanates which act like a mild fumigant and suppress fungal growth. This provides an excellent protection to crops against infestations like Rhizoctonia, Pythium, and Sclerotinia. Antagonistic fungi like Trichoderma are effective in

controlling Phytophthora which causes root rots of several host plants, whereas *Bauveria bassiana* and *Verticilium leccani* have been used effectively against larvae of beetles and mealy bugs. Cow urine and whey can be used as protective foliar sprays against a range of bacterial and fungal infestations, and wood ash is excellent for discouraging populations of aphids in vegetables.

With more and more information coming forth on induced defense mechanisms of plants, it is logical to create conditions where plants can fend for themselves. Growing crops organically enables the plants to develop and express their resistance pathway.

Crop protection in organic agriculture is not a simple matter. It depends on a thorough knowledge of the crops grown and their likely pests, pathogens and weeds. Successful organic crop protection strategies also rely on an understanding of the effects which local climate, topography, soils and all aspects of the production system are likely to have on crop performance and the possible host/pest complexes. Organic agriculture is rapidly expanding within India to include vegetables, fruits alongside traditional mixed organic farming. Many of the established strategies that have been developed to prevent crop diseases in traditional organic systems have limited applicability. Research is therefore urgently required to optimise these strategies for use in organic cropping systems.

Agriculture is the process of turning eco-systems into people.

Toby Hemenway

A Sustainable Agriculture does not deplete soils or people.

Wendell Berry

Agriculture for an honorable and high-minded man, is the best of all occupations or arts by which men procure the means of living.

Xenophon

A farmer is always going to be rich next year.

Philemon

To make agriculture sustainable, the grower has got to be able to make a profit.

Sam Farr

Recent perspective in soil borne disease management of organic farming system

Prashant P. Jambhulkar and Vaibhav Singh

There is an increasing awareness of the ill effects of chemical pesticides, everyone are looking for organic crops with the perception that they are chemical free and good for health than those conventionally grown. Crops are highly vulnerable to a number of pathogenic organisms that reduce yield by reducing the quality or by killing the plant. Soil-borne diseases are among the major factors contributing to low yields of organic produce. In place of agrochemicals there are several methods that can be used to protect crops from soil-borne pathogens. These include the introduction of biorational or biocontrol agents against soil-borne plant pathogens, plants with therapeutic effects and organic soil amendments that stimulate antagonistic activities of microorganisms to soil-borne diseases. The decomposition of organic matter in soil also results in the accumulation of specific compounds that may be antifungal or nematicidal. There are many techniques which are proving effective to ward of chemicals. This article is discussing some those techniques which can help in organic cultivation of crops

Introduction

In the present era we are witnessing rising awareness of the hazardous effects of agrochemicals in agriculture. There are number of issues namely, pollution due to synthetic chemical fertilizers and pesticides, production losses due to pest and disease pressure, soil degradation, loss of soil fertility and productivity which needs an urgent need for ecologically sound systems to address ongoing issues in mainstream agriculture.

Sustainable farming is largely depends directly on soil biology as it is the driving force behind decomposition processes that break down complex organic molecules and substances and convert them into plant available forms. Stable and large microbial inoculums are important for sustaining the productivity of soils under sustainable and organic farming systems. Such system develop when farmers adopt strategies such as crop rotation, cover cropping, and application of organic amendments (manures and composts) that significantly increase soil organic matter (SOM) and improve soil biology and quality.

Sr. No.	Strategies	Role
1.	Organic amendments	Suppression of a wide range of soilborne pathogens (mainly bacterial and fungal pathogens) due to the induction of physicochemical and biological changes in soils
2.	Cover cropping	Improving soil structure, reducing the need for synthetic chemicals by decreasing weed biomass, increasing soil organic matter, nutrients and retain soil moisture which make soils that are suppressive to plant diseases
3.	Soil solarisation	Solar energy trapped by transparent polyethylene sheet increases the soil temperature (10–15 °C above normal temperature) which effectively eliminate most of the soil-borne pathogens, weeds and nematodes
4.	Biological control	Bioprotectants provide a unique opportunity for crop protection, since they grow, proliferate, colonize and protect the newly-formed plant parts to which they were not initially applied
5.	Biofumigation	Glucosinolates (GSLs) of Brassica spp. are converted enzymatically into isothiocyanates (ITCs), the actual active ingredients. Reduce subsequent weed problems, increase soil organic matter, improve nutrient availability and control soil erosion.
6.	Resistant varieties	It is an important measure to manage the soilborne disease, because such varieties alleviate application of any other management practices
7.	Crop rotation	Reduce the pathogen's inoculum level sufficiently to avoid economic loss.

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The significance of organic vegetables

The organic production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity is solely depends on the minimal use of off-farm inputs and on management practices that restore, maintain or enhance ecological harmony.

One of the core philosophies of organic production systems is the development of healthy and productive soil that provides essential nutrients for plant growth, supports diverse and active soil biotic communities and balances the entire farm ecosystem.

Soil-borne diseases

Soil-borne diseases are one of the major factors responsible for low yields of organic products. Vegetable crops are vulnerable to a range of pathogenic organisms that reduce yield by damaging produce quality and make them unmarketable. Although the development of plant diseases is a regular part of an ecosystem and crop production, it becomes a concern when the diseases assume an epidemic form causing enormous crop losses.

Important soil-borne pathogens include fungi, fungi-like organisms, bacteria and plant parasitic nematodes. Fungal pathogens, including species of *Fusarium, Rhizoctonia, Verticillium, Sclerotinia* and *Macrophomina phaseolina*, cause huge yield loss each year. Inoculum of many soil-borne fungi persist in the soil for long periods by producing resistant survival structures such as chlamydospores, oospores and sclerotia.

Important soil-borne bacterial pathogens include Ralstonia, Pectobacterium, Agrobacterium and Streptomyces. Bacterial pathogens of Xanthomonas and Pseudomonas groups survive for shorter period of time in soil. Root-knot nematodes (*Meloidogyne* spp.) cause losses of up to 80% in heavily infested fields. Economically root knot nematodes constitute the most important phytonematode.

Control of soil-borne diseases

It is difficult to control soil borne pathogens through conventional methods. Use of fungicides or other pesticides in not ecofriendly thus biological methods of disease control is easy, safe and economic. A large number of microbial communities are maintaining productivity of soil under organic farming system. Such systems develop by adopting strategies like crop rotation, cover cropping, green manuring, application of farm yard manures and organic amendments as well as microbial antagonists. Application of such alternative methods on soil borne pathogens are needed to design soil suppressiveness to soil borne pathogens.

Plant products

Plants with medicinal properties have received the attention of plant pathologists as an alternate method of disease control which protects the environment from the use of hazardous chemicals. Brassicaceae family which include broccoli, cabbage, cauliflower, turnip, radish, canola, rapeseed and various mustards, produce sulfur compounds that when pulverise in soil breakdown glucosinolates to produce isothiocyanates takes place that are toxic to many soil organisms as part of a process referred to as biofumigation.

Another strategy is to alternate vegetable crops with field or forage crops such as small grains, alfalfa or clovers. Some growers try to rotate fields so they are in cash crops one year and cover crops the next year. For diseases that are soil-borne or over-winter in crop residues, rotating out of susceptible crops is a key in preventing infection, as in the case of Phytophthora blight, early blight, and many other diseases. It is known that plants and plant products (organic amendments, crop residues, green manures) can dramatically affect soil microbial communities, and are primary drivers of soil microbial dynamics, and thus may be important components in establishing and maintaining soil suppressiveness.

Pathogenic soil microbial communities are greatly suppressed by crop rotations and residue ame and can result in significant reductions in soil-borne diseases. Green manures of cabbage and cauliflower leaves, chopped pineapple leaves, dry straw of rice, rye or oats and cotton wastes are reported to reduce the incidence of root-knot in the field.

Organic manures

The strategy for management of soil borne pathogens is to apply organic amendments. Organic amendments such as organic wastes, composts and peats, have been proposed to control diseases caused by soil-borne pathogens. There are many examples of soilborne pathogens controlled effectively by the application of organic amendments: like *Gaeumannomyces graminis* f. sp. *tritici, M. phaseolina, R. solani, Thielaviopsis basicola, Verticillium dahliae,* species of *Fusarium, Phytophthora, Pythium and*

Sclerotium. Un-decomposed and mature composts were suppressive to *R. solani* damping-off, but partially decomposed materials were conducive. Compost extracts are gaining popularity particularly among those who are seeking substitutes to agrochemicals (Bess 2000). Compost extract contains a high population of microbiota, e.g. rhizobacteria, Trichoderma and *Pseudomonas* spp., which may enhance growth and yield of crops.

Oil seed cakes

Oil seed cakes by-products obtained after oil extraction from seeds are of two types, edible and nonedible. Non-edible oil seed cakes such as castor cake and neem cake are used as organic nitrogenous fertilizers, due to their NPK content. Some of these oil cakes have been found to increase the nitrogen uptake by the plant and protect the plants from soil nematodes, insects, and parasites. Several antimicrobial by-products (e.g. organic acids, hydrogen sulfide, phenols, tannins and nitrogenous compounds) are released during the decomposition of organic amendments, or synthesized by microorganisms involved in such degradation.

Microbial antagonists-Trichoderma

Trichoderma-based biofungicides are booming in an agricultural market with more than 50 formulations registered products worldwide. Nowadays, there are more than 50 different Trichoderma-based agricultural products being produced in different countries and are sold to farmers to get better yields in different crops. Presently, *Trichoderma spp*. based products are considered as relatively novel type of biocontrol agents (BCAs). The size of current biopesticide market is vague and only scattered information could be obtained based on registered as well as non-registered biofungicides. Recently, Trichoderma based BCAs share about 60% of all fungal based BCAs and an increasing number of *Trichoderma spp*. based BCAs products are registered regularly. This antagonistic potential serves as the basis for effective biological control applications of different Trichoderma strains as an alternative method to chemicals for the control of a wide spectrum of plant pathogens in organic farming. Increasingly, Trichoderma spp. are being investigated for their biocontrol potential against root-knot nematodes on a range of crops, such as tomato, okra, mungbean and bell pepper.

Farmers have always looked to new technologies as a way to reduce costs. There is increasing consumers demand for low-cost food of higher quality increasingly produced through organic methods. Thus there is an urgent need for an integration of biological pest control, biotechnology, information technology, bioremediation, precision farming, integrated and organic farming systems.

"When tillage begins, other arts follow. The farmers, therefore, are the founders of human civilization."
Daniel Webster

"Agriculture is our wisest pursuit, because it will in the end contribute most to real wealth, good morals, and happiness."
- Thomas Jefferson

"No race can prosper until it learns there is as much dignity in tilling a field as in writing a poem."
- Booker T. Washington

Role of biofertilizers in sustainable agriculture

Navneet Pareek

In nature, there are number of useful soil microorganisms which can help plants to absorb nutrients. Their utility can be enhanced by selecting efficient organisms, culturing and adding them to soils. These cultured microorganisms packed in some carrier material are called biofertilizers. In a country like India, where majority of farmers are marginal having small holdings, use of biofertilizers in conjunction with organic and inorganic fertilizers offers a great opportunity for sustainable crop production.

Introduction

Modern agriculture is heavily dependent on the fossil fuel based inputs such as inorganic fertilizers, pesticides, herbicides and energy intensive machinery. Because of demographic pressure and consequently intensive cultivation, soil is under tremendous stress. Large scale use of chemical fertilizers causes the problem of pollution and deterioration of soil structure. The use efficiency of chemical fertilizers in crops is generally low as they have varying fate in soils. The nitrogenous fertilizers are subjected to leaching, denitrifiacation and volatilization losses while phosphatic fertilizers undergo process of fixation in soil. In dry land and rain-fed agriculture, moisture is also a limitation in use of inorganic fertilizers. In recent past, cost of chemical fertilizers has increased tremendously and it becomes difficult by the farmers to use recommended dose of plant nutrients in their crops. Biofertilizers are the preparation of useful soil microorganisms, natural products and eco-friendly in nature and improve soil health directly or indirectly.

In nature, there are number of useful soil microorganisms which can help plants to absorb nutrients. Their utility can be enhanced by selecting efficient organisms, culturing and adding them to soils. These cultured microorganisms packed in some carrier material are called biofertilizers. Thus biofertilizers are live preparations of beneficial soil microorganisms, alone or in combination, which may help in increasing crop productivity by way of helping in biological nitrogen fixation, solublization of insoluble plant nutrients, stimulating plant growth or decomposition of plant residues. The term microbial inoculant (culture) is more appropriate for these products and should be used after the name of microorganisms they contain eg. *Rhizobium* inoculant, *Azotobacter* inoculant. Many bacterial, fungal and algal genera are used in preparation of biofertilizers for increasing the nutrient availability to crop plants and based upon the physiological functions carried out have been classified in to different groups (Table 1).

Table 1. Types of biofertilizers and potential microorganism(s)

Sl. No.	Type	Microorganism(s) involved
1.	**Nitrogenous biofertilizers**	
	a. Symbiotic	*Rhizobium, Frankia*
	b. Asymbiotic	*Azotobacter*
	c. Associative	*Azospirillum*
	d. Phototrophic	Blue Green Algae (BGA) or Cyanobacteria
	e. Obligate endophytic	G*luconacetobacter diazotrophicus*
2.	**Phosphate supplying biofertilizers**	
	a. Phosphate solubilizer	*Bacillus megaterium var phosphaticum, B. polymyxa, Aspergillus awamorei*
	b. Phosphate mobilizers	Mycorrhizae (ecto mycorrhizae and Arbuscular mycorrhizae)
3.	**Cellulose decomposers**	*Cellulomonas, Cytophaga, Trichoderma, Chaetomium, Aspergillus, Nocardia, Streptomyces* etc.
4.	**Plant growth promoting rhizobacteria (PGPR)**	*Pseudomonas, Serratia, Bacillus, Acetobacter* etc.

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Biofertilizers and crop production

Biofertilizers are known to activate soil biologically, economize the chemical fertilizers (nitrogenous and phosphorus), provide protection against drought and some soil borne diseases, reclamation of contaminated soils, restore natural fertility of soil and increase crop yields. Biofertilizers in strict sense are not fertilizers which directly give nutrition to crop plants. The critical input in biofertilizers is the micro organisms. The benefits of biofertilizers usually obtained are not as visible as that of chemical fertilizers except in some critical conditions. Biofertilizers can add nitrogen from 20 to 200 kg/ha depending upon the optimum conditions. Pastures and forages respond more than grain crops. The yield increases usually range around 10-35%. They stimulate plant growth, activate soil biologically, restore natural soil fertility and provide protection against drought and some soil borne diseases. The range of benefits usually seen with different organisms is given in Table 2.

The legume-*Rhizobium* symbiosis represents a most promising association in agriculture which supplements the substantive quantities of nitrogen under different ecosystems. It is widely believed that legumes improve the soil fertility mainly due to the nitrogen fixing ability. *Rhizobium* biofertilizer is recommended for application in pulse crops, groundnut and soybean. This bacterium forms root nodules in legumes and forms symbiosis by providing nitrogen to the host plant. The *Rhizobium* – legume association meet up to 80-90 % of the crop nitrogen needs. *Rhizobium* inoculation can further increase this amount by about 40-50 kg N/ha. Different legumes fix different amount of nitrogen ranging from 0 to 330 kg/ha depending on the crop, soil and environmental conditions. The efficiency of legume *Rhizobium* symbiosis depends upon the host crop and its compatibility with the *Rhizobium* bacteria, crop management practices and soil factors like available soil nitrogen, soil moisture, pH, temperature etc. *Rhizobium* inoculation was found to increase the crop yields by about 7-18% under on farm conditions (Table 3). Experimental conducted at Pantnagar evidences that contribution of nitrogen exclusively due to inoculation in chickpea is about 40 kg N/ ha and in mungbean about 30 kg/ha. The advantage through this symbiosis is greater in soils poor in N availability and in presence of adequate amount of phosphorus because it is required in energy transfer during nitrogen fixation.

Table 3. Response of pulses (yield, kg ha^{-1}) to *Rhizobium* inoculation at farmers field

Crop	No. of trials	Uninoculated	Inoculated	% increase
Pigeonpea	27	716	845	17.9
Moong	38	547	647	18.3
Urd	18	646	753	16.5
Lentil	18	1046	1163	11.1
Chickpea	59	1161	1241	6.9

Source: Trials conducted under AICRP on MULLaRP (Khurana et al., 1997)

Dobereiner and her co-workers isolated a number of diazotrophic bacteria e.g. *Azotobacter, Azospirillum, Herbaspirillum*. Out of these *Azotobacter and Azospirillum* are known to economize the nitrogen in cereals, vegetables besides synthesis of various growth promoting substances, auxins, cytokinins, antifungal compounds etc. Among these, *Azotobacter* and

Table 2. Range of benefits of commonly produced biofertilizers

Name	Crops suited	Benefits usually seen	Remarks
Rhizobium strains	Legumes like pulses, groundnut, soybean	10-35% yield increase, 50-200 kg N/ha	Fodders give better results. Leaves residual N in the soil
Azotobacter	Soil treatment for non-legume crops including dry land crops	10-15% yield increase adds 20-25 kg N /ha.	Also controls certain diseases.
A*zospirillum*	Non-legumes like maize, barley, oats, sorghum, millet, sugarcane, rice etc.	10-20% yield increase	Fodders give higher/enriches fodder response. Produces growth promoting substances. It can be applied to legumes as coinoculant.
Phosphate solubilizers	Soil application for all crops	5-30% yield increase	Can be mixed with rock phosphate.
Blue-green alga and Azolla	Rice/wet lands	20-30 kg N /ha, Azolla can give biomass upto 40-50 tonnes and fix 30-100 kg N /ha	Reduces soil alkalinity, can be used for fishes as feed. They have growth promoting hormonal effects.
Mycorrhizae (VAM)	Many trees, some crops, and some ornamental plants	30-50% yield increase, enhances uptake of P. Zn, S and water	Usually inoculated to seedlings.

Azospirillum are the potential biofertilizers for cereals, vegetables and oil seed crops. Their inoculation was found to increase the yields ranging from 2-50% depending upon the strains used, crop type, soil and environmental conditions and crop management practices under AICRP on MULLaRP. The amount of nitrogen fixed by these bioferilizers is relatively less ranging from 15-25 kg N/ ha/ year under optimum conditions. Inoculation with these biofertilizers can increase the grain yield by about 10 per cent depending on the management of the crops.

Acetobacter diazotrophicus was discovered recently from sugarcane rhizosphere and renamed as G*luconacetobacter diazotrophicus* in 1998. This bacterium has ability to fix atmospheric N_2 and to survive under high sugar concentration. It can tolerate low pH, fix N_2 even in presence of nitrate and is best adapted endophytically in sugarcane environment and therefore, assumes more importance in nitrogen economy as compared to the other biofertilizers in sugar cane. Besides, the bacterium secretes plant growth promontory substances such as Indole acetic acid and favours the germination and root development, which in turn help in the absorption of plant nutrients effectively from soil. This biofertilizer is useful in sugarcane crop and posses the ability to increase the crop yield by about 10 %.

Cynobacteria, also known as blue green algae (BGA), are photosynthetic bacteria and attracted the attention of workers as nitrogen fixer as well as soil conditioner. They synthesize their own energy source for nitrogen fixation unlike *Azotobacter* and *Rhizobium*. Lowland (puddled) rice is an ideal ecosystem for their survival, growth and nitrogen fixation and therefore, BGA are suitable biofertilizer for rice crop. They can fix about 20-30 kg N/ha/season. Application of 10 kg soil based BGA culture in rice can increase the yield approximately 10 % under optimum conditions. Microalgae have been reported to improve soil fertility and structure because of their addition of organic matter and stabilization of soil aggregates. The major problem in algal inoculation is the establishment of inoculated species in sufficient numbers in field. Grazers and green algae create problem in their establishment.

Several bacteria, particularly those belonging to genera *Pseudomonas* and *Bacillus* and fungi belonging to *Penicillium* and *Asprergillus* genera have the ability to solublize the insoluble inorganic phosphorus in soil to make it available for plants. The mechanisms of solublization appears to be either acid production or chelation of metal and release of phosphorus. Many a times these phosphate solublizers are also producers of plant growth harmones like Indole acetic acid, Gibberellic acid etc. Biofertilizers of these microorganisms can be used in all crops. Normally these bacteria can solubilize about 15-20 kg P/ha/season. Soils having high amount of plant available P show poor response to inoculation of their biofertilizers.

The group of beneficial free living soil bacteria capable of stimulating the growth of plants is referred as Plant Growth Promoting Rhizobacteria (PGPR). It includes the bacteria belonging to genera *Acetobacter, Actinoplanes, Bacillus, Cellulomonas, Pseudomonas and* others in addition to nitrogen fixers, P-solubilizers/ mobilizers etc. The interactions between PGPRs and biofertilizer organisms in the rhizosphere may be inhibitory, synergistic and stimulatory for the growth of biofertilizer organism(s). The major mechanisms responsible for stimulation of plant growth by PGPR include production of plant growth promoting substances, increased availability and uptake of nutrients; and suppression of growth of pathogenic microorganisms.

Among soil microorganisms mycorrhizal fungi forms the direct link between soil and plant roots. Among these Arbuscular Mycorrhiza (AM fungi) have great significance in heavy metal availability and metal toxicity to plants. They help in absorption of phosphorus and micronutrients like Zinc, Iron, Manganese and are potential biofertilizer for most field crops. However, commercial inoculants of these fungi are not available, as they do not grow on synthetic medium in laboratory conditions. In limited amount, the spores and mycellim grown on plants under controlled conditions are available as inoculum for field use at small scale. They are particularly useful in transplanted crops where VAM inoculum may be applied during nursery raising. Arbuscular mycorrhiza is an important factor in reclamation of mine spoils, metal and tannery effluent polluted soils. The mycorrhizal fungi contributes directly to plant establishment in soils contaminated with heavy metals by binding metals to fungal hyphae in roots or in the rhizosphere.

Biofertilizers are undisputable component of INM. Conjoint application of biofertilizers, chemical fertilizers and organic manures, in addition to inclusion of legumes in cropping system and incorporation of on and off farm generated crop residue constitutes an efficient nutrient management strategy. To harness the fullest potential of the tiny creatures for maintaining/improving the soil

fertility there is a need to develop specific efficient strains for use under varying agro climatic situations. For the development of such strains to work under normal as well as adverse conditions prevailing in agriculture the principles of selection of individual microorganism from the indigenous flora and/or use of modern molecular tools is warranted. In addition, the cropping sequence needs to be identified which will derive lesser quantities of nutrients from soil and add more residue along with the indirect impact on various soil properties.

"Farming looks mighty easy when your plow is a pencil and you're a thousand miles from the cornfield."

- Dwight D. Eisenhower.

"As long as there's a few farmers out there, we'll keep fighting for them."

- Willie Nelson

Biostimulants, botanicals and microbes for plant growth and development

Manali Singh[1]*, Yumnam Bijilaxmi Devi[2] and Anil Kumar[3]

A plant biostimulant is any chemical or microbe that is given to plants in order to improve the plant growth & development, food capacity, abiotic stress resistance, and collect quality ascribes, regardless of its enhancing content. Plant biostimulants, on the other hand, disperse commercial items containing mixtures of such compounds or potentially microbes. Conflicts related to perceptive facts on the nature, methods for improvement, and types of impacts of biostimulants on assemble and green plants are kept in mind by the term presented in this article. Furthermore, the suggested definition aims to improve biostimulant accreditation by future principles, by illustrating endpoints between biostimulants and fertilizers, pesticides or biocontrol organized professionals. Along with these, physical stimulant will also help in improving stress resistance against abiotic factors. These will improve the physical condition of the soil directly and indirectly, improve the growth of plants. Physical stimulant may include biochar, jivamrit, ghanamrit, vermicompost etc. All these are easy to prepare but has great importance in restoring the soil degradation thus helping plants to acquire optimum condition for its growth. Different biostimulants help food become more powerful and nutritious, and they do so by paying attention to it. Such biostimulants of plants, algae, seaweeds and others origins have wide applications by maintaining beneficial soil biota and thus enable to help in the restoration of soil fertility.

Introduction

For depicting biostimulants, the featured seeing biostimulants from redesigns and soil changes, which also advance plant improvement but are applied in more unmistakable aggregates, the word biostimulant was plainly started by improvement experts for depicting substances moving plant progress without being supplements, soil improvers, or pesticides, for depicting biostimulants, the featured seeing biostimulants from redesigns and soil changes, which moreover advance plant improvement but are applied in more unmistakable aggregate Humic acids and kelp are the biostimulants recommended for field level applications. Later study and publications by similar manufacturers on the same or similar examinations didn't really utilize the name biostimulant. For example, a publication describing the use of humic acid and kelp kills to increase turfgrass drought tolerance did not utilize the phrase biostimulant in any way possible. The focus of the article was on the compound-like actions of these blends, as well as the word substance containing.

Industry is a key player in the development and definition of biostimulants, including microorganisms. The European Biostimulants Industry Council (EBIC) in Europe and the Biostimulant Coalition in the United States have formed affiliations to communicate with various partners, regulators, and educated authorities. In regular talks, the business sector has also kept an eye on the connection. The goal of this article is to contribute to a unique perspective on plant biostimulants by including speculative and supporting data on the main kinds of biostimulant substances used in research and development.

Despite recent attempts to explain the administrative position of biostimulants, there is no legal or administrative definition of plant biostimulants anywhere on the globe, including the European Union and the United States. The existing situation prevents a detailed listing and plan of the compounds and microorganisms included by the concept. Despite this, subject matter experts, controllers, and accessories have identified a few of large classes that encompass both chemicals and microbes. Microorganisms are made up of powerful small conventional pieces, such as PGPRs, and remarkable parasites. They can be endosymbiotic, rhizospheric, or free-living. These gatherings are quickly presented in the going with district and will also be depicted in the going with papers of this incredible event. All these microbes require a genuine environment where they can perform their functions and physical stimulants like biochar, vermicompost which will improve the soil physical condition of soil will provide that environment. Applying microbial biostimulant along with these physical biostimulants will provide both the condition and agents where these components will contribute at the maximum in increasing yield of the crop/plant.

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The use of young kelp as a source of ordinary matter and as faeces is an ancient practice, although biostimulant effects have recently been documented. This leads to the commercial use of kelp confines and isolated mixtures that include the polysaccharides laminarin, alginates, and carrageenans, as well as their breakdown products. Miniature and macronutrients, sterols, N-containing uplifts like betaines, and engineered materials are some of the ingredients that contribute to plant growth enhancement. A couple of these buildings are unquestionably earth-shattering in terms of their algae source, demonstrating the growing interest of standard trained experts and the industry in these genuine representations. A large number of algae species belong to the phylum of normal shaded green improvement, with *Ascophyllum*, *Fucus*, and *Laminaria* as essential genera-however, carrageenans are descended from red kelp, which seem differently in relation to a clear phylogenetic line. More than 20 kelp items are used as a plant development biostimulant, and their names are listed below. Kelp is making a comeback in soils and on plants. They can be used as foliar prescriptions, on soils, or in aquaculture techniques. Their polysaccharides contribute to the gel development, water maintenance, and soil air circulation in soils. The polyanionic accumulating contribute to the fascination with and trade of cations, which is similar to the interest in major metals and soil remediation

The movement of plant progress promoting little natural elements and microorganism miscreants in suppressive soils is also portrayed, with significant consequences via the dirt microflora. In plants, nutritional influences are more mild than usual, and macronutrients demonstrate that they operate as fertilizers, despite their various locations. Hormone effects on seed germination, plant foundation, and other new development and progress are linked to hormonal effects, which are thought to be major explanations for biostimulation advancement on crop plants. Despite the fact that bioassays and immunological instruments have detected cytokinins, auxins, abscisic horrendous, gibberellins, and other classes of substance like mixes, such as sterols and polyamines, in kelp eliminates, there is proof that the hormonal effects of concentrates of the good hidden ocean advancement *Ascophyllum nodosum* are revealed generally by the down-and up regulation of engineered biosynthetic attributes in plant.

Botanicals are compounds extracted from plants that are used in pharmaceutical and supporting products, as well as food decorations and plant security products. Separated and ocean enhancement, basically less is understood about their biostimulant works out, with the focus recently shifting to their pesticidal characteristics. By the way, there's a good probability they may be used as biostimulants as well. Furthermore, plant coordinated efforts in natural structures are known to be mediated by plant dynamic mixes, also known as allelochemicals, which are gaining popularity as a thought for OK yield. Regardless of how harvest turns, intercropping, cover crops, and mulching are used in the most basic situation to take advantage of allelochemical cooperative attempts between plants (known as allelopathy), these compound correspondences should be given more care for the movement of novel biostimulants.

Many yield frameworks respond to plant biostimulants in different ways, and noteworthy consequences are often reported in assisted research office or nursery circumstances and in unmistakable gather species. Fragment collects and grains are the yields that have been thoroughly considered within corporate green creation frameworks and have been shown to react immovably to biostimulant elements. Unambiguous producing systems, express medicine regimens (often incorporating a few types of biostimulants or massive amounts of micronutrients), and other common variables further tangle their use. Kelp extracts, which contain a wide range of macronutrients and micronutrient upgrades as well as common parts like progression manufactured substances, amino acids, supplements, betains, cytokinins, and sterols, have played an important role in the development of an environmentally friendly seed developing project. If all else fails, kelp concentrates can start changing the physiological/biochemical correspondence associated with plant supplement uptake and development. Restoring the soil for better microbial habitat will surely ensure the workability of these plant biostimulant, be it microbe or any concentrate. Therefore, knowledge of biostimulant and its importance in improving the plant growth will twiddle the thinking of researchers and farmers towards sustainability. Providing more and more novel plant stimulants will help in maintaining the sustainable environment through restoration of the ecosystem along with boosting the growth of plants. Both ways, it will serve the purpose of increasing productivity by sustaining natural resources for future use.

Uses of spent mushroom substrate in organic farming

Vaibhav Singh and Prashant P. Jambhulkar

Mushroom is an important agricultural cash crop which has greatest potential of becoming a major source of income for the farmers. Indian mushroom industry is primarily based on white button mushroom and its share amounts to nearly 73 per cent followed by oyster mushroom which contributes around 16 per cent of the total mushroom production. As per National Horticulture Board data India produces 200 metric tons of mushroom and after harvesting of the primary crop of 1 kg new mushrooms results in 5-6 kg of spent substrate. Therefore, quantity of spent mushroom substrate available for further utilization in organic farming is enormous.

Introduction

Compost transforms as spent substrate when one complete cycle of mushroom has been taken and further use is unprofitable in terms of mushroom production this partially decompose paddy or wheat and other agroved which turns into valuable by product used for edible mushroom cultivation is termed as spent mushrooms substrate in USA, spend mushroom compost in Europe and as mushroom bran or mushroom residue or mushroom soil in China. SMS possesses environmental challenges as it starts polluting ground water and dumping soil if not managed. Keeping this in mind scientists are trying to develop technology for better and purposeful utilisation of SMS therefore new uses have become apparent very recently.

Above mentioned facts the term spent does not look appropriate, therefore a new term introduced “use mushroom substrate” or “post mushrooms substrate” because it serves as substrate for new group of microorganisms having simple forms of protein in abundance due to activity of mushroom cultivation. Contents of SMS types are based on different states preparation process and different type of mushroom cultivated.

Spent mushroom substrate composition, its role as manure for organic farming and recomposting methods

SMS serves as good organic manure as well as soil conditioner due to its associated attributes like moderate nutrient, neutral pH, beneficial microbes, leading to quality compost for cultivation of agriculture and horticulture crops. SMS is considered as nutrient rich source of agriculture manure it has high cation exchange capacity, high proportion of nutrients it can hold, slow rate of mineralisation and the amount of heavy metals is less as compared to sewer sludge therefore it is not considered as hazardous substance.

Mineral fertilizers are superior to SMS in terms of nitrogen, phosphorus and potassium content but SMS release nutrients slowly as compared to mineral fertilizers therefore plants can use nutrients released by SMS more efficiently further addition of SMS in nutrient poor soil will help in improving its texture, water holding capacity, along with improved nutrient status of the soil without adversely affecting the alkalinity though it increases pH and organic carbon content of the soil. Since the SMS is poor in nitrogen content, so more amount is needed to be incorporated as manure to fulfill the crop requirement but it can sufficiently provide phosphorus and potassium therefore 25% SMS by volume has to be incorporated for providing required amount of nitrogen while only 5% SMS volume by volume can fulfill the phosphorus and potassium requirement respectively.

Quality of SMS can be enhanced and negative effects get minimized if some processes like recomposting, desalting or prolonged leaching are done. Recomposting can be done by three methods first natural recomposting in which natural weathering process takes place, a kachha pit of 5 by 5 by 5 feet is filled fully with SMS and kept for 2 years second method is modified version of natural recomposting in which provision of natural aeration is incorporated by making perforated base with the help of wooden planks and 2 inches pipes with 0. 5 inch holes at each 15 cm in a circular pattern are placed vertically at regular intervals to enhance aeration. Third method is anaerobic process in which pits of the same size as mentioned earlier are completely filled with SMS then covered with a 1 feet thick layer of normal soil which creates anaerobic condition for recomposting and SMS is kept for 2 years.

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SMS as raw material for vermicomposting

SMS can serve as a raw material for vermicompost and it has been found that using the substrate from paddy and oyster mushroom are better substrates for vermicompost as compared to SMS of button mushroom. SMS from button mushrooms can be used fresh alone or can be mixed with FYM or 15-20 days old semi rotten SMS can be used as raw material for vermicompost.

Organic manure for horticultural crops and reuse in mushroom cultivation

Associated attributes of used mushroom substrates richness of nutrients and characters of organic manual make it suitable growing medium for horticultural crops like cucumber tomato broccoli to live cauliflower paper spinach and many more crops of fresh SMS is not recommended and some treatment like salt leaching and weathering is essential which makes the SMS more suitable for uses in agriculture and horticulture crops. After proper processing SMS can be used as casing material in mushroom cultivation, it was found that in anaerobic recomposted SMS when used as casing material yield was equivalent to peat based casing material with added advantage of less infection of bacterial blotch. When aerobically recomposted SMS used as casing material, it was found better than 2 year old open weathered SMS and 2 years old FYM but was at par with coir pith casing material with added advantage of 2-3 days early crop.

About 80% of the total nitrogen is inbound form with high molecular weight fractions of lignin and humic substances, therefore nitrogen release from SMS is very low and is insufficient which can be enhance by addition of some easily available form of nitrogen source Phosphorus potassium micronutrients and other growth substances in SMS are present in sufficient quantity and in the available form. The adsorption capacity of humus present in SMS helps in nitrogen retention in the topsoil (Table 1.).

The organic mineral fertilizer improves not only quality but also the dry matter of crops as compared to mineral fertilizers. Conversion of SMS into an organic - mineral fertiliser is an alternative way of using spent mushroom compost for soil amelioration and to make it a balanced source of nutrition for plant growth.

Table 1: Effect of SMS applied as organic manure on quality and disease severity of horticultural crops

Crop	Dose	Quality	Diseases management
Tomato (*Lycopersicon esculentum*)	18.5 ton/ha	Superior fruit weight, ascorbic acid content, dry matter, total soluble solids (TSS) & acidity in anaerobically recomposted SMS.	Lower incidence of Blossom end rot, Buck eye rot, Leaf curl in anaerobically recomposted SMS, while Fruit borer in FYM.
Shimla Mirch (*Capsicum annuum*)	25 ton/ha	Superior fruit length, fruit width, dry matter, total soluble solids & ascorbic acid content in 12 months old naturally weathered and aerobically recomposted SMS.	Lower incidence of Fruit rot, Chilli veinal mottle virus, Grasshopper attack in 24 months old naturally weathered and aerobically recomposted SMS.
Pea (*Pisum sativum*)	20 ton/ha	Higher contents of protein, ascorbic acid, dry matter & total soluble solids in 18 months aerobically/anaerobically recomposted SMS.	Lower incidence of Fusarium wilt and Powdery mildew score in SMS.
Cauliflower (*Brassica oleracea var botrytis*)	25 ton/ha	Superior stalk length, curd length, curd dia, dry matter, ascorbic acid content, curd appearance in 12 months old anaerobically/aerobically recomposted SMS.	lower incidence of black rot and Caterpillar in SMS.
Ginger (*Zingiber officinale*)	30-32 ton/ha	Superior rhizome length, breadth, thickness, dry matter, total soluble solids, fibre & NSS in 18 months old aerobically/anaerobically recomposted SMS + chemical fertilizers.	Lower rotting incidence in SMS
Onion (*Allium cepa* L.)	25 ton/ha	Superior length and diameter of bulb, total soluble solids, dry matter, pyruvic acid and ascorbic acid contents in 12 months old anaerobically recomposted SMS + fertilizer	-
Brinjal (*Solanum melongena*)	25 ton/ha	Best in standard followed by SMS treatments.	-

Source: DMR, Solan (H.P.)

Spent mushroom substrate for disease management

Inherent characteristics of chemical constituents and micro flora of SMS like actinomycetes bacteria and fungi place important role in decomposing the SMS as well as important to the SMS which affects pathogen surviving and multiplying the soil ecosystem these inhibitory properties of SMS remain affected even after autoclaving and filter sterilisation of aqueous extract

There are certain examples where SMS restricted the military incognito infection of tomato plants causing root not disease with if he levels are then carbofuran. In case of apple when aqueous extract of anaerobically fermented SMS inhibited conidial germination of Apple scab pathogen *Venturia inaequalis* and maize pathogen *Cochliobolus carbonum*. Reason for this activity was divulged in biological analysis which confirmed the presence of Pseudomonas and Bacillus species.

Bioremediation of contaminated soil for quickly converting into organic

Industrial and city waste released into the environment without prior retreatment has contributed to high levels of contaminants in the soil and natural process of their degradation depends upon the physical and chemical conditions prevailing along with the available microbes present in the soil the actinomycetes like Streptomyces and Thermomonospora species present in the SMS have been found to have strong pollutant catabolising capabilities due to which the help in reducing the level of pollutants in the contaminated soil.

According to the study conducted at DMR Solan SMS of button mushrooms when applied at the rate of 20% volume by volume reduce the maximum amount of agrochemicals like mancozeb, malathion Decis and Carbendazim from the treated soil. Also when the soil is amended at the rate of 10 and 20% volume by volume with SMS, maximum bio-elimination of Cadmium and lead was reported respectively.

Commercial mushroom production is increasing and the availability of used mushroom substrate is also increasing which has great economic value if utilised efficiently scientists are trying to explore new ways of SMS utilisation in different aspects for solving agriculture problems.

Inherently high levels of salts can be reduced to desirable levels if desalting or prolonged leaching is done because these salts are water soluble and other properties can be improved by recomposting for 2 years, which makes it suitable for use in agricultural and horticultural crops.

Besides this there are new upcoming technologies for SMS utilisation such as biofuel, biofertilizer and many other uses.

"You know, farming looks mighty easy when your plow is a pencil, and you're a thousand miles from the corn field."

- Dwight D. Eisenhower

"The farmer is the only man in our economy who buys everything at retail, sells everything at wholesale, and pays the freight both ways."

- John F. Kennedy

Impact of organic farming on nutritional, functional and organoleptic properties of food

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India has achieved the self-reliance in food production and now more focus is given on the methods of farming which uses no or minimal synthetic fertilizers, zero pesticides, produces grains with high nutritional value and cause minimal or no damage to the environment. To meet these requirements, natural and organic farming has emerged as the most reliable methods. It has been found in many studies that organically produced foods are nutritionally superior to conventionally produced foods. They are also rich in phytochemicals and possess better sensorial properties. They are also free from harmful pesticides and toxicants. The present article provides an insight of the scientific studies on the nutritional, phytochemical, and sensorial properties of the organically produced foods.

Introduction

Agriculture is one of the largest professions of India and nearly 52% of Indian population is directly engaged in agriculture. With the intensive agricultural practices we have mastered the techniques of food production and we have achieved self-reliance in the production of agro-commodities. This was possible only with the conventional method of farming that increased the yield offood crops by several fold by the use of synthetic chemical fertilizers, fungicides, insecticides, and herbicides and made country self-reliant in the food production. Presently, India is the 2nd largest producer of cereal grains (316 million metric tonnes), vegetables (192.8 million metric tonnes) and fruits (99.07 million metric tonnes). Since, we have achieved self-reliance in food production, now our major priority is to produce foods that are nutritionally superior, requires little or no means of synthetic fertilization and causes least damage to the environment. This can we achieved by using age old methods of natural farming and organic farming. Although, the concept of natural farming and organic farming is very old but the modern day credit of revitalizing this concept is given to Mokichi Okada. He was very concerned about the protection of environment, food safety and quality, and human health. He proposed the concept of natural farming in 1935 and conducted some experiments to prove that the chemical methods of cultivation are neither compatible nor good for environment.The terms 'Eco-agriculture' and 'Eco-friendly' agriculture are also used for this method of agriculture. The most critical aspect of natural farming is to let nature play a dominant role to the maximum extent possible. Some people also confuse natural farming with organic farming or consider both these systems of farming as organic system of farming. The organic system of farming is different from natural farming as it do not use chemical fertilizers, pesticides, and herbicides but animal manure and urban sewage are allowed for use as fertilizers and soil conditioners.In natural farming, all synthetic chemicals, animal manures (untreated), urban sewage and animal products are prohibited for use. However, the composts prepared by fermenting organic materials can be used in this method to increase soil fertility and physical properties. The physical, nutritional, phytochemical and sensorial properties of foods are also affected by the method of farming or cultivation. This article provides an idea about the effect of organic farming on the various quality parameters of foods.

Effect of type of farming on the physical properties and nutritional and phytochemical composition of plant based foods

There is a direct relationship between the health of soil (organic matter, microflora and mineral content) on the nutritional composition of the crop produced on it. These days the debate of consuming organic and natural foods is increasing and most of the consumers prefer organic foods over the conventional one. Many of the consumers also believe that the organic foods are nutritionally sound than there conventional counterparts and also possess better sensory properties. This section discusses the scientific literature on the nutritional, phytochemical and sensorial properties of organic, natural and synthetic foods.

Physical properties

The physical properties of the fresh produce like firmness are also affected by the method of farming i.e. conventional, organic and natural). The firmness mainly

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depends on the content of boron, calcium, selenium and silicon as these help to increase the cell wall thickness. So, we can say that the firmness is mainly affected by mineral content rather than the method of cultivation. Ochimian reported better firmness in the conventionally grown blue berries in comparison to the organically grown blueberries. In contrary to this, Guilherme reported higher level of firmness for organically grown sweet pepper in comparison to conventionally grown sweet pepper. So, we can conclude that the firmness mainly depends on mineral content and the cultivation conditions with better mineral profile will produce fruits with more firmness.

Nutritional composition

The major nutrients in the food are carbohydrates, proteins, lipids, minerals and vitamins. One the basis of their requirement they are categorised as macronutrients and micronutrients.

Macronutrients

The major macronutrients in the foods are carbohydrates, proteins and lipids. The type of farming is also reported to affect these macronutrients. Vrèek reported a lower protein content and higher protein digestibility for the organically grown wheat flour in comparison to the conventionally grown wheat flour. A higher level of carbohydrates and total acid concentration is also reported for the organically produced fruits. In a study conducted by Ciolek, it was found that the content of lipids was more in conventionally grown cereals (wheat, hulled barley, oats) in comparison to the organically grown cereals except naked barley. The oil from the organic cereals was richer in poly unsaturated fatty acids in comparison to conventional grown crops.

Micronutrients

The major micronutrients in foods are minerals and vitamins. Minerals represent the inorganic matter of the food while vitamins are organic compounds which are required in very small quantities in the diet for normal growth. Although both these nutrients are required in very small quantities, they are essential for good physical and mental health. Lower levels of calcium, manganese, and iron and higher levels of potassium, zinc and molybdenum were reported for the organically grown wheat in comparison to the conventionally grown wheat. Ciolek reported a higher level of manganese, iron, zinc and calcium in organically grown grains. Omondi conducted a study in 2014 to quantify effects of the nutrient density of oat grains in there types of agricultural systems i.e. organic manure-based (MNR), organic legume-based (LEG) and conventional input-based (CNV). It was found in the study that organic system increased six (aluminium, iron, chromium, calcium, barium and strontium) out of ten soil minerals. The level of essential amino acids was also higher in LEG systems compared with other systems except lysine, histidine and methionine. Organically grown crop also had higher thiamine content. The overall nutritional concentration of oat grains was greater in organic systems in comparison to conventional agricultural systems. A higher level of vitamin C (89.2 mg), iron (3.7 mg), magnesium (80.0 mg), phosphorus (124.0 mg) was found in one day vegetables intake, in comparison to the conventional diet containing 67.9, 3.0, 68.6 and 111.8 mg of vitamin C, iron, magnesium and phosphorus, respectively. Some studies claim that the organically produced fruits and vegetables contain lower amount of nitrogen in comparison to the conventional crops and hence contain high levels of Vitamin C but at the same many of studies do not support this claim. Organically grown produce also contain higher levels of Vitamin C (10.4%). This is attributed to the lower levels of nitrogen than the conventional crops. Organic strawberries, beetroots, lettuce, blueberries, plum, strawberries, tomatoes, and other plant foods are reported to contain higher vitamin C in comparison to the conventional one. The conventional potatoes are reported to contain more vitamin C than the organically grown potatoes. Some studies also claim that there is no significant difference between the vitamin C content of organically and conventionally grown foods.

Phytochemicals

High levels of anthocyanins are reported for organically produced blues berries from New Jersey farm, New York. High levels of polyphenols and flavonoids are reported for organically grown broccoli, purple grape juices, peaches and pears, and yellow plums. In an *in vitro* study it has been reported that organic fruits and vegetables have higher antioxidant activity, and they suppress the mutagenic action of toxic compounds, and inhibit the proliferation of certain cancer cell lines. However, the *in vivo* studies did not show any such effect in humans.

Sensorial properties

Many of the consumers believe that the organically and naturally produced foods (fruits, vegetables, tubers,

spices, cereals etc.) have better sensory profiles in comparison to the conventionally produced foods. However, in a quantitative descriptive sensory analysis of nine organic and conventional fruits and vegetables, the panel of 9 trained panellists failed to find any significant difference in the sensory attributes of organic and conventional fruits available in the Irish market. Roussos also reported that the taste of organic produce does not differ much with the type of cultivation. In a sensorial consumer study conducted by Zhao on organically and conventionally grown red loose leaf lettuce, spinach, arugula, mustard greens, tomatoes, cucumbers, onions, it was found that the consumer panellists were not able to find any significant difference in the taste and aroma of the vegetables grown using two methods. Dhakal also reported no significant textural differences on the instrumental analysis of organically and conventionally produced vegetables.

Pesticide residues

The levels of Arsenic and cadmium were significantly lower in organic wheat flour in comparison the conventional wheat flour. Crinnon has reported significantly lower levels of nitrates and pesticide residues in organically grown varieties.

There was little effect of the type of farming on the macronutrient composition of the foods. A major impact of type of farming was seen on the micronutrients *viz.* minerals and vitamins, and phytochemicals. Again, this effect was not linear and some of the nutrients were increasing in the organic farming, while, some others were decreasing. In many of the studies it was found that the nutritional composition of the grain was directly dependent on the health of the soil and the type of farming had non-significant effect on the nutritional and phytochemical composition of the foods. The effect on the sensory properties of the food was also not very clear; however, all the studies claim the reduced level of pesticides and toxicants in the organically produced foods.

"Do what you love to do, and be around things that make you smile. The cows make me smile every day." *- David Jackson*

"The farmer has to be an optimist or he wouldn't still be a farmer."

- Will Rogers

The regulations on the functional foods and nutraceuticals and the effect of natural and organic cultivation on their quality attributes

Manali Singh*, Ashwani Kumar and Anil Kumar

The health foods are categorised into two major classes i.e. functional foods and nutraceuticals. The functional foods are the foods which provides the additional health benefits beyond the basic nutrition, while, the nutraceuticals are the concentrated form of bioactive compounds in the form of powder, pills or extract which have ability to cure the disease. The main difference between functional foods and nutraceuticals is that functional foods contain nutraceuticals as one of their ingredients while nutraceuticals are the purified form of bioactive compounds. Functional foods generally prevent the diseases but do not have the ability to cure a disease, while, nutraceuticals can treat/cure the diseases. The functional foods are not required to pass through the strict regulations; however, the nutraceuticals need to pass through the similar regulations as that of pharmaceuticals. This causes a considerable variation in the regulation of advertising authorisation. To ease this, government of India has passed a regulation named Food Safety and Standards (health supplements, nutraceuticals, food for special dietary use, food for special medical purpose, functional food and novel food) regulations, 2016. This regulation discusses about the laws on the use of functional foods and nutraceuticals.

Introduction

A health care product may be the one that can prevent or delay the onset of the disease or has the ability to cure a prevailing medical condition. Functional foods, pharmaceuticals and nutraceuticals are among the major health care products. These products can individually or in combination may be used by the people with the goal of restoring, correcting, or modifying physiological processes through immunological, pharmacological, or metabolic changes, Although the size of the pharmaceuticals is very big but the number of people believing the capability of functional foods to prevent the onset of diseases and the ability of nutraceuticals to cure the diseases it also increasing rapidly. People have begun to utilise dietary items as consumables that will prevent disease and boost physiological performance rather than eating them to satisfy the prescribed dietary intake. The demand of nutraceuticals is also increasing rapidly and the popularisation of the traditional medicinal systems like Ayurveda, Unani, Siddha and Homeopathy has further strengthen the belief of people on the nutraceuticals. It has been found that the organically and naturally grown foods can provide phytochemicals in concentrated form without the accumulation of the toxic compounds (pesticide residues from sprays). This article discusses the role of organic and natural farming in improving the quality and health benefits of functional foods and nutraceuticals and their role in minimizing the safety concerns. Further, the regulations operational in the country for development and utilization of functional foods in the country are also discussed.

Role of organic and natural farming

Organic and natural farming are now widely recognised as a new strategy to agricultural growth that places a premium on the production of healthy and safe food. The functional foods prepared using the organic and naturally grown has been reported to contain less or no toxic compounds compared to their conventional counterparts. This increases the overall health benefits and safety of the functional foods prepared using the organic produce. The safety and the reliability of these products can be enhanced by adopting the laws on the functional foods and nutraceuticals.

Laws on nutraceuticals and functional foods in the country

To ensure the safety and desired health benefits of the functional foods and nutraceuticals India has introduced Food Safety and Standards (health supplements, nutraceuticals, food for special dietary use, food for special medical purpose, functional food and novel food) regulations, 2016 under the Food Safety and Standards Act, 2006. Under these regulations, the functional foods and nutraceuticals are categorised into eight major categories i.e. Health Supplements, Nutraceuticals, Food for Special Dietary Use, Food for Special Medical Purpose, Specialty food containing plant or botanicals,

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Foods containing Probiotics, Foods containing Prebiotics and Novel Foods.

New approaches for the development of nutraceuticals and functional foods

Nutrigenomics

Nutrigenomics is a field of research that examines the impact of dietary nutrients and other food compounds on gene expression and gene regulation. It is a strategy for identifying dietic chemicals that have beneficial health benefits by looking into diet gene interactions. It will also aid in determining each required nutritional property using an individual's genetic makeup, as well as the relationship between diet and acute diseases, which will aid us in recognising the genetic aspects of acute diseases such as obesity, cardiovascular disease, type 2 diabetes, and cancer. It will also assist us in identifying the genes implicated in diverse phenotypic reactions to a certain diet, as well as the genes that are indulged.

Nutrigenetics

Nutrigenetics is a field of study that identifies a person's genetic composition by comparing their reactions to a variety of dietary nutrients. It also reveals the various reactions that people have to a certain nutrient. When these two perspectives are combined, they guarantee to provide a critical part of scientific knowledge that helps us recognise an individual's diet effects and, in most cases, it will also guide us into an exhibit form of dietary intercessions actions for the restoration of health and well-being in order to prevent diet-related issues. Many of the difficulties are embodied in the introduction of botanically based nutraceuticals for use in food supplements and functional foods. The most important is the status of meals or components in terms of regulations governing both pharmaceuticals and food materials, since many chemicals are quite close to the line separating the two groups.

Conclusion

The demand of value-added products is continuously increasing due to lack of time in this competitive era. Hence, people prefer **"Ready to eat and easy to carry food items"** for fulfilling their nutritional and food requirements. Development of functional foods and nutraceuticals and the market for such value-added products that are envisioned to grow many folds in coming years. The Food and Drug Administration has also released regulations that support this emerging industry therefore fostering scientific research. Hence, an immediate goal should be identification of health benefitting factors to enhance the essential nutrient levels in staple crops to significantly impact human nutrition worldwide.

Agriculture is the most healthful, most useful, and most noble employment of man

George Washington

When the Nobel Peace Prize Committee designated me the recipient of the 1970 award for my contribution to the 'green revolution,' they were in effect, I believe, selecting an individual to symbolize the vital role of agriculture and food production in a world that is hungry, both for bread and for peace.

Norman Borlaug

What is natural farming and how to start?

V.K. Sachan

Abstract

Green revolution certainly brought food stability and made the country self sufficient. But but these methods have created new issues which should to be addressed at priority for maintaining the sustainability of human. Excessive use of chemical fertilizers and pesticides hampered the natural farming. There is an urgent necessity to promote and conserve the beneficial micro-organisms found in the soil have a great contribution not only to protect the crops from diseases but improve fertility of soil. It is necessary to understand the ancient culture of our agriculture; because it is a matter of philosophy and not of economics.

Introduction

To increase the production of food grains, under the Green Revolution programs, the use of improved seeds, chemical fertilizers, tractor and its allied agricultural equipment, irrigation tools, agro-technical methods and crop protection chemicals were increased. There is no doubt that due to the programs adopted under the Green Revolution, the food grain production of the country had increased to 170 million tonnes as against 50 million tonnes per annum in the 1990s and the country became self-reliant in the field of food production.

The programs adopted in the Green Revolution were the need of the hour and the country's agricultural scientists, extension workers and farmers worked tirelessly for this.

But we also have to accept that in this race to increase the production of food grains, we have

1. The fertility of the cultivable lands of the country has been weakened.
2. Exploitation of ground water has been done a lot.
3. Biodiversity has been destroyed.
4. The presence of chemicals in food and water has also spoiled the health of human beings.

We are not the last people of this earth, but after my death, many generations to come, also have to live in this splendour of nature, so it is my responsibility to maintain the splendour of nature right and this is natural agriculture.

Our ancestors used to say that

THE NAME OF THE EATER IS WRITTEN ON THE GRAIN.

But today we do not want to give share to anyone in our crops.

Purpose of our Sanatan Agricultural Culture-

SARVE BHAVANTU SUKHINAH BELONGED TO SARVE SANTU NIRAMAYAH.

But today we are hurting all the living beings of the earth and spoiling the health of all the living beings.

The description of the totality of natural agriculture is found in the definition of the cropping branch of agricultural science.

Agronomy says that such management of land and crops so that all the needs of the farming family are fulfilled, but there should be no adverse effect on the fertility of the land.

This definition was given when crop protection chemicals were not used at all.

But today, when we are increasing the use of crop protection chemicals in the production of crops, then the definition of natural agriculture is that-

*That technique of farming so that most of the needs of the farmer family are fulfilled and no damage should be done to any unit of nature.

Today, thousands of farmers of the country commit suicide every year due to losses in agriculture, whereas before 1950 there was no such problem in the country. The taste is not what it used to be, we also accept that harmful chemicals are present in food and water.

Deputy Director, Agriculture, Aligarh

*Maybe that's why there is talk of adopting natural agriculture.

If natural agriculture is to be really increased in the country, then we have to-

1. Work towards increasing the amount of fossil carbon in the land to one percent.
2. Work will have to be done towards increasing the area of surface water reserves in villages to five percent.
3. Farms will have to cover 25 percent of the land with trees by planting trees on the bunds.
4. The use of crop protection chemicals will have to be stopped to save the many dying creatures of aquatic, amphibious and overland.
5. Efforts will have to be made to increase animal husbandry in the village.

Earthworms and beneficial micro-organisms have a great contribution to maintain the fertility of the fields. Butterfly and bee have a great contribution in completing the process of pollination in cross-pollinated crops. Frogs and birds have a great contribution to protect crops from pests.

The beneficial micro-organisms found in the soil have a great contribution to protect the crops from diseases. In natural agriculture, we have to understand that for our happy life, the units of nature which support me, we should preserve and promote all those units of the inanimate and conscious world. As long as man kept his relation with nature and lived in harmony with nature, happiness remained in his life and since man started ignoring nature, the name of his life's sorrows diminished. Agriculture is our ancient culture, in fact agriculture is a matter of philosophy and not of economics. Today in the country's lands, the average amount of biomass carbon in the land has come down to 0.30, whereas the amount of biomass carbon in agricultural land should be more than 1%. Thirty three per cent of the earth should be covered with green trees, but today only 7% of the country's land has trees left.

When we talk about ground water, we find that 70 years from today, water used to be found at a depth of 40 to 50 feet in most parts of the country, but today, except 20% of the lowlands of the country, 80% of the area has water below 200 feet.

In the 1950s, there used to be an average water reservoir in the villages of the country on 4 percent of the total land area, whereas today only 0.7 percent of the area is left with water bodies, whereas 5 percent of the area should have water bodies.

To understand natural agriculture, we have to understand the history of India in the 17th century when the economy of our country used to be the largest economy in the world. We all have heard that India was called the golden bird. But when we compare our country's today's agriculture with the agriculture of 1950s, we do not understand natural agriculture because we see that in 1950 there was food problem in the country which has been overcome by chemicals and mechanization. Why don't we go back 300 years to the history of Indian agriculture.

"Farming is a profession of hope."

- Brett Brian

"It is only the farmer who faithfully plants seeds in the Spring, who reaps a harvest in the Autumn."

B. C. Forbes

Vedic principles and scientific approach to natural farming

Sumati Narayan[1], Sujit Chakrabarty[2], Anil Kumar[3] and Astha[4]

Pheasants are at the receiving end as negative impact of climate change happening due to **"global warming"**, is affecting the agriculture across the world. Because, this is resulting to excessive rainfall in some parts, simultaneously monsoon season going dry in other parts; which hits farmers' the socio-economic status of both such regions.

Season - Weather – Climate is a continuous process in nature since the beginning of creation of Earth. These phenomena are happening as the rule of nature, which are actually determined by cosmic events. The cosmic energy yielded from specific planetary, zodiac & constellation combinations at different times of the year effects the atmosphere in the Earth which results into the changes.

Ancient sages have given thorough explanation about the natural phenomena regarding change in Season - Weather – Climate due to specific planetary, zodiac & constellation combinations. "Nav Grah" i.e., nine planets in our solar system have been considered most important in respect to the cosmic energy received on the Earth.

Changes of Season - Weather – Climate in nature never happens suddenly but the energy & forces generated & emitted due to specific combinations of various cosmic objects, is the result of such changes in the Earth's atmosphere. Specific behavior of certain plants & animals does indicate as forecast for changes in nature for Season - Weather – Climate.

Human interference with mother nature the pre-text of development is visibly evident in the form of climate change as a result of **"global warming".**

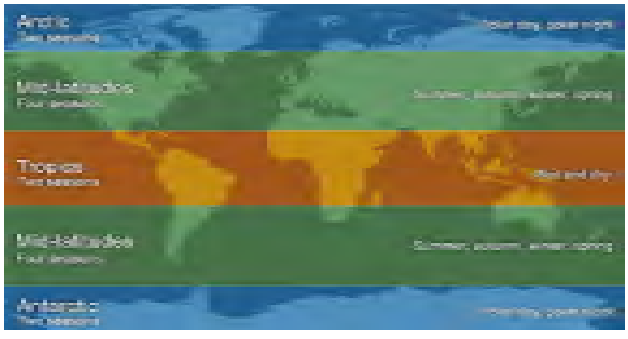
Introduction

Pheasants are experiencing most about the negative impact of **"global warming".** Flooding due to excess rain or unseasonal rainfall in some parts, simultaneously no rain or deficient rainfall in other parts of the globe, both these situations actually lead to total or partial crop loss, and in turn negatively affect farm productivity. Resultant effect on socio-economic scenario is more frightening... first threat is the shortage of food end drinking water. Incidence of deaths due to starvation or diseases due to malnutrition, recession in economy in the third world countries are also after effect of crop failure. Even the developed countries facing various issues related to new more complicated health diseases & disorders.

Season - Weather - Climate is a continuous process in nature on Earth's atmosphere since the beginning of creation of the Universe. Man has no role to play in determining or directing this everlasting continuous process in the nature, nor has any capacity to cause any deviation or disruption in the course of this phenomena. However, man has been playing a role of 'villain' to fulfill his own quest under the camouflage of "Science" by doing actions to disturb natural systems.

The Earth as a globe, can be divided as per the latitude, in to three regions on the basis of seasonal changes:-

- *Tropical region* - This is the area around the globe between Tropic of Cancer in the northern hemisphere & Tropic of Capricorn in the southern hemisphere on both sides of Equator. This region is dominated by two seasons namely, summer season followed by Monsoon i.e., Rainy season. Change in season i.e., rotation of seasonal cycle is a daily routine. Dawn time weather remains cool, calm & still, which gradually warms up with rising sun; hottest time of the day can be understood as peak of summer, which is followed by gathering



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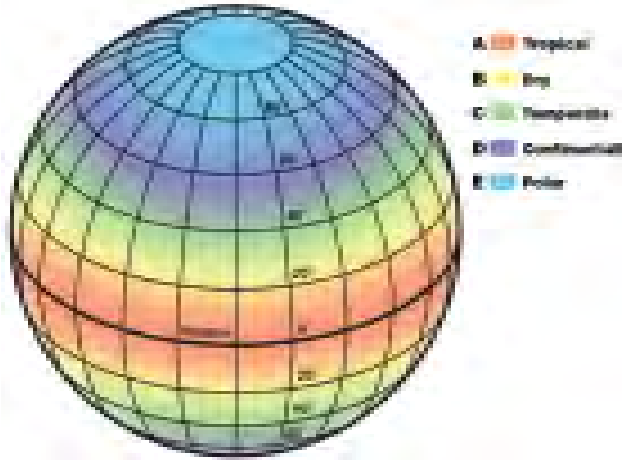
rain clouds towards eastern horizon before sunset, resulting to rain/showers in the evening as the day temperature cools down during the night.

- *Temperate region* - This is the area beyond Tropic of Cancer in the northern hemisphere & beyond Tropic of Capricorn in the southern hemisphere, which is also known as 'mid - latitude'. Temperate region has annually four seasonal cycles, namely, summer, autumn, winter & spring. Change in seasonal cycle is determined by sun's ascending & descending phases. In the northern hemisphere when the sun, moving from tropic of cancer to equator, after half-way in this path till equator and then further to tropic of Capricorn, till half-way, is autumn followed by winter season, when sun further moves till the tropic & return up till half-wat to the equator. Peak of winter is when sun is on the tropic of Capricorn. Similarly, on return journey of the sun, from half-way of travel between tropic of Capricorn till equator and further till half-wat towards tropic of cancer, is characterized as spring season in the northern hemisphere. Sun's travel further till tropic of cancer and return journey till half-way between the tropic & equator is summer season, having peak of the season, when sun is on the tropic of cancer. Exactly reverse seasonal cycle of the above happens in the southern hemisphere.



- *Arctic region* - This is the area around north & south poles, where sunrays fall angular hence it remains ice covered due to sub-zero temperature round the year. This region has two seasons which are equal to day & night. Summer season prevails, when sun is in the northern hemisphere i.e., traveling from Equator to tropic of Cancer & back to Equator. It is day time in the north pole from 22nd March till 21st September. Night begins in north pole as sun moves to southern hemisphere, travelling between Equator to tropic of Capricorn & back to Equator from 22nd September to 21st March. Exactly reverse phenomena of the above happens in the south pole during same periods.

The world (earth) can be divided into five regions as per climate on the basis of latitude:-

- *Tropical region* - This region is like a 30^0 wide belt around the earth on Equator up to 15^0 on both sides, having warm & wet climate. Weather remains 'salty' here round the year.
- *Dry region* - It is a dry & desert area due to less or zero annual rainfall, a belt of 20^0 area i.e., 10^0 on both sides of 20^0 latitudes in northern & southern hemispheres.
- *Temperate region* - It is a cool area due to low temperature prevailing round the year, a belt of 20^0 area i.e., 10^0 on both sides of 40^0 latitudes in northern & southern hemispheres.
- *Continental region* - It is a snow cladded area due to sub-zero temperature prevailing round the year, a belt of 20^0 area i.e., 10^0 on both sides of 60^0 latitudes in northern & southern hemispheres.
- *Polar region* - It is the area beyond 80^0 latitudes in both the hemisphere which is covered with very thick layer of ice due to freezing temperature prevailing round the year, even during summer season of very long sunny days.

Change in Season - Weather - Climate on earth has deep cosmic connection. The various forces & energies being generated & emitted out of different & specific combination of the cosmic objects like planets, zodiac & constellation, determine these changes.

Everything in nature, be it living or non-living, is constituted out of 'five elements' i.e., fire, earth, air, water & ether. Therefore, all the cosmic objects like planets, zodiac & constellation are also constituted of these five elements. However, these cosmic objects have greater influence of one or more of these five elements, therefore they behave differently in their specific combination of forces & energies in the universe. Hence, impact on earth as the change in Season - Weather - Climate also is according to the domination element among five elements.

Earth's rotation on its axis is from west to east, results in day & night as sun rises in the morning each

Planets – Zodiac – Constellation – Element – Climate - Crop					
Planets	**Zodiac**	**Constellation**	**Element**	**Climate**	**Crop**
Sun, Mars, Ketu	Aries, Leo, Sagittarius	Ashwini, Magha, Mula, Kritika, Uttarfalguni, Uttarashadha, Mrigashira, Chitra, Dhanishta	Fire	Hot	Fruit/Seed
Mercury, Saturn	Taurus, Virgo, Capricorn	Pushya, Anuradha, Uttarbhadrapada, Ashlesha, Jyeshtha, Revati,	Earth	Cool	Root
Jupiter, Rahu	Gemini, Libra, Aquarius	Aridra, Swati, Shatbhisa, Punarvasu, Vishakha, Purvabhadrapada	Air/Light	Windy	Flower
Moon, Venus	Cancer, Scorpio, Pisces	Bharani, Purvafalguni, Purvashadha, Rohini, Hasta, Shravan	Water	Wet	Leaf

day from the eastern horizon and sets in the evening same day on the western horizon. However, the day length is not uniform throughout the year. Rather, days are longer than 12 hours during summer and nights are longer than 12 hours during winter season. However, when sun is on the equator i.e., on 21st March & 21st September, length of day & night is of equal period of 12 hours each.

Day length is calculated as time period between sunrise & sunset in the Indian Almanac, which based on Vadic principles. Scientific fulcrum is that the at 12 noon sun is in the position of Zenith and at mid night sun is in the position of Nadir.

Changes in the season happens because sun's stance on its axis, is tiled by 23^0, due to this, sunrays fall more direct in one hemisphere and angular on the other hemisphere. Earth's half portion receiving more direct sunrays go through summer season whereas the other half portion, receiving more angular sunrays experience winter season. Sun travels in northern hemisphere from equator to tropic of Cancer & back to equator between 22nd March to 21st September. During this period of six months, depending on the position of a location on earth's latitude, a place experience seasons in order of Spring *(Vasant ritu)* - Summer *(Grishm ritu)* - Rain *(Varsha ritu)*. Similarly, when Sun travels in southern hemisphere from equator to tropic of Capricorn & back to equator between 22nd September to 21st March, during this period of six months, same location on earth's latitude, a place experience seasons in order of Autumn *(Hemant ritu)* - Fall winter *(Sharad ritu)* - Winter *(Sheet ritu)*. Simultaneously, in the southern hemisphere, changes in seasons happen exactly in the reverse order.

Nine planets *(Nav Grah)* of our solar system, have been considered of utmost importance for factors related to cosmic forces & energies, which influence life & atmosphere based on the earth centric postulate, because we are on earth, which is stationary for us. Therefore, sun & moon is considered as planets. Hence, the seven planets out of nine planets are after seven weekly days viz. Sunday named after *Sun*, Monday - *Moon*, Tuesday - *Mars*, Wednesday - *Mercury*, Thursday - *Jupiter*, Friday – *Venus* & Saturday named after *Saturn*. Test of the two are imaginary or shadow planets namely *Rahu* & *Ketu*. These are in fact the intersecting points of earth's orbit around the sun & moon's orbit around the earth, which happens twice every lunar month. In the Vedic principle, intersection point in the ascending phase of moon is known as Rahu & the similar point in descending phase is called Ketu. As the moon approaches towards Rahu or Ketu, all the forces of moon gradually diminish to zero, when moon is on the intersection point. This process of gradual diminishes from normal to zero takes four hours, then back to normal level also takes four hours.

Earth travels through 12 zodiacs & 27 constellations in a solar year. Since for us earth is a stationary planet, hence from earth, the sun looks moving in solar rhythm of change in day-night, seasons & ascending - descending phases. In fact, comic energy is received on earth in the form of sunrays, which is absorbed & utilized naturally, primarily by plant leaves through process of photosynthesis.

Moon travels through 12 zodiacs & 27 constellations while completing one rotation of the earth in one lunar month. Moon acts as a very large convex mirror in the sky for reflecting sunlight during the day and/or in the night as moonlight during full moon.

Effect of cosmic energies is experienced by plants to the maximum quantum. For example, photoperiod regulates flowering & fruiting behavior in many plants. Long day plants do not flower during short day condition. In fact, length of dark nights determines the possibility of flowering, which is therefore related with seasons also. Day length is > 12 hours during summer season. Plants going into flowering in summer season fail to produce flowers in the winter season, when day length is < 12 hours. However, few plants are day-neutral in their flowering behavior. But in certain plants, temperature also plays a role in anthesis (flowering). For example, Okra is a long day plant but anthesis fails in temperate region even in summer season, though goes into flowering successfully in tropical & sub-tropical regions in same season.

Cosmic energies emitted from different specific combinations of Planets - Zodiac - Constellation have an influence on plant behavior and thus crop performance. Therefore, crop agronomy from seed sowing till harvesting, if done accordingly, then a safe, productive & quality produce can be harvested resulting to better income for the farmers.

Ideal timing for seed sowing of fruit/seed crops, is when moon is travelling through any of the zodiac signs of fire element. Similarly, for root crops, it is earth element, flower crops - air element & leafy crops - water element.

Waxing - wanning phase as well as ascending - descending phases of moon also determines plants' behavioral response & reaction to the external environmental conditions like pests & disease incidences, which controls the plant physiology. Plant sap flows upwards during waxing phase and is concentrated in the leaves, flowers & fruits at the time of full moon *(Poornima)*. Probability of sucking pest attack & air borne fungal and bacterial disease attack is maximum. Sap flow is downwards during waxing phase and is concentrated in the roots at the time of new moon *(Amavasya)*. Probability of soil borne fungal and bacterial disease attack is maximum. Therefore, spraying of medicines in the morning of 14th day of waxing phase *(shukl paksh chaturdashi)* after sunrise before 9.30 am will minimize the pest & disease attack. Similarly, applying medicine in soil drenching with irrigation in the evening after 3.30 pm on the 14th day of wanning phase *(krishn paksh chaturdashi)* will prevent diseases like fusarium & verticillium wilt etc. The gravitational force of moon is maximum at full moon, thus giving light but frequent irrigation before & after, is advisable. Similarly, gravitational force of moon is minimum at new moon, thus giving deep irrigation at longer interval maintains optimum moisture around root zone in the soil. These phenomena happen in accordance with nature's rule. Farmers need to learn, understand & harmonize with mother nature, in his agronomical practices.

Phenomena of season - weather - climate in the earth's atmosphere never happens suddenly or accidentally; rather it is the result of specific combination of various cosmic objects, happening in the universe. Nature has bestowed caliber & capability to all the living organisms viz. plants & animals including humans, to pre-empt & presume the forthcoming changes in long - medium - short term period regarding phenomena of season - weather - climate. However, in the backdrop of scientific research & analysis, dominated by human ego, has off late started acting against nature's rules. his Pheasants are the biggest sufferers due to this negative & revolting approach towards mother nature. So called scientific & modern farming techniques have almost vanished the traditional practices & ancient values of deep link between crop & season in nature.

A keen observation of different plants & animals around us and studying their behavior vis-à-vis their actions and/or adaptability towards natural conditions gives good indication for forecasting about season - weather - climate. For example, pre-monsoon behavior a common bird Pewit *(Titahari)*gives fairly good idea about behavior of the forthcoming monsoon season. Similarly, timing of profuse flowering in Golden Shower *(Cassia fistula)* during peak of summer indicates timing for onset of monsoon. Rainy season i.e., kharif crop is of utmost importance followed by the rabi crop for the farmers in India. Crop performance in both the season is determined by the quantity & distribution of rain during the entire monsoon season.

Following few natural indicators, which are helpful short - medium - long term forecasting of the Season - Weather - Climate:-

- Large flock of Pewit sighted before start of rainy season indicates pre-monsoon shower & humid weather.

- Pewit laying eggs away from water bodies in higher places indicate excess rain & flooding of low lands during rainy season; therefore, farmers should avoid any crop planning in low lying fields.
- Pewit laying eggs near water bodies indicate scanty rain & drought; therefore, farmers should plan cultivation of drought tolerant crops in low lying fields near irrigation water source.
- Large flock of black & white Storks sighted before start of rainy season indicates average & normal rain during entire monsoon season; therefore, farmers should plan normal conventional crop cultivation.
- Black & brown Ants sighted carrying food grain towards their nest before monsoon indicates possibility of excess rainfall in an extended monsoon season, resulting in erosion of fertile top soil; therefore, farmers should plan such crops which can sustain water logging condition for few days as well as perform well in low soil fertility.
- Ants sighted busy in cleaning up their nest of dead ants and bring out wet food grain for drying in sunny day indicates that after this short dry spell, rainy days will prevail again; therefore, farmers should avoid plowing land & seed sowing hurriedly because forthcoming rain may spoil the early-stage crop in field.
- Lots of Crickets sighted as collected in place & chirping loudly indicates onset of humid climate very soon; therefore, farmers should start field preparation for seed sowing immediately.
- Cool westerly wind indicates dry weather; therefore, farmers should start field works like weeding & soil turning up etc.
- Moist north-easterly wind indicates possibility of wet weather due to light showers in the near future; therefore, farmers should prepare for manure application in the moist soil.
- Moist air carrying earthly scent from any direction indicates possibility of humid weather in next 6 to 12 hours: therefore, farmers should continue normal routine work in their fields.
- A clear blue sky after thunder storm indicates a pleasant weather; therefore, farmers should continue normal routine work in their fields.
- Forest fire during peak of summer in mountain region indicates early arrival of monsoon which will prevail for longer duration; therefore, farmers in foothill areas should plan crop cultivation in their fields accordingly.
- Low clouds gathering above the mountains indicate a wet climate will prevail for a week or so; therefore, farmers should avoid weeding now or delay it for a couple of weeks otherwise regeneration of the same is possible.
- Clear blue sky over the head but dense cloud gathering visible towards the eastern horizon indicates expected thunder storm in next 6 to 24 hours; therefore, farmers should plan precautions & remedies for this in their fields.
- Low clouds hovering in the sky post a spell of rainfall indicates humid climate will prevail foe some more time; therefore, farmers may resume normal routine work in their fields.
- Different types of clouds present in the sky at different height indicates confusion in forecasting of climate; therefore, farmers should decide about work in their fields according to the current weather conditions.
- Very high white clouds in the blue sky indicates dry weather; therefore, it is ideal condition for the farmers to do weeding & soil turning up works in their fields.
- Formation of dense fog during *Bhadrapad* i.e., Sept. - Oct. month indicates lesser than average rainfall & duration; therefore, farmers should start early preparation for Rabi crops in their fields.
- Sight of red aura in the western horizon at the time of sunset indicates possibility of long dry weather in the next season; therefore, farmers should prepare for expected drought condition in their fields.

There are few useful indicators available in nature regarding ground water sources:-

- Presence of an ant-hill in the eastern direction from Jamun tree indicates a source for sweet water is present in the south of the tree which may yield water year-round.
- Presence of an ant-hill in the northern direction from Arjun tree indicates a source for water is present in the south of the tree which may yield average quantity of water.

Global environment faced maximum challenge from the scientific research & development during the world wars, which actually changed traditional agricultural practices towards so called modern or advanced techniques with the logic of higher productivity.

Developed countries immediately initiated global propaganda, especially among the developing countries, of the momentary benefits of better crop performance in terms of productivity; hence developing countries took control of agriculture in the developing countries, thus also their economy.

However, over the time, this human interference in nature's environmental system, started showing the horrible negative effects in the form of **"global warming"** resulting to climate change.

Principles of agriculture has deviated so much during last 4-5 decades that methods & values of traditional system of farming is almost forgotten. As a result, a false concept has been developed in the minds of pheasants that improvement in crop productivity is possible only with application of heavier dose of synthetic chemical fertilizers & plant protection agri inputs, while completely ignoring the fact that how much destruction is done of soil micro-macro flora-fauna which actually determines & maintains soil fertility for reaping a good harvest.

The whole world is witness to the amelioration of "ecology & environment" during a brief period of the global 'lockdown' due to COVID pandemic since last two years.

Unless we go back to organic farming and save the soil, there is no future.

- Jaggi Vasudev

We must heal the Earth with sustainable, biodynamic, organic farming, and reject the unnatural, monoculture plant concentration camps of the industrial era of force and control.

- Bryant H. McGill

Augmentation of medicinal properties of Ashwagandha under the organic farming practices in water scarce region of Bundelkhand

Abhishek Kumar[1], M. J.Dobriyal[2], Maneet Rana[3], A. K.Panday[4] and Anil Kumar[5]

Ashwagandha [*Withania somnifera* (L.)] is an ayurvedic medicinal herb also known as Indian ginseng, poison gooseberry, or winter cherry belongs to the solanaceous family. It is a cross-pollinated perennial crop with a chromosome number 2n = 48. It is widely grown in dry parts of India such as Rajasthan, Punjab, Haryana, Uttar Pradesh, Gujarat, Maharashtra, and Madhya Pradesh. The plants have wide adaptability and grow even up to an altitude of 600 to 1200 m from MSL. The main phytochemicals are alkaloids i.e withanolides. The plant part such as roots leaves and seeds are mainly used for medicinal purposes. It is known for its action as an aphrodisiac, tonic, Rasayana drug, and prevention of arthritis, debility anxiety, depression, alcoholic paranoia, etc. The importance of secondary metabolites is increasing rapidly as these compounds are utilized as raw materials for various industries apart from therapeutic agents for animal and human health care. It is cultivated in semi-arid regions of India as a rain-fed crop and grown even in a 40 cm rainfall area with a temperature range between 20°C to 35°C. Being a hardy and drought-tolerant crop, Ashwagandha requires **a** relatively dry season throughout its growing period. It is a known fact the continuous use of chemical fertilizers has a negative impact on soil health besides the high cost of cultivation and bad impact on microbial biodiversity and overall medicinal properties of the Ashwagandha. However, the use of organic fertilizers is widely accepted for good natural farming in many crops. Therefore it has the potential to be grown in Bundelkhand through the proper use of organic farming besides the development of good cultural practices to get the optimal yield.

Introduction

Ashwagandha crop is known for the secondary metabolites production that is attributed to the medicinal property in the form of alkaloids and steroidal lactones. The plant has many branches, with the minutely stellate to mentose type (Figure.1). Roots are fleshy tapering varies in length and whitish brown in color which has the main medicinal value. Plant height can reach even more than 120 cm. Leaves are ovate in shape and it contains alkaloids, withanolides, glycosides, glucose, and many free amino acids which have important medicinal value. Leaves are reported to possess anthelmintic and febrifuge properties. The flowers are greenish. The mature fruits are orange-red berries which are diuretic in nature. The root powder is used in ulcers, vital tonics, and inflammations as well as antibiotics, more particularly antibacterial. It can lower blood sugar levels, reduce cortical, boost brain function and help fight symptoms of anxiety and depression. The yield of Ashwagandha crop on an average from one hectare of crop under commercial cultivation approximately 6-8 quintals of dried roots and 50-75 kg seeds can be obtained depending upon many more factors starting with optimal climatic conditions and varieties of the crop apart from good agriculture practices. Being a hardy and drought-tolerant crop, Ashwagandha requires **a** relatively dry season throughout its growing period. It is normally grown as **a** late rainy season crop receiving 60-75 cm rainfall even suitable for its cultivation. Late winter rains are conducive to the proper development of the plant roots however water should not stagnate. However, the use of synthetic fertilizers increases the undesirable effect on the environment and finally the yield attributes. Therefore by the judicious use of organic fertilizers, we can get a good yield of the pharmaceutical value of Ashwagandha in the form of good quality roots.

Figure.1 A representative felid grown Aswagandha with single plant

Aswagandha a crop of water deficit region

In order to understand more about water requirement, it is advisable to know the soil moisture status in the soil of the respective crop since it is directly related to the growth and development of the crop apart from secondary metabolites contents. Water stress, characterized by low availability of soil water with more evapotranspiration losses leads to decrease crop productivity worldwide. It is perceived as drought stress results in a decrease in the water potential of the crop.

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At this juncture, different responses of physiological, molecular, and biochemical processes are induced differently as plants balance the water stress and alter the secondary metabolism of plants and its sequestration in different parts. Therefore the term soil water potential or leaf water potentials at this juncture should be calculative. It is known that area of the leaf is also related to water stress, and severe water stress it can reduce by more than 30%. Similarly, the chlorophyll content can be reduced by more than 50% in severe water stress. Changes in the steroidal or secondary metabolites contents in water stress have also been reported in different parts of the plants. If we consider the reduction in net photosynthesis produced under severe stress which is also more than 50% has been noticed. Therefore, preferential reduction of biomass leads to proportion the reduction of yield in water stress conditions. Sometimes specific crops can lose the specific metabolites contents see for example the reduction of bioactive compounds of Aswagandha under soil moisture stress. Ashwagandha is one such promising crop to grow well in soils having residual moisture with some important supplementary irrigation during the entire period of its growing season depending upon climatic conditions. It is a drought-tolerant crop and producers can get good yield under residual moisture. The active compounds content of this plant in moisture stress conditions was reported with good root quality. This medicinal crop has withanolides of about 0.3% in the dry root of the Jawahar variety and less than 500 mm climate rainfall sufficient for its cultivation.

High demand of Ashwagandha during Corona pandemic

Ayurvedic medicine is one of the world's oldest medical systems and it relies on a natural and holistic approach to physical and mental health. Ashwagandha is a very revered herb in the Ayurvedic system which is used for various kinds of disease especially as a nervine tonic and adaptogen by helping to maintain levels of immune function that are already within the normal range and nourishing and strengthening the inner reserve of the human body. Recently, India's Ministry of AYUSH and CSIR announced important measures and clinical trials aimed at studying the use of Ashwagandha, along with, Guduchi, Yasthimadhu, Peepli, and, 'Ayush 64', which will be tested on close to 50,000 people. It has been reported that Ashwagandha, contains some natural biochemical compounds which can work as an anti-viral remedy even though it can also be true as anti-corona virus drugs. Researchers used the properties of Ashwagandha to target some of the main illness-causing enzymes in the body and split proteins, Mpro (Main protease) which help in the replication and spread of the coronavirus.

Good cultural methods for Ashwagandha cultivation

Cultural methods (companion crops, trap crops, rotation, adjusting sowing time and spacing, balanced plant nutrition, and timely irrigation), biological methods (parasites, predators, and biopesticides), and mechanical methods (light traps) are preferred for the management of insect pests and diseases in medicinal crops. Ashwagandha is damaged by insects like aphids and hadda beetle which can be controlled by 2 to 3 sprays of Azadirachtin at 1% and Flavanoids at 6%. Seedling mortality becomes severe under high temperature and humid conditions. The disease can be minimized by the use of disease-free seeds and by giving seed treatment before sowing with Carbofuran at the rate of 2-2.5 kg per hectare. Alternaria leaf blight can successfully be controlled with the spray of Mancozeb (12.3%). Bio-pesticides prepared from neem, Chitrakoot, dhatura, and cow urine can be sprayed when required. Neem cake can also be applied to soil to control diseases.

Harvesting should be done at the right stage of the crop to ensure maximum levels of active ingredients and better quality of output. Normally after 150 to 180 days of sowing the crop is ready for harvesting of roots depending upon climate conditions and variety. Ashwagandha plants start flowering and bearing fruits after 120-130 days of sowing. The maturity of a crop is judged when leaves start drying and berries become yellow or red. Leaf shading may also occur. Ashwagandha should be harvested in dry weather and not in rain or in the early morning when it is due on the ground. Harvesting is done by uprooting the whole plant without damaging the roots. There should be sufficient moisture in the soil at the time of harvesting for easy uprooting of the plants. Then roots are separated from aerial parts by cutting the stem 1-2 cm above the crown roots. The roots are beaten with a club to remove adhering soil and break off the thin, brittle lateral rootlets. Then the root sare washed and sun or shade dried up to 10-12% moisture content. Fruits are also collected separately. Use a clean surface, preferably a cemented floor or tarpaulin sheet which is in good condition for drying out the harvested material. The roots are either cut transversely into small pieces of 7-10 cm or dried as

it is in the sun or shade depending upon the environmental conditions. Then the roots are graded and preserved in gunny bags for the marketing depending upon the availability of local materials. Leaves and berries of Ashwagandha are hand plucked and crushed separately to take out the seeds. Pack the produce into clean and dry bags, ensuring it is clearly labeled. Store the production in a clean and dry place to minimize the post-harvest losses.

Ashwagandha under the organic farming practices

Presently, natural farming plays a pivotal role in agricultural farming being known for the environmentally eco-friendly sustainable enhancement of optimal yield besides the overall healthiest development of the plant to mitigate the adverse effect on the quality of soil because of uncontrolled use of chemical fertilizers. Similarly, in Ashwagandha the use of organic fertilizers as amendments can have a profound effect on yield starting from the pre-seed treatment before the sowing in the field apart from the nursery in the form of vermicompost/farmyard manure (about the 20-30% in stating to 80% in the subsequent period of cultivation depending upon the actual agricultural practice in the same field), etc since it is known for the enhance the germination. The use of organic fertilizers during the growing period of the plants have also a good impact on the overall growth and development of the plant since it is known for an increase in the leaf area, earlier onset of flowering, fruiting, and total root biomass production. Finally, it has a high impact on the production of very important active ingredients so-called withanolides, withanone, and withaferin. Therefore, by the proper use of organic fertilizers at the proper time we can enhance not only the growth and development of the plant, and soil health but also plays a crucial role to increase the medicinal properties of the Ashwagandha in the Bundelkhand region.

Ashwagandha in Bundelkhand region is not a new crop, but there is a need to develop good cultural practices for yield and quality through scientific and technological intervention. Attempts have been made in Jhansi began at Rani Lakshmi Bai Central Agriculture University, Jhansi by using the concept of nanotechnology for augmenting the production of Ashwagandha development of good agricultural practices for Ashwagandha production in Bundelkhand is still in the infancy stage. In the Bundelkhand region, it can be grown with optimal use of organic fertilizers besides the agriculture practices to fetch the premium prices of products to increase the income for the farmers by reducing the cost of cultivation. Even though Ashwagandha is perennial in nature but the use of organic fertilizers with minimum input we can get the optimal yield apart from the use of modern technology such as biotechnological and or nanotechnological which can further boost the secondary and tertiary agriculture. However, the complex nature of plant secondary metabolites synthetic pathways and diverse array of secondary metabolites demands a holistic approach to understanding the biochemical, molecular, and physiological basis of secondary metabolites production and the true nature of the crop must be there to get the optimal yield in the Bundelkhand region.

There are 6.6 billion people on the planet today. With organic farming we could only feed four billion of them. Which two billion would volunteer to die?

- Norman Borlaug

Far from being a "luxury for the rich," organic farming may turn out to be a necessity not just for the poor, but for everyone.

- Raj Patel

News and innovations in agriculture

1. **Current Initiatives under Digital Agriculture in India:** The demand for digitisation in Indian agriculture is well understood and acknowledged, likewise efforts have also been made towards digitizing the prevailing value chain. In September 2021, the Union Minister of Agriculture & Farmers Welfare, Mr. Narendra Singh Tomar, announced the initiation of the Digital Agriculture Mission 2021-2025, while signing five memorandum of understandings (MoUs) with CISCO, Ninjacart, Jio Platforms Limited, ITC Limited and NCDEX e-Markets Limited (NeML), to forward digital agriculture through pilot projects. The Digital Agriculture Mission 2021-2025 aims to support and accelerate projects based on new technologies, like AI, block chain, remote sensing and GIS technology and use of drones and robots.

2. **New mango hybrid NMBP-1243:** Three new mango varieties have been developed by the National Mango Breeding Program (NMBP). NMBP-1243 is a hybrid cross between Irwin[@&] x Kensington Pride[B&] (KP). Yield is medium to heavy and consistent year to year. The fruit has an average weight of 507 grams. It has a strong red/ pink blush over a pale yellow background and similar flavour to KP. This is an early season variety maturing two to four weeks earlier than KP. Hot water dipping and vapour heat treatment cause little damage. NMBP-1243 is licensed and protected under Australian Plant Breeder's Rights legislation.

3. **Drone Based Potato Crop Management Technologies:** In the wake of immense potential of the Application of unmanned Aerial Vehicle also known as *"Drone"*, the ICAR-Central Potato Research Institute, Shimla, Himachal Pradesh has initiated the work for the "Development of Drone-based Potato Crop Management Technologies" at its Regional Stations of Modipuram and Jalandhar since 2020. The initiative was undertaken in collaboration with the Bayer Crop Science Ltd. India and General Aeronautics Pvt. Ltd. having defined objective of developing the précised Crop Management Technologies for the Potato Crop

4. **Banana Fibre Processing:** Wealth from Waste Technology transferred to UP based Entrepreneur: The ICAR-National Research Centre for Banana, Tiruchirapalli, Tamil Nadu has licensed and transferred an eco-friendly technology for *Banana Fibre Processing* to Smt. Anita Roy, Women Entrepreneur & District Trainer, PMFME Scheme of Kushinagar, Uttar Pradesh today.

5. **Adoption of Zorin Bean:** A step towards economic prosperity of Mizo Farmers: The French Bean is one of the important cash crops for the Mizo farmers of Lusei Hill Region of Mizoram. Considering its importance for the economic wellbeing of the Mizo farmers, the ICAR-Research Complex for North-Eastern Hills Region, Mizoram introduced the several high yielding released determinate type French Bean varieties in 2016-17. These include Contender, Pusa Parvati from ICAR-IARI and Arka Komal & Arka Sarathfrom ICAR-IIHR in summer *Jhum* agro-ecosystem and winter cultivation in the low-lying rice fallows of Kolasib District under the Tribal Sub Plan.

6. **Kufri sangam a new variety of potao**: Kufri sangam is a medium maturing, the main season high yielding dual purpose potato variety suitable for cultivation in central plains (for processing and table use) and northern plains (for table purpose) it produces attarctive white cream ovoid tubers with shallow eyes and cream flesh. Kufri sangam possesses 18-20% tuber dry matter, low reducing sugars (<150mg/100g fresh weight), mealy teture, very good taste and quality.''

7. **Virtual learining mobile app "Matsya Setu":** Shri Giriraj Singh launched ICAR-CIFA developed virtual learining mobile app "Matsya setu" on 6th july, 2021. App developed in association with NFDB, Hyderabad aims at providing latest freshwater aquaculture technologies to aqua farmers.

8. **Brimato a combination of Brinjal and Tomato:** At ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh after a successful field demonstration of Grafted Pomato (Potato + Tomato), the Dual Grafting of Brinjal and Tomato (Brimato) was demonstrated in the field during 2020-21. The Brinjal Hybrid-Kashi Sandesh and improved cultivar of Tomato-Kashi Aman were successfully grafted into brinjal rootstock-IC 111056. 2.3kg tomato and 2.64kg brinjal was noted per plant.

9. **Dr S. Ayyappan awarded with Padam Shri award-2022:** Dr S. Ayyappan, Former secretary (DARE) & Director General (ICAR) has been conferred with the prestigious Padam Shri Award-2022 for his unparalleled contributions in the field of aqauculture in the country.

10. **Dr Moti Lal Madan awarded with Padam Shri award-2022:** Dr Moti Lal Madan, former deputy director general (Animal science), ICAR has been conferred with the prestigious padma shri award-2022 for his distinguished services and contributions in the fields of science and engeering in the country.

11. **Shri Amai Mahalinga Naik awarded with Padam Shri award-2022:** Shri Amai Mahalinga Naik nominated by ICAR-CCARI, Goa conferred with Padma Shri Award-2022: Shri Amai Mahalinga Naik (Age 77 Years), an Innovative Farmer from Adyanadka Village of Coastal Dakshina Kannada District of Karnataka has been conferred with the prestigious Padma Shri Award-2022 for transforming an arid sloping hill into a fertile farm through the Innovative Zero-Energy Micro-Irrigation System.

12. **Malay rose apple:** Malay rose apple (*S. malaccense*) also known as mountain apple; malaya jamun in hindi; jambe in Kannada; malaya jamba in marathi belongs to family myrtaceae was introduceed to india by the portugese voyagers.

13. **Happy seeder:** Happy seeder provides an economically viable alternative to residue burning. it allows farmers to sow wheat immediately after their paddy is harvested without burning paddy residue for land preparation.

14. **PSLV-C52 was launched successfully:** The PSLV-C52 was launched from the First Launch Pad of the Satish Dhawan Space Centre in Sriharikota, Andhra Pradesh, India. The PSLV C52 rocket carried primary payload, RISAT-1A with 2 other satellites. These will be the INSPIREsat from the IIST and the INS-2TD technology demonstrator from ISRO. It has a thermal imaging camera as its payload and the satellite will benefit in the assessment of land surface temperature, water surface temperature of wetland or lakes, delineation of vegetation (crops and forest), and thermal inertia (day and night).

15. **AI/ML & Data Science in Agriculture Technology:** Artificial intelligence is the application of human intelligence via a machine body where instructions are fed into the machine, and hence you get clever work without effort. All the crucial agricultural data collected by IoT devices and ML algorithms are processed and channelized with data science. Farmers cannot use the raw data, and hence data science is changing farmers' lives in making vital decisions.

16. **GIS in Agriculture:** GIS is a technology that represents any geographical entity in the spatial representation using hardware, software, and data. The hardware used in satellites, drones, GPS systems to locate data points and fetch information from them for analysis. In the agricultural domain, farmers can use GIS to analyze complex spatial data like rainfall amount, topography, soil elevation, slope aspect, wind direction, flooding, erosion, etc., and so much more. Several satellites are already launched by the government or universal bodies, e.g., Landsat 8, where you need to pay a specific fee for accessing your geography data.

Compiled by: Dr. Govind Vishwakarma, Teaching cum Research Associate, Fruit Science.

"With wrong farming methods, we turn fertile land into desert. Unless we go back to organic farming and save the soil, there is no future."

~ Jaggi Vasudev

"To forget how to dig the earth and to tend the soil is to forget ourselves."

~ Mahatma Gandhi

आत्मनिर्भर भारत

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