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Chapter- 8

Hindrance and Potentiality on Sustainable Agriculture in India in Scenario

Somdatta Ghosh

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Abstract:

The world is now shifting to sustainable agriculture to reduce negative impact of agrochemicals on soil, water, biodiversity, human health and on ecosystem as a whole without compromising the production in future. The production cost of agrochemicals offers a huge toll on carbon footprint of the earth, with pollution beyond remediation and depletes non-renewable resources. Small and marginal farmers are unable to bear the cost of input chemicals and irrigation and carry on agriculture as an occupation for thin slice of profit. The lands are being hand overed for other purposes. This scenario is not very acceptable for the rising global or state population. To convert the high doses agrochemical loaded conventional land to organic sustainable land is not an overnight remedy without compromising production in transition period, but the transformation would certainly save us and our earth in future. The obstacles and remedies are to be properly addressed for actions to be taken for.

Introduction:

India has managed to cater the increasing need of food grains and other agriculture products for the rapidly rising population in last few decades very efficiently. Almost all the credits mostly go to the 'Green revolution,' the much needed implementation at that time and subsidy in chemical fertilizers by govt. India is an agro-based and agro-economic country because of rich crop diversity, favourable climate and availability of manpower also. The combination of rich traditional knowledge, high yielding varieties, and Government subsidy to agrochemicals altogether reached the annual production to self-sufficiency and high GDP. Now is the challenge to keep the production sustainable for the future and ensure healthy food with least negative impact on ecosystem.

Unfortunately, it is also the fact that to ensure food for everyone in the rising population, we had to compromise with our rich Indigenous diversity of food grains, especially rice, millet, and now vegetables. Continuous cultivation of high-yielding varieties led to the loss of nearly one lakh Indigenous varieties of rice (Eliazer Nelson et al., 2019), which were mostly folk varieties with some specialties, i.e., adapted to certain environments, rich in vitamins, proteins, or minerals and with delicacies and evolved in a million years. Besides that, we had to compromise our

Somdatta Ghosh
Ecology and Mycorrhizae Research Section, UG & PG Department of Botany, Midnapore College (Autonomous), Midnapore 721101, W. B., India
E-mail: somdattaghosh@yahoo.co.in
Orcid iD: https://orcid.org/0000-0002-4840-0615
*__Corresponding Author__: somdattaghosh@yahoo.co.in

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traditional sustainable agriculture, replaced with a semi-synthetic agroecosystem with almost synthetic inputs and altered cultivation cultures.

The most unfortunate is our marginal and small-scale farmers can't bear the cost of agrochemicals nowadays, and the cost-benefit ratio is gradually declining. Most of the high yielding varieties are demanding irrigation and disease prone. Hence, input expenditure is raised and margin of profit is declining. In some cases, lack of irrigation facilities or affordability is compelling to leave the lands fallow for one or two seasons. The long-generation farmers are losing interest in cultivation. Land transformation is a very common issue throughout India now. This situation of losing agriculture lands will surely affect our national annual production & GDP along with the global production too. This shifting of occupation will also drain the rich traditional knowledge of cultivation. The transformation of cultivable land to other purposes is a worldwide problem due to urbanization, industrialization, natural disasters, etc. But being forced into an unprofitable occupation is more pathetic for consumers, too.

Moreover, overuse of agrochemicals in fields for years increases toxicity in soil, water, and the whole ecosystem. Excess nutrients go to waterbodies by runoffs, hampering aquatic lives; leach to underground water and ultimately to our drinking water. An imbalance in the soil pH disrupts the soil micro-floral combination, hampering nutrient cycles, which turns the soil into conductive soil (Dubey et al., 2012). Agrochemicals are agro-pollutants and a potential threat to biodiversity (Zaller et al., 2022), and causing numerous health hazards (Savci, 2012; Dawn et al., 2023; Banerjee et al., 2021). Those render soil less productive in long-term use, which, has been observed in a study of 1998 to 2018 (Xin, 2022). High subsidy to agrochemicals is a serious threat to mankind in future and obstacle to sustainable agriculture (Guo et al., 2021).

In recent years, pollution due to agro-waste burning is a burning issue, that even disrupting normal human life. Not only affects the air but also affects the fertile top-soil layer, causing soil compaction, volatilization of minerals from soil, and destruction of natural soil microflora, ultimately rendering the soil unstable and infertile.

The decrease in total agricultural lands and transformation of the nature of agricultural soil with increasing toxicity in the ecosystem is a sure threat to human civilization. To get rid of these problems, it's the high time to plan properly to carry on sustainable agriculture for a s better future and escape hazards. In this write-up up an attempt to focus on problems and potential remedies towards sustainable agriculture are discussed.

Problems towards sustainable management: -

Inputs (chemical):

Most of the high-yielding crop varieties, susceptible to disease (Runno-Paurson et al., 2013) and drought (Vikram et al., 2015), demand irrigation and high doses of chemical inputs in the form of mineral fertilizers and pesticides. Most of the minerals get readily converted to insoluble form and/or runoff or leached and get wasted. Actually, a major part of the expenditure is wasted annually and transforms the soil into toxic. For example, the second most demanding nutrient for plants in phosphate, that's is sourced from phosphate rock only. 80% of fertilizes deposited in

soil unused, unavailable for year after year. But the source is limited and it's the only mineral with no 'cycle' at all. All unused portion is ultimately deposited in sea or sub soil water table. Morocco is the largest supplier of phosphate rock for fertilizer production. The wise 1st world countries are storing their rocks without exporting; and stepping towards sustainable agriculture (Vaccari, 2009). When phosphate solubilizing bacteria and fungi are able to supply soluble P to rhizosphere and mycorrhizal hyphae are able to transport P to plant root, and these functions maybe availed 'free of cost' for us, why are we producing soluble P-fertilizers with cost of increasing 'carbon foot print' on earth? And forced our agriculture to be expensive? In sake of businessmen only. Supplement of rock phosphate only is sufficient along with these microbes. But the changed soil pH and high concentrations of minerals in soil, either eradicate the beneficial microflora from soil or render them inactive, even parasitic (Johnson et al., 1997). Phosphorous is with a long history of offering an adverse effect on arbuscular mycorrhiza (AM). Exogenous supply of soluble phosphate leads to a rapid suppression in arbuscule development and intraradical colonization (Kobae et al. 2016), which are directly related in P uptake for plants. Fertilizer application, specially, phosphorous reduces diversity of AMF species severely, possibly leaving some phosphorous resistant AMF strains (Yang et al. 2016). The continuous fertilization for 37 years altered the phylogenetic structure of AMF in a Chinese Mollisols (Ma et al. 2018).

Input of fungicides, pesticides and herbicides also similarly affect beneficial microflora affectively natural nutrient cycle in soil and plant immunity too. The recommended doses of most fungicides are detrimental to AM; some are neutral, while few fungicides are inducing at low doses (Rivera-Becerril et al. 2017; Rodriguez-Morelos et al. 2021). In different studies fungicides were found to affect root colonization (Calonne et al. 2012), spore germination (Buysens et al. 2015), transport of phosphorus from fungus to plant (Zocco et al. 2011); and significantly correlated with doses.

Shift of Cultures:

The brittle and harsh straws of high yielding grain varieties are suitable for use neither for thatching houses nor as cattle fodder. The decreasing trend of cattle rearing also have decreased the demand of fodder or vice-versa. Technology have taken the function of cattle and manpower, that is not a good step in utilization of manpower in this highly populated country, reducing the work facility and supply of organic manure for our fields. For large agriculture fields the uses of these technologies are sound but for limited boundary field, human skill and labour is feasible. The harvesting machine design leaves half of the stem of crops in field after harvest. To eradicate the remaining quickly and prepare the field for next crop, farmers burn the agro waste in field. In spite of Supreme Court order, there is no other options to them. They have to neglect the immense air pollution, the loss of nutrients by volatilization, the compaction of soil erosion proneness, loss of soil biota etc (Ni et al, 2015; Pellegrini et al, 2020). This simple action surely and promptly rise some soluble nutrient concentration in soil but degrades more depriving the next crops, and

adding green-house gases in air (Bhatia et al, 2013). Agricultural technology with error forcefully implemented these hazards.

Another rich traditional culture and knowledge of biological and cultural controls are just overruled and abolished and we are now totally depended on chemical control mainly. So now a days, farmers don't think twice to kill even birds. Pesticides have successfully eradicated earthworms from field. In near future, probably we may be able to lose honey bees also. New generation farmers need a sound knowledge of conserving these beneficial organisms in a harmonious way.

Lack of proper knowledge:

Along with the rich traditional knowledge of our farmer we need to provide them modern scientific knowledge by training or workshops. Most of our farmers are not of aware of soil sustainability, natural farming, biodiversity or biofertilizers. Even they are forgetting traditional knowledges; need of keeping earthworm in field, of functions of honeybees, need and steps of conserving these, and traditional biological control by food chain. They also need to know the justification of conserving local crop varieties, the increasing threat of toxic substance in food grains causing health hazards. How to manage all these without compromising production and profit.

Farmers in Himalayan belt, are mostly reluctant to use agrochemicals in field; they opt for amendments only, sustain natural microflora and agroecosystem. Though indigenous folk varieties are quickly decreasing there too (Choudhury et al, 2013). But farmers in plain are almost influenced by advertisements and apply overdoses of agrochemicals in fields, with aim to boost up and quick yield and ultimately hamper the productivity for future, and increase carcinogens in marketed foodgrains and vegetables. As fertilizer is to be used to make up the deficiency of soil, agriculture department can't avert the responsibility of proper guiding, otherwise it would be converted to a 'Frankenstein' or already have been. With the implementation of modern technologies, the need to maintain the natural resources should be part of cultivation technology with proper guidance.

Potential measures: -

Integrated management: -

The 1st world is opting for natural farming or natural agriculture, in this decade. This is the concept based on 'Gaya' hypothesis; as the mother earth has created the soil suitable for plant growth gradually by its own; just rely on it without any external input. But in our country, the soil of conventional agriculture lands is already overloaded with high chemical inputs and will not be feasible overnight for this practice agriculture department can't avert the responsibility of for proper use otherwise it would be converted to a 'Frankenstein'. Rather gradually move towards integrated management is better.

A. Variety:-

The very fast step of which is selection of crop varieties adapted to indigenous climate and soil, specially, should be prioritized in disturbed areas of drought, salinity and flood affected zone. These varieties are mostly environment hardy and resistant to diseases. The comparative less production by these varieties will ensure the margin of profit and always accepted than no production by fallowing land for one or two seasons. Revive of local varieties paves the way of producing effective high yielding and environment friendly hybrids in future. Initially encouraging marginal or small-scale farmers in cultivation indigenous or folk varieties will reduce the input cost and be thus profitable and able to cater their own need of food grains. Again, it is important to cultivate crops according to climate or soil. For example, in W.B a large portion of agriculture soil is lateritic, dry and nutrient poor. These lands remain fallow for seasons for lack of irrigation for high yield is crops varieties. But cultivation of suitable varieties of millets and rice, has great possibility there. Local peoples are not interested mainly for different food habits, lack of markets for products, and lack of knowledge for cultivation of those crops. Proper guidance skill development and marketing provision may turn these lands under-utilization and uplift the rural economy. Again, local culture or food habits also to be given importance by conserving the local varieties. Discouraging of the cultivation of those low yielding but low input indigenous variety are abolishing these local delicacies, which too have both cultural and economic value. Fortunately, there are several initiatives in both Govt. and non-govt. sectors conserving and rescuing local varieties, which may be utilized with local farmers.

B. Cultural:

Sowing and drilling time is very important to avoid pathogens, specially, fungal pathogen, as most of the destructive fungal pathogens favour humid conditions, and a range of physical conditions. Planning according to weather forecast is expected to avoid unwanted loss avoiding period with suitable germinate conditions of fungal spores.

Time and intensity of irrigation various crops to be differed with climate for some reasons. Proper overall sanitization is often overruled for being overdependent on chemical overuse. But the opposite is expected for sustainable and integrated management.

Reduction of chemicals inputs are the only way to return the balance of ecosystem in agriculture field; mainly a sound of food-web for natural biological control which in turn would reduce the dependency on chemical control, silvi-agriculture, silvi-pasture, agro-pisciculture may be opted according to possibilities (Lodha, S., 1997).

Last but not the least, post-harvest agro-waste burning of machine harvest remains need to be urgently addressed, by changing of machine design. Recent studies in ICAR have shown that some strains of *Trichoderma* are very effective in rapid decomposition of straws in field (Organo et al. 2022; Sarangi, et al. 2021) and also be used as biocontrol agent (Poveda, J., 2021). Biotechnological approaches may be taken in fields or nearby separate zones to convert waste into organic manure by similar green technology. Contacts with paper pulp industries to collect post-harvest debris from field may be another way.

Revive of bioresources:

Researches have shown that beneficial microflora are degraded in conventional agriculture fields than organic treated farmlands or natural vegetations (Baweja et al, 2020; Tripathi et al., 2020).

In order to return sustainable soil management in agriculture fields, re-establishment and proper maintenance of beneficial microflora, i.e cellulose degrading, nitrogen fixing, phosphate solubilizing microbes are specially needed. Introduction of suitable species and strains are needed according to soil and climate. The role of these microbial consortium is no doubt effective in increasing crop production and maintaining soil health (Tailor et al, 2023). Mycorrhizae, specially, arbuscular mycorrhizal fungi (AMF) are one of the key factors in maintenance of soil sustainability and increasing plant vigour. AM are active in soil aggregation and stabilization, uptake of nutrients, specially, phosphate and other less motile nutrients (Battini et al. 2017; Garg and Singh. 2017), but very sensitive to high nutrient condition (Dora et al. 2021) and most of the fungicides (Channabasava et al. 2015). Application and conserve by proper amendments and management of AM may be an effective tool for sustainable farming (Kuila and Ghosh, 2022).

The natural indigenous earthworms are now abolished from conventional fields. Earthworms are also very good detrivores with rapid degrading ability of cellulose agro-wastes and mixing up minerals in fields. Application of indigenous earthworms are better than application of exported earthworm formed vermicompost or vermiliquid (Singh, 1997; Sruthi and Ramasamy, 2018). Most exported earthworm's habitats on very top layer with specified media and unable to survive and work in agriculture fields. But all are susceptible to pesticides. Hence just application of those bio-resources in conventional would render no expected or effective results; by which most farmers tend to reach the conclusion- 'those do not work'! To prepare and maintain the land for sustainable condition need to focus on chemical inputs simultaneously. A holistic approach towards sustainability is very much needed, in order to take help of low-cost biotechnology, application of their media is needful, such as, organic amendments, for bacterial flora and slow P releasing rock phosphate for effectivity of AMF.

Beneficial bacteria, phosphate solubilizing microbes also provides plant immunity to various diseases (Babbal et al. 2017; Soni and Keharia, 2021). The suitable microbial consortium with AMF successfully bio-controls some major soil and airborne disease of plants by improving the innate immunity or by other means (Dey and Ghosh, 2022). There is an immense scope to apply bio-waste for recycling and reuse as organic amendments in fields through the green technology and reduce the cost of input that will increase the profit. In this process of conversion from conventional to sustainable fields for first several years' compromise to yield in evident. But the profit maybe stabilized by reduction cost of inputs. Organic or green manures of low cost and biotic amendments are not required every year**.**

Present scenario:

At present, In India, 38 lakh hectres area is under natural farming of wheat in M.P. The states in south India and Himalayan foothills, mostly rely on organic fertilizers. Though the latter are

traditionally organic, some lands in the south are transformed from conventional to organic and sustainable with the application of mycorrhizae and plant growth-promoting bacteria, compromising with 4-5 years less production, which now increased the production than a conventional system. Sikkim is now a 100% organic agriculture country, as the steps were taken from govt. sector. In some other countries, small endeavors by farmers as initiation processes are later magnified by govt. aids. In Malaysia, some small farmers applied mycorrhizae in their fields and initiated organic farming; now agriculture dept of the country supplies mycorrhizae to rice fields (Ghosh, 2019).

Conclusion:

India relies mostly on conventional agriculture. The agrochemical residues in fields is rendering the soil toxic and decreasing production day by day. To ensure security for healthy food for the rising population and reduce pollution, health hazards, and carbon footprint, a switch to sustainable agriculture is a necessity. It may save the transformation of fallow agricultural lands and improve the earnings of small farmers by reducing the input cost. The hindrances need to be addressed at all levels. The low production in the transition period is to be compromised for the sake of the future. Our farmers need to be updated, and a new educated generation needs to apply their knowledge in the field to make agriculture a profitable, predictable, and prestigious means of earning. The scope of entrepreneurship in the production of biofertilizers and biopesticides, along with waste conversion, would increase employment. There are many instances in abroad and India too.

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