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An urgent need for sustainable thinking in agriculture – An Indian scenario

Pratap Srivastava [a,*], Rishikesh Singh [b], Sachchidanand Tripathi [c], Akhilesh Singh Raghubanshi [b,**]

[a] Ecosystems Analysis Laboratory, Department of Botany, Institute of Science, Banaras Hindu University, Varanasi, Uttar Pradesh 221005, India
[b] Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi 221005, India
[c] Deen Dayal Upadhyaya College, University of Delhi, New Delhi 110015, India

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ABSTRACT

This article emphasizes on the present urgent need to think in "Holistic Dimensions" to achieve a sustainable agro-ecosystem. In this respect, the complex network of dynamic interactions in the agro-ecosystem soil at spatiotemporal dimensions holds crucial importance. It reflects the inherent tendency of dynamic ecosystems to achieve a more efficient state successively through improved interactions. The short-sighted and inefficient agro-management during Green Revolution decades has been detrimental to these interactions in agricultural soils, which is widely evident by its boomerang effects (i.e. declining efficiency, productivity and multi-functionality). It jeopardized the internal regulation in our agro-ecosystem's functioning by erosion of efficiency building interactions among biotic and abiotic components. Therefore, a bottom-up as well as top-down approach in the soil management is required to restore and sustain the unaccounted but indispensible ecological subsidies for sustainable agriculture and development, globally. We propose a "commercial ecological agriculture" which should be an amalgamation of sustainable agricultural practices and supported by a progressive co-ordination among all the stakeholders via participatory learning and adaptation with time. It should be least-disturbing, resilience-building, resource (i.e. energy and nutrient) use efficient, site-specific, labor and skill-intensive, low-input, diversified and integrated, and intimately harmonized with nature. It may potentially provide us agricultural sustainability with time in real sense. It would be primarily based on management of interactions indirectly through identification of integrative variables as surrogate, which may help to achieve internal regulation or self-reliance in agroecosystems. Further, it would be helpful to eliminate the widening socio-economic divide and in mitigation of global change in environment (i.e. air, water and soil) and climate. Additionally, it would improve and restore the multifaceted potential of soil, thus quality and productivity, through improved internal regulation on resource-use efficiency.

1. Introduction

Agriculture, which is a practice to cultivate food from the soil, gives humans an opportunity to interact and understand the nature, closely. It has been at the root of origin, evolution and down of civilization (Dale and Carter, 1956; Montgomery, 2007). Intensification (i.e. use of off-farm inputs to achieve higher yields) and extensification (i.e. Increase in the cultivated area to increase yield) of agriculture to feed the increasingly growing human population is among the predominant global changes responsible for the present global environmental problems (Matson and Vitousek, 2006). Agricultural intensification led to the emergence of Green Revolution technology (Fig. 1) which multiplied the agro-production many folds. It was based on three important principles viz., people need to eat, land resources are limited, and thereby one has the last resort to increase the yield through external inputs (Lobell et al., 2014). Therefore, the application of agro-chemicals (i.e. nitrogenous fertilizers and pesticides) has been made in this industrial agro-management for increasing grain yield (Saikia et al., 2013). However, it led to a widely evident decline in soil quality/multi-functionality (Singh, 2000). Further, it led to a variety of socio-economic (such as widening socio-economic

* Corresponding author at: Ecosystems Analysis Laboratory (EAL), Department of Botany, Institute of Science, Banaras Hindu University, Varanasi, Uttar Pradesh 221005, India. Tel.: +91 09305174058.
** Corresponding author at: Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi, Uttar Pradesh 221005, India.
E-mail addresses: prataps103@gmail.com (P. Srivastava), raghubansh@gmail.com (A.S. Raghubanshi).

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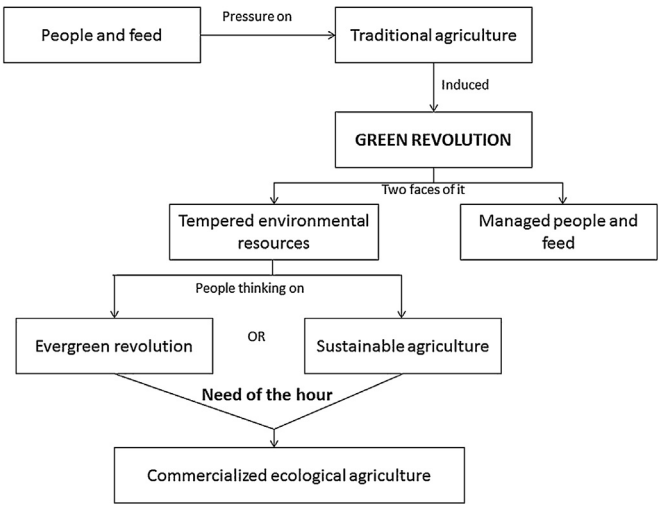

Fig. 1. General overview of emergence of Green Revolution to sustainable agriculture.

gap, food insecurity, disruption of traditional rural structure and livelihoods, indebtedness and suicide among marginal farmers, agricultural abandonment and urbanization and downfall in public health) and ecological (such as disruption of ecosystem integrity, efficiency and stability) problems (Altieri, 2000). Among the other long-term flaws (Fig. 2) of this industrial agro-management are loss of soil organic carbon (SOC) and fertility, soil erosion, dwindling biodiversity, desertification, pesticide pollution and emerging pest resistance, pressing climate change, rising food prices etc. (Lichtfouse et al., 2009). The projected human population of about 9.2 billion by 2050 (Godfray et al., 2010) would require a doubling in the food production. These conditions, altogether, have necessitated the search for an alternative agriculture practice which is ecologically sound.

For centuries, the agriculture of developing countries like India relied upon the local resources such as local indigenous varieties and knowledge, which was achieved through sustained interaction with the nature (Umarani and Subramaniyan, 2000; Altieri, 2004). The present high external-input based industrial agriculture, created socio-economical and ecological problems, primarily through externalization of control by means of its core applications (i.e. pesticides, fertilizers, unjust irrigation practices, high yielding varieties and mechanization) (Singh, 2000). The consequent boomerang effects of this Green Revolution technology, as evident in Punjab (Ludhiana), India is an exemplary of our underestimation of ecological interactions in sustainable management of soil/agro-ecosystem. Therefore, in spite of enhancing crop production, Green Revolution proved to be unsustainable, globally (Horrigan et al., 2002). It is primarily due to dramatic loss/erosion of biodiversity as well as their evolved spatiotemporal interactions (Daily, 1997), and associated traditional knowledge used in the past for efficient management of the former. This industrial technology though favored agro-based industries and wealthier farmers, however left many small holding farmers in acute debt. Due to such global repercussions, the concepts of food sovereignty (Badgley et al., 2007), evergreen revolution and ecological production systems have gained much attention since past few decades.

In the present dooming environmental scenario, traditional ecological knowledge (TEK) of indigenous people has been accepted as scientific and sustainable knowledge. It has been developed through generations of intimate interactive learning by the native people with local environment after several trials and errors. This has nurtured the agroecosystems with a potent efficiency and a built-in resilience in the past (Gunderson, 2000). It has helped farmers in the past to adjust to the continuously fluctuating and changing climatic conditions. Highly-productive traditional systems (e.g. livestock-integrated mixed-cropping, agro-forestry

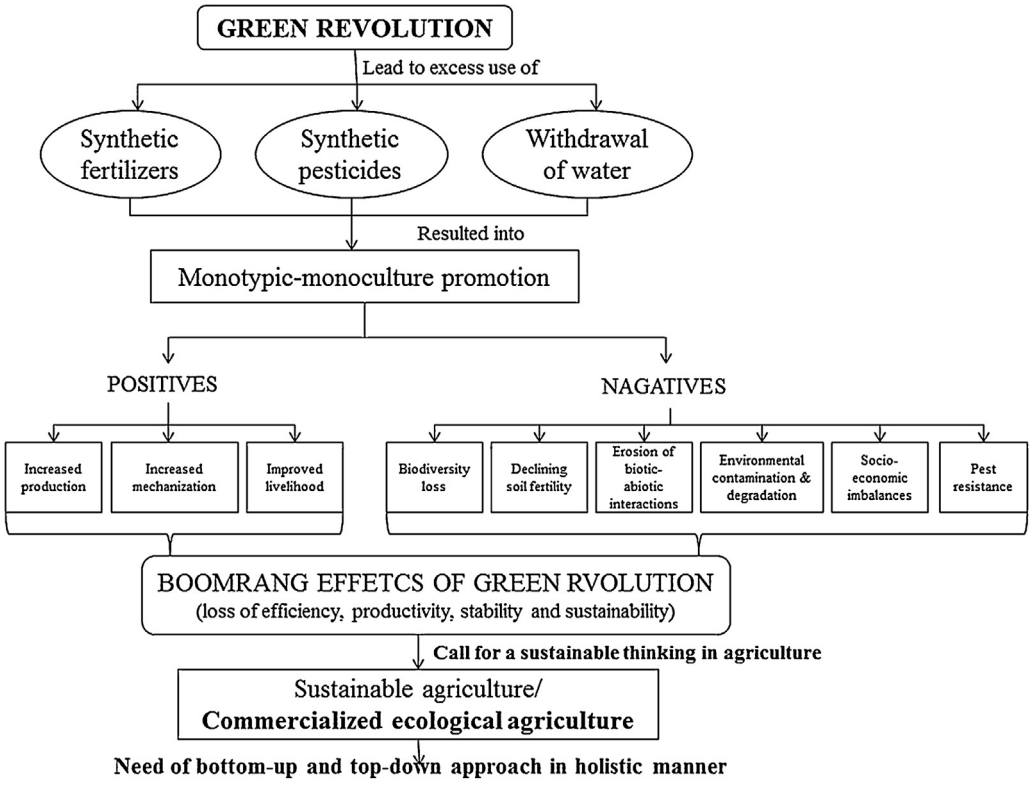

Fig. 2. Environmental impacts of Green Revolution and need for ecological agriculture.