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Short Note

Green Revolution in India: Environmental Degradation and Impact on Livestock

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Abstract: The Green Revolution has transformed India to a food grain surplus country from a deficit one. No other activity has such immense impact on the socio-economic development of the people as the Green Revolution. Intensification of agriculture over the years has led to overall degradation of the fragile agro-ecosystem. High cost of production and diminishing economic returns from agricultural practices are affecting the socio-economic condition of farmers. Loss of soil fertility, erosion of soil, soil toxicity, diminishing water resources, pollution of underground water, salinity of underground water, increased incidence of human and livestock diseases and global warming are some of the negative impacts of over adoption of agricultural technologies by the farmers to make the Green Revolution successful. Indiscriminate and disproportionate use of chemicals pollutes the soil, air and water and feed and fodders offered to animals. This may be one of the important etiologies of increased productive and reproductive health problems of livestock.

Various scientific studies and surveys conducted on fertilizer and pesticide residues during last 45 years indicate the presence of residues of fertilizers and pesticides like nitrates, organochlorines, organophosphates, synthetic pyrethroids and carbamates at higher level than permissible limit in milk, dairy products, water, fodder, livestock feeds and other food products. As urea, a nitrogen-rich fertilizer is used much more than the recommended 4-to-1 ratio to potassium; it is contributing to the global warming. The extent of systematic damages caused in the process of Green Revolution to the soil, groundwater, and ecosystem needs to be quantified. It could lead to irreversible consequence to the life of the people who are benefited once if the timely, adequate and sustainable measures are not taken up to mitigate the harm done by the Green Revolution.

Key words: Green revolution, environment, global warming, livestock.

Introduction

The most remarkable accomplishment in the history of India has been its ability to transform it to a food grain surplus country from a deficit one and strengthening this sector that is so crucial to India's survival. No other activity has such immense impact on the socio-economic development of the people as the Green Revolution. It ushered a dynamic development of Indian agriculture in all spheres. The daunting challenge of feeding 1.2 billion people was easily overcome by the nation because of impressive success of Green Revolution. Although the success of the Green Revolution is immense and crucial in meeting hunger and poverty, the other side of Green Revolution is creating concerns among the stakeholders of this most vital sector of the country. The Green Revolution is now showing sign of fatigue and productivity of soil is diminishing at an alarming rate. Indiscriminate and repeated use of pesticides leads to loss of bio-diversity, pest-resistance and other ecological imbalances (Kumar et al., 2013). In this article an attempt is being made to analyse the environment degradation due to intensive farming practices and how it is affecting the livestock health.

The Origin of Green Revolution

"Green Revolution", a term coined in the 1960s by William Gaud, then Director of the U.S. Agency for International Development, symbolized a significant increase in agricultural productivity resulting from the introduction of high-yield varieties of grains, use of chemicals, and improved management techniques. Green Revolution emerged from a combination of scientific, technological and geopolitical conditions. Dr. Norman Borlaug's development of new and different kinds of seeds from crops during 1960s was an important breakthrough in food production that fuelled the Green Revolution. The Mexican Agricultural Programme established by the Rockefeller Foundation in 1943 initiated the process of the green revolution in which American and Mexican scientists worked to develop synthetic and hybrid corn and wheat varieties that were high-yielding in comparison to local varieties (Conway, 1997; Lipton, 1988). Due to the success of the Green Revolution in Mexico, its technologies spread worldwide in the 1950s and 1960s (Briney, 2010). In 1961, the International Rice Research Institute began operations in the Philippines with assistance from the Ford and Rockefeller Foundations, and developing high-yielding hybrid rice varieties.

Indian Agriculture and Green Revolution

Agriculture is the mainstay of rural India as about 70 per cent of population is engaged in this activity. Agriculture and its allied sectors contribute substantially to the Gross Domestic Product though it is declining over the years. Pre-independent India witnessed many famines and these had broken the backbone of Indian economy. The most severe one was Bengal famine in 1943 that killed three million people equal to the Nazi holocaust. Grow More Food campaign, Intensive Agriculture Development Programme and Intensive Agriculture Area Programme were launched to strengthen this sector and to increase the food grain production during 1947-60. These programmes could not meet the required demand of food grains and the country was importing million tonnes of food grains from countries like USA. In early sixties, India was facing food crisis and the agriculture was in the brink of collapse. Urgent attention was required to prevent famine-like condition to occur.

The Indian government's decision to embrace the 'Green Revolution' was an emergency response to a perceived crisis in food production caused by agricultural sector failures (CED, 2007). Benjamin Peary Pal, the first Director-General of Indian Council of Agricultural Research, initiated the wheat improvement programme at the Indian Agricultural Research Institute (IARI), New Delhi, during 1950s and developed wheat varieties like NP 809 and NP 824 but the real breakthrough came in March, 1961, when a few dwarf spring wheat strains possessing the Norin-10 dwarfing genes, developed by Norman E. Borlaug in Mexico, were grown in the fields of IARI (Anonymous, 2001). In 1965, C. Subramaniam, the then minister of agriculture, Government of India, took major restructuring steps in the agriculture research system and initiated the vigorous campaign to increase the food grain production. In 1966, 18,000 tonnes of seed of the Mexican semi-dwarf varieties, Lerma Rojo 64A and Sonora 64, were imported for seed multiplication (Anonymous, 2001). Thus the story of Indian version of "Green Revolution" was steered in.

Indian scientists led by father of Indian Green Revolution, M.S. Swaminathan, brought out new varieties of Kalyan Sona and Sonalika, selected from the advanced generation material received from Mexico. Hybridization between Mexican strains and Indian varieties resulted in many high yielding strains in different parts of the country. The remarkable speed with which the HYV were identified by the agricultural scientists led to upward trend in wheat production in last 40 years and so on. The Indian wheat varieties Sonalika, WL 711, HD 2009 and HD 2172 are also popular in countries like Bangladesh, Pakistan, Nepal, Bhutan, Afghanistan, Sudan and Syria. In Sudan, wheat variety HD 2172, grown in 90 per cent of the wheat area, has paved the way for self-sufficiency in food grains (Anonymous, 2001). The food grains production has increased from 50.80 MT in 1950 to about 264.3 MT in 2013-14 (advance estimates).

Environmental Degradation

Green Revolution advocates chemical agriculture and as a result the rate of application of nitrogen fertilizers and pesticides has increased by manifolds and seriously affecting ecosystems. Diminishing economic returns from agricultural practices are affecting the socio-economic condition of farmers. These farmers have been forced to over-use their land by increasing cropping intensity and over-adoption of package of practices to increase the production. Declining farm yield and income due to economic (high cost of inputs like seeds, fertilizers, pesticides and farm labour, as well as, low Minimum Support Price) and ecological (low productivity of soil, receding water table, etc.)

factors is pushing marginal and small farmers into the vicious cycle of debt (Tiwana et al., 2007). Reyes Tirado, a research scientist at the Greenpeace Research Laboratories in the University of Exeter (UK), said, "It's clear that Punjab is in a deep ecological crisis with its ramifications on socio-economic and cultural aspects of its population". After 50 years of launching, the negative aspects of the Green Revolution have threatened the agriculture system itself. Dr Devinder Sharma, Food and Agriculture Policy Analyst, described that as a consequence of intensive farming methods practiced for the past four decades, Punjab is in the grip of a terrible environmental crisis.

Studies by the Consultative Group on International Agricultural Research (CGIAR) have established that Punjab is faced with second generation environmental crisis. "The cultivable land is sick, the environment has been heavily contaminated by the use and abuse of chemical pesticides and the underground water table is plummeting at a dangerous pace" (Sarma, 2008). Over intensification of agriculture has led to heavy demand of water for irrigation and degradation of the fragile agro-ecosystem. The groundwater table has alarmingly decreased from 15 feet to 100-115 feet or more in Punjab state of India. The water table is depleting at an annual average rate of 55 cm across whole of the state of Punjab. More than half of development blocks of Punjab and Haryana state of India, where intensive irrigation is practiced, cannot sustain any further increase in the number of tube wells. In Punjab state, out of 137 blocks, 103 blocks were over-exploited, five blocks are critical, four blocks were semi critical and only 25 blocks were in safe category (Tiwana et al., 2007). The total requirement of water for agriculture activities based on cropping pattern and practices stands at 4.38 mham against the total availability of 3.13 mham. The deficit of 1.25 mham is met through over-exploitation of groundwater reserves through tube wells, resulting in rapid decline of water table in the entire state (Tiwana et al., 2007). This induced desertification of rich alluvial soil of Punjab state which has negligible slope (Shiva, 1991).

It is estimated that about 0.7 lakh hectares in Punjab (about one third of the total area), just like in one third of the world's irrigated land, were salt affected and produce either no yields or very poor yields (Shiva, 1991). Disproportionate use of nitrate-rich fertilizers aggravates the problem of climate change by emitting nitrous oxide and this nitrous oxide have 300 times more heat-trapping capacity per unit of volume than does carbon dioxide. According to the *Indian Journal of Fertilizers*, in Haryana and Punjab, farmers used 32 times and 24 times more nitrogen than potassium in the fiscal year 2008-2009, respectively, much more than the recommended 4-to-1 ratio (Anand, 2010). As urea, a nitrogen-rich fertilizer, is used substantially more by the farmers, it is contributing to the global warming. The effect of pesticide and fertilizer residues on the rumen microflora and its role in methane production, which is another element of greenhouse gases, need to be ascertained. The ever increasing use of non-renewable energy due to the mechanization of agriculture is also one of the contributing factors to the global warming. Pesticides being used in agriculture tracts are released into the environment and come into human contact directly or indirectly affecting human life (Wadhwani and Lall, 1972; Kasyap and Gupta, 1973). A number of studies reported pesticides and heavy metals in drinking and goundwater in different parts of India (Dikshit et al., 1990: Kumar et al., 1995; Bansal and Gupta, 2000). Organochlorine and organophosphorous pesticide residues were detected in goundwater samples from irrigation and drinking purposes in Aligarh (Ray, 1992).

Loss of soil fertility, erosion of soil, soil toxicity, diminishing water resources, pollution of underground water, salinity of underground water, increased incidence of human and livestock diseases and global warming are some of the negative impacts of over adoption of improved agricultural technologies by the farmers to make the Green Revolution a success.

Impact on Livestock due to Environmental Degradation

Indiscriminate and disproportionate use of chemicals pollutes the soil, air and water and is primarily responsible for various adverse livestock health conditions. The livestock fodder crops and feeds produced on this salt affected, toxic and micronutrient deficient soil contain nitrates and pesticide residues and deficient in micronutrients. This may be one of the important etiologies of increased productive and reproductive health problems of livestock, especially bovine. Shiva (1991), mentioned that heavy use of chemical fertilizers and new seeds directly led to decreased soil fertility, and to new deficiencies and diseases. Feed and fodder offered to animals are often contaminated with pesticide residues (Sandhu, 1980; Raikwar and Nag, 2003) and the livestock reared on pesticides contaminated soils, crops and fodders may accumulate considerable residues in edible tissues (Kumar et al., 2013). Endosulfan, an organochlorinated

insecticide used in agriculture has been reported to be found as residues in different feed concentrates and green fodders up to a concentration of 6 ppm (Dikshit et al., 1989; Kang et al., 20012; Imrankhan et al., 2003; Deka et al., 2004).

The quantity of pesticides used in India is very low (only 0.5 kg/ha) as compared to other developed countries (Japan 12 kg/ha) (Chauhan, 2009), even then problem of pesticide residue is very high in India. Chemical radiation and biological toxicity was rampant in Punjab (Garg, 2010). Soil toxicity arose through irrigation and high chemical fertilizer input, for example fluorine, boron, selenium and aluminium toxicity. It is 'posing a threat to crop production as well as animal health' (Shiva, 1991). Various scientific studies and surveys conducted on fertilizer and pesticide residues during last 45 years indicate the presence of residues of fertilizers and pesticides like nitrates, organochlorines, organophosphates, synthetic pyrethroids and carbamates at higher level than permissible limit in milk, dairy products, water, fodder, livestock feeds and other food products. Studies showed that in Punjab only few per cent of livestock (cattle and Buffaloes) had normal mineral status. Widespread sub-clinical hypocalcemia (Ca < 2.1 mmol) in buffaloes (Dua, 2003) and cattle of Punjab were reported.

The survey of the micro-nutrient status of the dairy animals revealed that iodine deficiency, manganese deficiency and selenium toxicity, both in cattle and buffaloes, were observed (Gupta et al., 1982). Cases of leucoderma or vitilgo were fairly common in buffaloes of Punjab (Randhawa et al., 1994). More than 30 per cent cows and buffaloes were exhibiting anoestrous and repeat breeding in Punjab (Dua, 2003). During November 2007 to Sept 2008 in Punjab, 28 deaths were recorded due to poisoning and 702 animals at risk, 99 were affected in twelve outbreaks of toxicities in animals. Seven outbreaks were due to excessive nitrate contents in fodder crops like sorghum, oat, berseem and toria. The fodders contained high nitrate (> 6300 ppm) which was due to excessive use of nitrogenous fertilizers. Pyrethroids, which are becoming more popular farm chemicals, are responsible for three outbreaks and 27 animals death. Apart from these, two outbreaks mainly due to use of Endosulfan killed four animals (Gupta et al., 2008). A study of organized dairy farms of Punjab state found that farms which were feeding fodder with elevated nitrate content experienced more anestrous (5.96, 2.19%), repeat breeding (5.46, 7.1%) and abortions (5.21, 1.25%) percent as compared to normal fodder feeding. The farms offering drinking water with higher levels of nitrate than permissible limits (1 ppm) had more incidence of anestrous (4.25, 2.75%), repeat breeding (10.4, 4.39%) and abortions (1.93, 2.01%) as compared to animal taking normal water (Deosi et al., 2008). The increased paddy crop cultivation and using paddy straw as fodder resulted in development of Degnala disease in buffaloes in Punjab (Dua, 2003). Higher contents of organochlorine pesticide residues had been reported in milk samples collected at different locations of the country (ICMR, 1993) and meat samples (Nag et al., 2005). Singh et al. (2013) reported that Endosulfan I and II were found to exceed MRL recommended by Codex in the milk samples collected from local markets of Nadia district of West Bengal. Extensive use of pesticides for controlling pests resulted in presence of significant amount of their residues in poultry feeds and ultimately in poultry products. An analysis of randomly selected samples of ready to eat chicken products collected from different areas of Punjab revealed that 74.00 per cent of samples showed the presence of pesticide residues. HCH, DDT and Endosulfan were detected above minimum detectable levels in 52.63, 42.11 and 15.79 per cent samples, respectively (Kaushal et al., 2008). Pesticide contamination poses significant risks to the livestock and human health.

Conclusion

Green Revolution transforms the starving nation to one which occupies the first or second position in terms of production and area in several major crops. It has impressive effect on the economic development of the country and helps to stand as one of the major economic powers in the world. Though the success of Indian Green revolution is unparalleled in recent history of mankind, the revolution has done damages to the agriculture system as a whole. The extent of systematic damages caused in the process of Green Revolution to the soil, groundwater, and ecosystem is yet to be quantified. It could lead to irreversible consequence to the life of the people who are benefited once if the timely, adequate and sustainable measures are not taken up to mitigate the harm done by the Green Revolution.

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