

Green Cultivation Practices to Promote Sustainable Crop Production in India: An Overview

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Abstract: Healthy soil forms the foundation on which sustainable agriculture is established. The Green Revolution technologies have more than doubled the yield potential of cereals, especially rice and wheat, in India. However, conventional chemical farming practices, involving the excessive use of chemical fertilizers and pesticides, damage beneficial soil microorganisms, alter soil properties, increase crop production costs, and are not sustainable over the long term. The future food security and economic independence of the country depend on enhancing the productivity of bio-physical resources through sustainable production methods, improving crop tolerance to adverse environmental conditions, and minimizing crop and post-harvest losses. Traditional agricultural practices such as growing competitive crop varieties, modifying sowing and planting techniques, adjusting sowing times and directions, mulching with organic residues, using green and brown manures, and adopting reduced or zero tillage create unfavorable conditions for weed seed germination and growth. These methods can play a crucial role in designing sustainable and eco-friendly agricultural systems, increasing the chances that rural communities will accept, develop, and maintain these innovations. In this regard, green cultivation practices of crop production are considered environmentally safe, selective, biodegradable, economical, and renewable alternatives suitable for organic farming systems. Bio-intensive or organic agriculture aims to achieve the highest yields from the smallest land area while simultaneously enhancing and maintaining soil fertility by maximizing biomass production per unit area. Therefore, environment friendly agricultural technologies that ensure food safety and do not harm nature are essential for food security, improving human health, and conserving and rehabilitating the environment for the well-being of future generations. This paper reviews the principles of natural farming, highlighting its eco-friendly nature and sustainability.

Keywords: Eco-friendly agricultural practices, Organic farming, Sustainable crop production

Introduction:

Government of India is already promoting green agriculture by way of green/ sustainable agricultural and good agriculture practices with environment concern. It is implementing National Mission for Sustainable Agriculture (NMSA) which is one of the National Missions under National Action Plan on Climate Change (NAPCC). Government has announced “PM Programme for Restoration, Awareness, Nourishment and Amelioration of Mother Earth” (PM-PRANAM) scheme in Budget 2023-24 with the objective to incentivise the States and UTs to promote usage of alternative fertilizers and balanced use of chemical fertilizers.

Eco-friendly farming, often referred to as sustainable agriculture, is an approach that prioritizes the conservation of the environment, the protection of biodiversity, and the careful management of natural resources. Unlike conventional farming—which frequently depends on synthetic fertilizers, chemical pesticides, and intensive irrigation—sustainable farming emphasizes organic and natural methods to produce food.

Agriculture is the foundation of human civilization, providing food, feed, fiber, and other essential products through the cultivation of plants and the rearing of animals. In essence, agriculture is a productive system that harmoniously integrates the natural elements provided by the environment—such as land, sunlight, air, temperature, rainfall, and humidity—into a single, indispensable unit for human survival.

However, the long-term and excessive use of chemical inputs in crop production has led to significant health risks for humans and has polluted both the environment and groundwater resources. Today, there is a growing debate about whether to continue with input-intensive, chemical-based farming technologies or to return to traditional, environmentally friendly practices like organic farming, which promise sustainable yields, improved incomes, and socio-economic benefits for farming communities.

In this context, biological pesticides are gaining attention as eco-friendly alternatives. These biopesticides are considered environmentally safe, target-specific, biodegradable, cost-effective, and renewable, making them suitable for use in organic farming systems that support sustainable agriculture.

Green pesticides, also known as ecological pesticides, are considered to be environmentally friendly and are believed to pose less risk to ecosystems and animal health. In the field of agrology, the assessment of pesticides focuses on ensuring they have the lowest possible environmental impact. The term "biocides" covers a range of substances, including those with germicidal, antibiotic, antibacterial, antiviral, antifungal, antiprotozoal, and antiparasitic properties. Traditionally, pesticides have been applied as sprays or dusts. Many green or ecological pesticides are derived from biological sources.

Environmentally responsible agricultural technologies play a crucial role in ensuring food safety. These technologies, which work in harmony with nature rather than against it, are vital for securing food supplies, promoting human health, and restoring and protecting the environment for future generations. Rather than pursuing further "green revolutions" that depend heavily on high-yield seeds, synthetic chemicals, and increased fertilizer use, the focus should shift toward natural methods and processes to boost agricultural productivity.

Ultimately, all development initiatives should operate within clear ecological boundaries rather than being driven solely by short-term economic interests. For agriculture to be sustainable, systems must be ecologically viable for long-term food security, fair in delivering social justice, and ethical in considering the needs of future generations and other living beings.

Target/ Goal of Green Agriculture:(Strategies / Actions)

The goal of eco-agriculture is to manage rural community resources in ways that enhance local well-being, protect biodiversity and ecosystem services, and create farming systems that are both more productive and sustainable. Eco-agriculture is now recognized as a comprehensive approach to land use that is both ecologically and socially responsible. It envisions rural communities working together to manage their landscapes and resources in order to achieve three main objectives:

- Improving community welfare,
- Conserving biodiversity and ecosystem services,
- Developing farming systems that are more productive and sustainable.

The essence of ecological-based farming lies in aligning agricultural or business activities with the natural functions of ecosystems. This approach ensures that processes such as the cycling of soil nutrients and the maintenance of biodiversity are preserved, resulting in an agricultural system that is naturally resistant to pests and capable of sustaining soil fertility without external inputs. As a result, farmers are no longer reliant on expensive chemicals and artificial pest control methods.

Furthermore, by revitalizing local or indigenous seed varieties, farmers can significantly reduce or even eliminate their dependence on hybrid seeds produced by multinational corporations. This empowers farmers to select seeds that are best suited to local environmental conditions and available at reasonable costs. Consequently, this can lower the overall cost of agricultural production and enable farmers to sell their products as premium organic goods, thereby increasing their income. Additionally, agricultural products that are free from chemicals and genetically modified organisms are safer and healthier for consumers.

In summary, eco-agriculture seeks to integrate conservation with economic development. Farmers and rural communities play a crucial role in preserving biodiversity and ecosystems. For example, Indian farmers have achieved a 40 percent increase in production by using organic fertilizers in paddy fields, demonstrating results comparable to conventional rice farming. To make eco-agriculture successful, it is essential to have supportive institutional frameworks, adequate financing, and effective information dissemination.

To Advance/ Boost Agricultural Development, It Is Essential to Establish Biodiversity Reserves That:

- Support and empower local farming communities,
- Create interconnected habitats in areas not used for cultivation,
- Limit the expansion of farmland by enhancing yields on existing agricultural land,
- Lessen the environmental impact of farming activities,
- Improve the management of soil resources,
- Optimize the use and stewardship of water and plant resources,
- Adapt agricultural practices to better reflect the structure and function of natural ecosystems.

These steps can be initiated through grassroots-level initiatives, involving coordinated and collaborative efforts from various stakeholders. However, it is essential that the government also plays a role in supporting the promotion of eco-friendly agricultural practices and in building a sustainable agricultural system in India. Climate change is increasingly affecting agriculture and calls for the adoption of new methods and approaches to ensure the sustainability of farming, which remains the primary livelihood for most Indian farmers. Agriculture is an activity that is closely linked to the use of natural resources. Nowadays, we often hear about and witness crop failures caused by climatic factors. This situation is worsened by agricultural practices that do not adequately consider ecosystem balance and environmental conservation, which ultimately impacts agriculture itself.

Eco-friendly Agricultural practices: Eco-friendly agricultural practices are a set of methods that promote sustainable farming by minimizing environmental impact, conserving resources, and supporting biodiversity. These practices may be as-

Agronomy: Cropping pattern and sowing time: Selecting appropriate crop sequences (cropping patterns) and optimal sowing times helps maintain soil fertility, manage pests, and optimize resource use. Practices like crop rotation and timely planting are central to sustainable agriculture.

Water Management: SRI Technology, DSR, and Rainwater collection: Techniques like the System of Rice Intensification (SRI) and Direct Seeded Rice (DSR) reduce water use and improve yields. Collecting rainwater in ponds conserves water for irrigation and reduces dependence on external resources.

Soil Conservation and Reclamation: IPM involves using biological, cultural, and mechanical methods, along with minimal chemical inputs, to control pests like termites, bollworms, and sucking insects. This reduces pesticide use and environmental impact.

Entomological Practices: IPM involves using biological, cultural, and mechanical methods, along with minimal chemical inputs, to control pests like termites, bollworms, and sucking insects. This reduces pesticide use and environmental impact.

Storage: Use of Traditional Containers and Neem Leaves (*Azadirachta indica*)

Zoological: Rats Control by Cats and Pet Dogs: Using natural predators like cats and dogs to control rodent populations reduces the need for chemical rodenticides, supporting ecological balance.

Classification of Eco-Friendly Agricultural Practices:

- Crop production and Management:
- Soil health and Fertility Management:
- Efficient Water Use and Preservation:
- Weed Prevention and Regulation
- Management of Crop Pest and Disease:
- Agricultural Weather Prediction Tools:
- Farm Machinery and Infrastructure Engineering
- Household Organization and Resource Management
- Apparel and Fabric Studies
- Livestock Rearing and Care

Sustainable Agriculture: The Sustainable Agriculture Mission is one of the eight missions under the National Action Plan on Climate Change (NAPCC). The National Mission for Sustainable Agriculture (NMSA) has been designed to boost agricultural productivity, especially in rainfed areas, by focusing on integrated farming systems, efficient use of water, management of soil health, and coordinated efforts for conserving resources. Mac Rae et al. (1990) argue that sustainable agriculture is both a philosophy and a system of farming.

Social and Environmental Aspects: Sustainable agriculture is a multifaceted issue that involves producing food while preserving essential natural resources such as soil, water, and biodiversity, without causing negative effects on the broader environment. The goal is to ensure that agricultural practices are both environmentally responsible and socially beneficial. It should be:

- 1. Sustain or enhance the output of safe and wholesome food products.

- 2. Preserve or elevate the integrity of landscapes, encompassing soil health, water resources, biodiversity, and visual appeal.
- 3. Cause minimal disturbance to the broader environment.
- 4. Be supported and approved by the community.

Concerns of Eco-Friendly Sustainable Agriculture: “Sustainable agriculture is the successful management of resources for agriculture to meet changing human needs while maintaining or enhancing environmental quality and conserving natural resources.”- CGIAR/TAC, 1988. The sustainability concept has many dimensions. That includes economic sustainability, social sustainability, institutional sustainability as well as environmental sustainability. The environmental sustainability in agriculture, is the core concept of this paper, it reviews the protection of the resource base, the reduction of Harmful side effects (negative externalities) and the promotion of beneficial side effects (positive externalities). Principal issues include in our review is water quality and quantity, air quality, soil erosion, biodiversity, and landscape protection as well as food safety and animal welfare. The agenda includes:

Water quality and quantity concerns: Issues in this context involve the loss of nutrients and pesticides through leaching, excessive water withdrawal, and problems related to drainage and flooding. Pollution of both groundwater and surface water due to the heavy application and runoff of manure and synthetic fertilizers poses a significant threat, especially in regions with concentrated livestock farming or intensive crop cultivation.

Air quality concerns: Emissions of ammonia and greenhouse gases are the major issues. At EU level, agriculture is responsible for about 8% of total greenhouse gas emissions but due to the pastoral nature of Irish farming, the proportion here rises to 30%.

Biodiversity concerns: Issues include genetic, species and ecosystem diversity. The intensification of agriculture has led to widespread reduction of species and habitats.

Landscape concerns: The marginalisation of agricultural land can lead to its abandonment if farming ceases to be viable. Alternatively, intensification of agriculture can lead to the loss of important landscape features such as hedges and ponds, the enlargement of fields and the replacement of traditional farm buildings with industrial structures. Rights of access may be restricted in interests of more efficient farming.

Soil erosion concerns: Overgrazing particularly in mountain areas has led to the erosion of vegetation cover with the consequent loss of soil, the silting of rivers, etc.

Food safety and animal welfare concern: The issue here is the effect of agricultural practices on human health and animal well-being rather than the physical environment. There is concern about the consequences for the quality and safety of the food supply of the increasing use of pesticides and drugs, as well as the consequences of introducing genetically-modified organisms.

Eco-Friendly Approaches for Farming System:

Organic farming: Organic farming is a production system, which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, and livestock feed additives. To the maximum extent feasible, organic farming system rely upon crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, mechanical cultivation, mineral-bearing rocks, and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients, and to control insects, weeds, and other pests.

Biological farming: Biological farming allows the use of selected chemical fertilizers (avoiding disruptive materials such as anhydrous ammonia and potassium chloride) and adopts low-inputs approaches to use of herbicides and insecticides. (diagnostic instruments to monitor plant and soil conditions are frequently used in biological farming. These include refract meters to monitor sugar content (Brix) in plant tissue sap; electrical conductivity meters to monitor ERGS (or energy released per gram of soil); ORPS meters (or oxygen reduction potential of soil); and radionics.)

Nature farming: In addition to these methods-based approaches to sustainable farming, regenerative agriculture and permaculture are widely recognized. However, these latter systems, like sustainable agriculture, are more conceptually oriented than methods-based.

Regenerative Agriculture: In regenerative agriculture builds on nature's own inherent capacity to cope with pests, enhance soil fertility, and increase productivity. It implies a continuing ability to re-create the resources that the system requires. In practice, regenerative agriculture uses low-input and organic farming systems as a frame work to achieve these goals.

Permaculture: Permaculture is concerned with designing ecological human habitats and food production systems, and follows specific guidelines and principles in the design of these systems. To the extent that permaculture is not a

production system, per se,, but rather a land use planning philosophy, it is not limited to a specific method of production. Thus, practically any site-specific ecological farming system is amenable to permaculture.

Agroforestry: Integrating trees into agricultural systems can improve soil health, provide additional income, and enhance biodiversity.

Problems and Suggestions on The Use of Eco-Friendly Practices in Crop Production in India:

Sl. No.	Problems	Suggestions
1	In case of severe pest attack on crop farmers mostly to uses chemical pesticides.	Raw materials for compost, green manures, bio- fertilizer, bio-pesticide, etc. may be increased.
2	Lack of sufficient publicity on eco-friendly practices.	More publicity should be given in different media.
3.	Lack of proper technical knowhow about eco-friendly agricultural practices.	Establishment of adult education can enhance the eco-friendly agricultural practices.
4.	Lack of awareness of environment pollution.	Increasing farmers' awareness on environmental pollution.
5.	Lake of livestock and poultry for necessary excreta.	Increasing motivational program for rearing more livestock and poultry.
6.	Lack of proper training on eco-friendly agricultural practices related organization.	Arranging more number of training on eco-friendly agricultural practices specially by GOs and NGOs collaboration.
7.	Limited availability of readymade ingredients to prepare compost botanical fertilizer and pesticide.	Increasing opportunities for availability of necessary ingredients and more awareness on environment pollution.
8	No punishment for failure and awarded for the successful adopters of eco- friendly practiced farmers/change agent.	Establishment the punishment for failure and awarded for the successful adopters of eco- friendly practiced farmers/ change agent.
9	Lack of proper sell value due to involvement of middle men.	Government should popularize the e mandi and strictly control the whole sale and retail market both centrally and locally.
10	Un popularity of agro-chemical free products.	Making social movement on increasing popularity of agro-chemical free products.

The methods of ecological agriculture are based on modern ecological science combined with time-tested indigenous knowledge, giving emphasis on the mode of cultivation through Integrated Crop Management (ICM), which providing Integrated Farming System (IFS), Integrated Pest Management (IPM) for crop production. ICM program arranging FFS and provide various types of training courses on eco-friendly agriculture for their club members in order to increase their eco-friendly agricultural knowledge and to make a favorable attitude and adoption of these activities. Sometimes, ICM program provides financial facility to its group members for practicing ecological agriculture and help them for marketing their ecologically produced organic products.

CONCLUSION: In a healthy farm system, agriculture works in harmony with the natural environment. This begins with healthy soil that stores water and nutrients and provides a stable base to support plant roots. In a sustainable system, soil is kept in balance. Crops are rotated through the fields to replace nutrients in the soil. Where there is livestock, animals graze the land, then waste from those animals is used to fertilize the soil. The idea is that as farmers take from the land they also give back. Industrial farms disregard that need for balance. Land is used continuously and not given proper rest. Crops are not rotated in a way that replenishes the soil. Manure and chemical fertilizers are used to “feed” the soil, but through over-application these additives become a problem.

Organic, mechanical, physical and cultural practices of agriculture are mainly used in ecological agriculture. Chemical fertilizers and chemical pesticides not only contaminate surface water, they also affect fish population and human health as well. To regain the lost ecological status, it is high time to start the ecological agriculture without further delay. Some NGOs, GOs became very much concerned about the devastating effect of indiscriminate use of chemical fertilizers and pesticides since long, and earnestly felt the need for developing an alternative agricultural strategy that is

sustainable, productive and environment-friendly. Since 1985 DAE has been working towards development of this alternative strategy and termed it as “Eco-friendly agriculture”.

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