

A New Perspective of Agroecosystem in 21st Century

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Abstract

Land is a living legend, including all eroded and forest land that all would contribute to agriculture. In a wider perspective, a long-term view will have to be taken to manage our soil, plant and bio-resources. Sustainable intensification of agriculture productivity enhancement and loss prevention is the only option to meet our growing requirement. Integrated water resource management approach for irrigated cropping systems per unit of agriculture water use holds key to both food and environmental security. For harnessing effective ecosystem based production, enhanced water use efficiency, promoting balanced use of nutrients and water and soil biota test based technology adoption is the needs of hour.

Keywords: Agro ecology; Water management; Precision farming; Nanotechnology; Sustainable agriculture

Introduction

Ecology is the study which represents the relationship among living things and their environment. It has been termed as such biotic and a biotic factors interacting with other in a specific location. Ecosystems are naturally self-sustaining process with basic component of photosynthesis, energy flow through food chain and nutrient recycling. But there is forth player too which act as a manipulators or managers of ecosystem for producing agricultural products i.e., agro ecosystem. Scientifically agro ecosystem has, mechanical -biological- chemical technology which is blended together. Keep in mind that in the natural ecosystem, agro-ecosystem increase in agriculture production should be with environmental protection. Ecology believes to be entire nature and it's a development with enhanced efficiency effectiveness and relevance for well being. We need, vision, mission, vigor to have an enhanced planned growth. There is urgent need to consider ecology for sustained inclusive growth with wide system approach rather than fragmented approach.

Ecological Agriculture for Sustainability Why?

Techniques, innovation allowed increase in productivity which undermined the basis for that productivity. But such productivity enhancement causes overdrawn and degraded resources of all kinds like soil, water and natural genetic diversity. It created dependence on non-renewable fossil fuels that shows our system of production is not sustainable on long term basis. Also, notably emergence of new disease and pest and climate become threats, in such circumstances, the only option left is preserving the long

term productivity considering the ecological agriculture for sustainability.

In some areas the challenge is to revert the systems that have already undergone modernization and where farmers experience high environmental and economic costs due to reliance on agrochemicals. The idea is to transition from high input monocultures to more diversified farms that instead of being capital intensive are knowledge intensive, as the design of agro ecosystems that depend on ecological principles requires an in-depth knowledge of the interactions between crops, soils, and associated biodiversity. As we all know that the global human population may range 8.1 to 14.0 billion up to 2080, on an average of 9.0 billion populations at the end of year 2050 [1].

All these natural resources are finite and fragile where land and water availability shrinking day by day and advanced threat cases evolved recently as soil fertility degradation, ground water depletion, bio-diversity erosion, soil-water-air pollution, including total factor productivity reduction and increase in the cost of production. India today has 17% world's population 11% livestock population, 4.2% world's fresh water and 2.4% of world's land area, but the pressure on Indian land is 5-6 times more than world average. The demand says that we require 70% grain yield increase upto 2050.

The long term fertility experiment in Pantnagar interpret the decline or stagnation in paddy yield from past 23 years which was reduced up to 179 kg/ha with recommended dose of fertilizers

application. The result shows decline in food productivity with change in biochemical and physical composition of soil organic matter, build-up of phenolic substances which altering the release of N and deterioration of soil physical properties and over mining of nutrients, emerging nutrient deficiencies. Such indications were also clearly stated by Dr. M.S. Swaminathan, who says that, "The initiation of exploitative agriculture without a proper understanding of the various consequences of every one of the changes introduced into traditional agriculture and without first building up a proper scientific and training base to sustain it, may only lead us into an era of agricultural disaster in the long run, rather than to an era of agricultural prosperity."

The change in environment leads instability in food production and there is need to visualize impact of climate change of each agro ecological regions. We need to act fast on perspective mitigation, and need to adopt such management technology for Refinement of land use system, resource conservation technology, conservation of crops, water, energy, incentives to promising services, regulating services, supportive and improve management services. The 21st century realities are quite horrible to conclude where per capita land and water availability has been declined, energy and production input cost are rising, diminished returns, yield stagnation, food security concerns etc.

Therefore, the conventional agriculture needs to be converted in low input required agriculture. The overall process in conversion of high input conventional management to low-external-input system works as a transitional stage with three marked phases:

I. Increased efficiency of input use through integrated pest management or integrated soil fertility management.

II. Input substitution or replacement of chemical inputs by environmentally benign inputs.

III. System redesign: diversification with an optimal crop/ animal assemblage, which encourages synergisms so that the agro ecosystem may sponsor its own soil fertility, natural pest regulation, and crop productivity.

Promotion of biodiversity within agricultural systems is the cornerstone strategy of system redesign, as research has demonstrated that higher diversity within the cropping system leads to higher diversity in associated biota which in turn leads to more effective pest control and pollination and to tighter nutrient cycling. The transition towards a more biodiverse system redesign relies on two fundamental pillars i.e., the improvement of soil quality and its biological activity via copious additions of organic matter and the enhancement of the above ground plant diversity to improve habitats that harbor beneficial biota. Both pillars secure crop health and total agroecosystem health.

Agroecology has expanded the concept of food sovereignty to include the concepts of energy and technological sovereignty. Energy sovereignty defines the right for all people to have an access of sufficient energy within ecological limits from suitable sources. For farmers energy sovereignty means the production of their own energy (solar, biofuels in certain portion of their lands without

displacing food crops) to run their own machineries and farming operations. Technological sovereignty mainly deals with an ability to achieve those two sovereignty environmental services from diversified farming systems that use locally available resources.

Water Management

Water is critical for agricultural development. The inadequate availability of irrigation water is highly inefficient and energy intensive. National Commission on Integrated Water Resources Development stated that "It should be possible to achieve 60% and 75% efficiency by 2050 in surface water and ground water use respectively." Only 38% Overall water use efficiency of 28 major/ medium irrigation projects of India had put in efforts which need to improve in coming decades. Several improved water management techniques are options as on farm water management such as Land leveling and improved irrigation methods check basin and Border strip irrigation, Furrow/Surge flow irrigation, Raised bed-planting system, Pressurized irrigation systems. Study of laser leveling at Yamuna nagar shown water saving up to 38% in paddy cultivation compared to traditional land leveling practice. Also the water productivity was enhanced by 0.2 kg/m³ of water compared to traditional leveling Jat et al. [2] in other study. Surge irrigation and furrow irrigation method also reveals improvement in yield of maize Abou Al-Hassan [3] cotton Horst [4] and groundnut Solaimalai, Rajagopal [5] as well as water use efficiency by 6-25 kg/ha-mm. Fertigation released as improved technology for precise management of fertilizers and water simultaneously giving 40% savings and it can be used to apply any water soluble fertilizer or chemical in precise amounts, as and when required to match the plant needs.

Nutrient Management

Nutrient-use efficiency can be enhanced if it marches temporal and spatial supply with demand of plants. Any applied fertilizers at most critical period, in precise application, at or near plant root zone have the potential to reduce the losses while maintaining yields or improving the quality. Tilman et al. [6] Use of chlorophyll meter or Soil Plant Analysis Determination (SPAD meter), leaf colour chart, optical sensor based N management can reduce the N application rates substantially. Applying 30 kg N ha⁻¹ using SPAD value fell below the critical value of 37.5 resulted in application of 90 kg N ha⁻¹, that found to be produce rice yields equivalent to those with 120 kg N ha⁻¹ applied in three splits. Significantly higher and positive interaction reported among applied N and water supply on wheat yield as well as water and nutrient use efficiency by wheat Bhale, Wanjari [7].

Precision Farming

Adoption of precision farming practices in countries like India has been slow largely due high cost, small land holding and greater skill requirements. However, now certain low cost sensors are available which can help precise application of nutrients and water. Applying N when SPAD value of top-most fully expanded leaf approaches 37.5 saved 30 kg N /ha and increased yield by about 10 % Dass [8]. Applying water at crop water stress index (CWSI)

value of H⁶ was found rewarding in-terms of water productivity in *kharif* maize Dass [9]. Water-use efficiency of 80-90% has been achieved with drip irrigation method with higher crop yields.

Nanotechnology in Agriculture

Nanotechnology has the potential to revolutionize the agricultural systems as nano formulated fertilizers could release their active ingredients in controlled/slow form in respond to environment and biological demands much effectively. Nano fertilizers are the nano particles based fertilizer, where supply of the nutrients precisely for maximum plant growth, have higher use efficiency, and can be delivered in timely manner to a rhizospheric target or by foliar spray. Studies show that the use of nano fertilizers causes an increase in nutrients use efficiency, reduces soil toxicity, minimizes the potential negative effects associated with over dosage and reduces the frequency of the application. For example, if we consider at the present level of fertilizer consumption are 14.05 Mt N and 5.66 Mt P₂O₅ in 2006-07 with nutrient use efficiency of 50% for N and 20% for P. The increase in the efficiency of N and P use by just 2 percentage that would lead to a saving of 5.38 lakh tonnes of N and 5.15 lakh tonnes of P, which together translate to a saving of Rs.14,920 million annually. Nano-matereials provide an opportunity to increase the nanopores on seed surface, which facilitate more moisture and oxygen penetration for better seed germination and crop establishment.

Conclusion

It is clearly indicated that we need ecosystem approach to agriculture production intensification, efficiency mediated productivity, profitability enhancement measures, system approach to production, protection, and developing long term strategic land and water use. In this endeavor, technology development must out pass problems faced and challenges posed.

Integrated water resource management approach for irrigated cropping systems per unit of agriculture water use holds key to

both food and environmental security. Also, agroecology provides the scientific basis to design the only agricultural system that will be able to confront future challenges is one that will exhibit high levels of diversity, productivity and efficiency. The transformation of agricultural production so that not only produces abundant food but becomes a major contributor to global biodiversity conservation and a continuing source of redistributive ecosystem and socio-economic services is unquestionably a key endeavour for both scientists and farmers in the second decade of the twenty-first century.

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