ISBN: 978-81-974088-4-7

13. Effective Role of Eco-Friendly Practices in Achieving Developmental Goals for Sustainable Agriculture

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Abstract:

The Green Revolution technologies have significantly increased the potential yield of wheat and rice crops, peculiarly in Asia. Despite this advancement, these high-input production systems, which necessitate substantial quantities of fertilizers, pesticides, irrigation, and machinery, have largely overlooked the ecological integrity of land, forests, and water resources.

This oversight poses a threat to the flora and fauna and is unsustainable across generations.

The future food security and economic self-reliance of developing nations hinge significantly upon the enhancement of biophysical resource productivity through the implementation of sustainable production methods.

This entails augmenting crop resilience to adverse environmental conditions and mitigating losses arising from pests and diseases.

Notably, indigenous agricultural practices can serve as a pivotal cornerstone in the establishment of sustainable and eco-friendly agricultural systems, thereby bolstering the likelihood of rural population acceptance, development, and perpetuation of innovative interventions.

Consequently, environmentally safe, selective, biodegradable, cost-effective, and renewable techniques are increasingly under scrutiny as viable alternatives for integration into organic farming systems.

Organic farming involves the utilization of organic nutrients and the implementation of natural plant protection methods in lieu of traditional fertilizers and pesticides.

Such system predominantly relies on animal manure, crop rotation, legumes, crop residues, mineral-laden rocks, biological pest control, and green manure to uphold soil fertility, furnish plant nutrients, and manage pests and weeds.

Keywords:

Agriculture, sustainable, farming, environment, resources.

13.1 Introduction:

Figure 13.1: Agriculture

Agriculture stands as the most pivotal enterprise in the global landscape, encompassing the intricate processes involved in the production of food, feed, fiber, and other essential commodities through the cultivation of plants and the domestication of animals (Ahirwar et al., 2020).

It emerges as a productive entity that leverages natural endowments, including land, light, air, temperature, rainwater, and humidity, as integral components crucial for human sustenance. However, the extended and excessive use of chemicals in crop production has led to consequential health hazards for humans and the pollution of the environment and groundwater.

At this juncture, a critical discourse emerges, deliberating the need to either persist with chemical-intensive technologies or revert to traditional environmentally friendly farming procedures, such as organic farming, to underpin income, sustainable production, and the socio-economic advancement of farming communities. In this context, natural pesticides have garnered attention as environmentally benign, discerning, biodegradable, cost-effective, and renewable alternatives suitable for integration into organic farming systems.

Terms such as "Green Pesticides" or "ecological pesticides" signify their presumed environmentally friendly nature, indicating reduced harm to ecosystems and animal health (Mishra, 2013). Within the domain of agrology, stringent evaluation standards are applied to pesticides in order to minimize their average environmental impact. The category of biocides encompasses antibiotic, antiviral, antifungal, antibacterial, antiparasitic, and antitrotozaols agents.

Pesticides are typically distributed in the form of dusts and sprays, with a considerable number of ecological pesticides aligning with the classification of biological pesticides. Environmentally friendly agricultural technologies aimed at ensuring food safety without harming the natural environment are poised to play critical roles in securing food supplies, enhancing human health, and revitalizing and preserving the environment for the well-being of future generations. Rather than pursuing further "green revolutions" reliant on genetically modified seeds, potent synthetic pesticides, and intensified fertilizer use, the path ahead should prioritize natural methods and processes for improving agricultural productivity.

All developmental initiatives and undertakings should be in accordance with precisely defined ecological principles rather than exclusively prioritizing limited economic advantages. Sustainable agricultural systems must align with ecological rules to ensure long-term food security, provide social justice equitably, and demonstrate ethical responsibility toward future generations and other species (Caron et al., 2018).

13.2 Goals of Eco-Agriculture:

The primary aim of eco-agriculture is to adeptly administer the resources of rural communities, with the goal of improving their welfare, conserving biodiversity, and bolstering ecosystem services. This approach also seeks to establish farming systems that are both more productive and sustainable in the long term. This approach constitutes a holistic method that integrates ecological and social responsibility into land use, envisioning rural communities to achieve three main objectives:

- Enhancement of rural livelihoods
- Conservation of ecosystem and biodiversity
- Development of productive and sustainable agricultural systems

Emerging from the bedrock of ecological principles, this particular farming approach centers on the fundamental concept of harmonizing business or agricultural activities with the innate functions of ecosystems.

This intricate process involves nurturing the continuous cycle of soil nutrients and the intricate web of biodiversity to foster an agriculture system that exhibits resilience to pests and operates self-sufficiently, drawing exclusively from natural soil nutrients. By adopting such measures, farmers can curtail their dependence on costly chemicals and artificial pest control.

Furthermore, the reintroduction of local or indigenous seed varieties reduces farmers' dependency on commercial hybrid seeds, allowing them to choose seeds that are best suited to local conditions at a reasonable cost.

This ultimately lowers agricultural production expenses, enabling farmers to sell premium organic products and increase their incomes. Additionally, chemicals-free and non-genetically modified agricultural products are not only safe but also highly suitable for human consumption.

13.3 Sustainable Agriculture:

Sustainable agriculture is a multifaceted endeavor that encompasses the production of food while carefully managing and preserving our natural resources, such as soil, water, and biota, to ensure minimal impact on the environment (Figure 13.1).

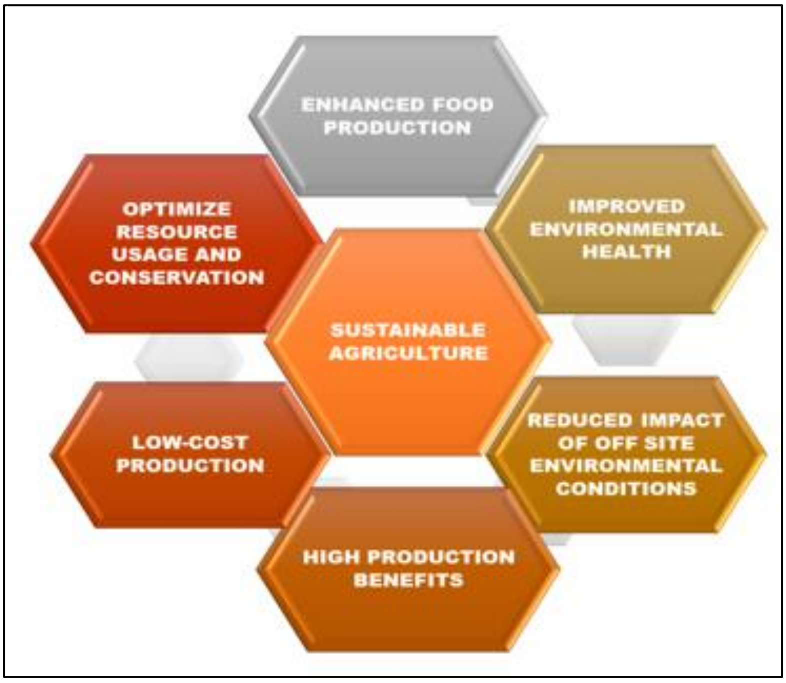

Figure 13.1: Sustainable Agricultural Practice

13.4 Concerns of Eco-friendly Agriculture:

The concept of sustainability has various dimensions, such as economic, social, institutional, and environmental sustainability. In agriculture, environmental sustainability involves protecting the resource base, minimizing negative externalities, and promoting positive externalities. Key issues include ensuring water and air quality, preventing soil erosion, conserving biodiversity and landscape, and ensuring food safety and animal welfare. This agenda encompasses a wide range of factors for sustainable agriculture:

A. Water quality and quantity: The environmental issues in this context encompass the leaching of nutrients and pesticides, the depletion of water resources, and the potential for drainage and flooding. Moreover, the contamination of ground and surface waters is a significant concern due to the extensive use of manure and chemical fertilizers, especially in regions with intensive livestock rearing or specific crop production.

B. Air quality: The primary concerns in this context pertain to the release of ammonia and greenhouse gases. At the European Union level, the agricultural sector contributes approximately 8% of the total greenhouse gas emissions. Nonetheless, the proportion substantially rises to 30% at the local level, owing to the pastoral characteristics of Irish farming.

C. Biodiversity: The diminishment of genetic, species, and ecosystem diversity stands as a pivotal concern. The intensification of agriculture is triggering widespread diminution of species and habitats, thus underscoring severe decline in biodiversity.

D. Landscape concerns: The marginalization of agricultural land can lead to its abandonment if farming becomes economically unviable. On the other hand, intensifying agricultural activities may lead to the disappearance of distinctive landscape features such as hedges and ponds, the merging of fields, and the substitution of traditional farm structures with industrial facilities. Additionally, access rights may be limited to facilitate more streamlined farming practices.

E. Soil erosion concerns: The adverse effects of overgrazing, especially in mountainous areas, cannot be overstated. The depletion of vegetation cover has led to significant soil loss and the siltation of rivers.

F. Food safety and animal welfare: The primary focus of concern pertains to the ramifications of agricultural practices on human health and animal welfare, rather than solely on the natural environment. It is of paramount importance to meticulously scrutinize the escalating use of pesticides and drugs, along with the potential implications of the introduction of genetically-modified organisms, with regard to the safety and quality of our food supply.

A.5 Eco-friendly Approaches for Farming System:

A. Organic farming: Organic farming is an agricultural method that emphasizes natural processes and biodiversity. It avoids the use of synthetic fertilizers, pesticides, and other chemicals, relying instead on techniques such as crop rotation, composting, and biological pest control. This approach aims to maintain soil health, provide essential nutrients to plants, and manage pests without relying on artificial substances.

B. Biological farming: Biological farming, also known as organic farming, is an agricultural approach that utilizes selected chemical fertilizers while purposefully avoiding disruptive substances such as anhydrous ammonia and potassium chloride. This method emphasizes the application of low-input strategies for herbicides and insecticides, aiming to minimize environmental impact and promote sustainable farming practices. By prioritizing these eco-conscious techniques, biological farming contributes to long-term soil health and biodiversity conservation

C. Nature farming: In addition to method-based approaches to sustainable farming, regenerative agriculture and permaculture are both widely embraced for their proven effectiveness in enhancing environmental sustainability and agricultural productivity.

D. Regenerative Agriculture: Regenerative agriculture harnesses the natural resilience of ecosystems to effectively manage pests, improve soil fertility, and enhance agricultural productivity. It is centered around the continual regeneration of essential resources required by the agricultural system.

E. Permaculture: Permaculture is a revolutionary approach to designing sustainable human habitats and food production systems that prioritize ecological balance and diversity. By adhering to specific guidelines and principles, permaculture aims to create self-sustaining and regenerative ecosystems.

13.6 Problems, Challenges and Opportunities for Sustainable Agriculture:

Researchers are currently dedicating their efforts towards addressing a critical challenge arising from the need to sustain a rapidly growing and increasingly urbanized global population. By 2050, the Earth is projected to be inhabited by 10.2 billion individuals, necessitating a significant increase in the production of nutritious food, fiber, and bio-energy while simultaneously ensuring the protection of biosphere. The urgency of intensive agricultural production is undeniable; however, these methods lead to extensive consumption of finite natural resources such as fossil fuels, water, agricultural soil, and rock phosphate reserves. Additionally, the industrial processes involved in fertilizer production, coupled with the leaching of soluble nutrients from agrochemicals into aquatic systems, contribute to environmental contamination (Browne et al., 2013).

The pervasive contamination of environments by toxic heavy metals due to industrial activities, notably in India, poses significant threats to human and animal health aalong with the food chain (Ramana et al., 2012; Ramana et al., 2013 a, b; Ahirwar et al., 2018). Consequently, the remediation of soils contaminated with potentially toxic metals and metalloids has emerged as a critical global priority, prompting extensive efforts to develop effective remediation methodologies (Ramana et al., 2014).

Moreover, intensive agricultural practices are linked to a rise in greenhouse gas emissions, leading to elevate global temperatures and subsequent impacts on biosphere stability (Duarte et al., 2006). Consequently, these practices create various stress-inducing scenarios that directly impede the functionality and productivity of both agricultural systems and natural ecosystems, thus limiting the range of services they can effectively provide. The factors causing stress in agriculture and forestry, such as salinity, drought, nutrient deficits, contamination, and pests, pose significant challenges. The use of agrochemicals to combat these issues can lead to environmental contamination and potential threats to human health. These ecological constraints have far-reaching impacts, including agricultural and forest productivity losses, soil erosion, water deficit, biodiversity losses, and landscape fragmentation (Vitousek et al., 1997). To address these challenges, it is crucial to implement agricultural practices on a global scale with a focus on sustainable environmental and economic development, aiming to maintain yields while preserving the biosphere. The concept of "sustainable development" arises from the interplay of three primary factors: environment, society, and economy. The interactions between these elements are critical in shaping sustainable development (Zancarini et al., 2013). In this context, soil quality, a non-renewable resource that fulfills numerous environmental and social functions, is of paramount importance. Various efficient methods to recycle nutrients, control pests and pathogens, and mitigate the impact of abiotic stress factors is essential for human well-being and the sustainability of global ecosystems.

13.7 Conclusion:

The foundation of a healthy farm system lies in the symbiotic relationship between agriculture and the natural environment. This synergy commences with the presence of fertile soil, which serves as a reservoir for water and nutrients, and establishes a steadfast foundation for the sustenance of plant roots.

Within a sustainable framework, soil equilibrium is maintained through a process of crop rotation aimed at replenishing soil nutrients. In instances where livestock is present, the animals graze the land, and their waste is subsequently repurposed to enrich the soil. These reciprocal dynamic underscores the notion that farmers should give back to the land from which they take. However, industrial farms often disregard this essential balance, continuing to exploit the land without providing it with adequate respite. Consequently, soil exhaustion ensues due to the absence of replenishment via strategic crop rotation. Furthermore, the excessive application of manure and chemical fertilizers exacerbates the issue. Ecological agriculture predominantly employs organic, mechanical, physical, and cultural practices, seeking to minimize the usage of chemical fertilizers. These chemicals not only contaminate surface water, but they also exert adverse effects on aquatic life and human health. It is imperative to restore ecological equilibrium through the expeditious adoption of ecological agriculture. Several non-governmental and governmental organizations have expressed grave concerns regarding the detrimental impact of indiscriminate chemical fertilizer and pesticide application. This has propelled a collective impetus to develop an alternative agricultural strategy that embodies sustainability, productivity, and environmental friendliness. Since 1985, the Department of Agricultural Extension (DAE) has been dedicated to the formulation of this alternative strategy, recognized as "Eco-friendly agriculture."

13.8 References:

1. Ahirwar, N. K., Gupta, G., Singh, R., & Singh, V. (2018). Assessment of present heavy metals in industrial affected soil area of Mandideep, Madhya Pradesh, India. *Int. J. Curr. Microbiol. App. Sci*, *7*(1), 3572-3582.
2. Ahirwar, N. K., Singh, R., Chaurasia, S., Chandra, R., & Ramana, S. (2020). Effective role of beneficial microbes in achieving the sustainable agriculture and eco-friendly environment development goals: a review. *Frontiers in Microbiology*, *5*, 111-123.
3. Browne, P., Barret, M., Morrissey, J. P., & O'Gara, F. (2013). Molecular-Based Strategies to Exploit the Inorganic Phosphate-Solubilization Ability of Pseudomonas in Sustainable Agriculture. *Molecular microbial ecology of the rhizosphere*, *1*, 615-628.
4. Caron, P., Ferrero y de Loma-Osorio, G., Nabarro, D., Hainzelin, E., Guillou, M., Andersen, I., Arnold, T., Astralaga, M., Beukeboom, M., Bickersteth, S., Bwalya, M., Caballero, P., Campbell, B.M., Divine, N., Fan, S., Frick, M., Friis, A., Gallagher, M., Halkin, J.P., Hanson, C., Lasbennes, F., Ribera, T., Rockstrom, J., Schuepbach, M., Steer, A., Tutwiler, A., & Verburg, G. (2018). Food systems for sustainable development: proposals for a profound four-part transformation. *Agronomy for sustainable development*, *38*, 1-12.
5. Duarte, C. M., Alonso, S., Benito, G., Dachs, J., Montes, C., Pardo Buendía, M., Simo, R., & Valladares, F. (2006). *Cambio Global. Impacto de la actividad humana sobre el sistema Tierra*. CSIC. Consejo superior de investigaciones científicas.
6. Mishra, M. (2013). Role of eco-friendly agricultural practices in Indian agriculture development. *International Journal of Agriculture and Food Science Technology (IJAFST)*, *4*(2), 11-15.
7. Ramana, S., Biswas, A. K., Ajay, Singh, A. B., & Ahirwar, N. K. (2012). Phytoremediation of chromium by tuberose. *National Academy Science Letters*, *35*, 71-73.

8. Ramana, S., Biswas, A. K., Ajay, Singh, A. B., Ahirwar, N. K., & Subba Rao, A. (2013a). Potential of rose for phytostabilization of chromium contaminated soils. *Indian Journal of Plant Physiology*, *18*, 381-383.
9. Ramana, S., Biswas, A. K., Singh, A. B., Ajay, Ahirwar, N. K., & Subba Rao, A. (2013b). Phytoremediation ability of some floricultural plant species. *Indian journal of plant physiology*, *18*(2), 187-190.
10. Sivakoti Ramana, S. R., Biswas, A. K., Singh, A. B., Ajay, A., Ahirwar, N. K., & Rao, A. S. (2014). Tolerance of ornamental succulent plant crown of thorns (Euphorbia milli) to chromium and its remediation. *International Journal of Phytoremediation*, *17*(4), 363-368.
11. Vitousek, P. M., Mooney, H. A., Lubchenco, J., & Melillo, J. M. (1997). Human domination of Earth's ecosystems. *Science*, *277*(5325), 494-499.
12. Zancarini, A., Lépinay, C., Burstin, J., Duc, G., Lemanceau, P., Moreau, D., Munier-Jolain, N., Pivato, B., Rigaud, T., Salon, C., & Mougel, C. (2013). Combining Molecular Microbial Ecology with Ecophysiology and Plant Genetics for a Better Understanding of Plant–Microbial Communities' Interactions in the Rhizosphere.In: F. J. de Bruijn (eds). Molecular Microbial Ecology of the Rhizosphere. Vol- 1. Wiley Blackwell, Hoboken, New Jersey, USA, pp- 69-86.