

Sustainable Agriculture –A Review of Literature

Meena

Research Scholar,

Department of Economics, M.D. University, Rohtak

Abstract

Aim of the present study is to analyze the issues related to Sustainable Agriculture in India. For this purpose various research papers have been reviewed to know the issues related to Sustainable Agriculture. Most of studies have stated that rice-wheat cropping pattern was emerged as the dominating cropping pattern after Green Revolution. The continuous rice-wheat cropping pattern is supported by modern technology. Farmers of the states (Haryana and Punjab) are more interested in rice-wheat cropping pattern which require more water availability. Although cost, yield and assured price consideration are also encouraged them for doing so. As the returns from paddy-wheat cropping pattern are more than other crops. Some research work have pointed out the with the availability of High Yielding variety Seeds (HYVs), fertilizer, pesticides and increased irrigation facilities have made a considerable shift in area from coarse cereals, pulses and oilseeds to rice-wheat crops. There was huge increase in the cropping intensity after Green Revolution. Some studies depicted that the unbroken rice-wheat cycle and the intensive cropping are the chief reason for loss or depletion of nutrients from the soil causing unbearable pressure on the nutritional base of the soil. Other studies reflected that Soil Micro-Organism system have adversely effected by pesticides. It has been reported by most of studies that due to continuous rice and wheat rotation, the intensities of pests, diseases and weeds have increased. The other environmental problems associated with rice and wheat system include water logging related salinity, pollution of ground water due to leaching of chemical fertilizer and pesticides and pollution due to burning of rice-wheat straw in many places.

Introduction

India is an agrarian economy. It has made tremendous progress in agriculture over the past decades. Technological change with the introduction of short duration high yielding varieties of wheat and rice in the sixties increased productivity of these crops manifold. The effective price policy coupled with relatively better technology has resulted in the emergence of paddy in kharif and wheat in rabi as the most secured and profitable crops in several states. The output of wheat and rice in the country has reached a saturation point. But, farmers in agriculturally advanced states like Punjab and Haryana still prefer to grow wheat and rice despite being aware of problems created by this crop rotation in terms of deteriorating soil health and depleting water table. The production, productivity and profitability which reached a plateau in leading green revolution states, started plummeting in early eighties. These developments made clear that the country would have a surplus of superior cereals and therefore, farmers should diversify towards other crops by increasing area under pulses, oilseeds, fruits, vegetables and commercial crops. With this realization, crop pattern in several states experienced significant change with diversification from traditional food crops to commercial crops, plantation crops and horticultural crops (Vyas (1996), Nadkarni and Vedini (1996), Joshi et.al (2004), Joshi (2014). However, cropping pattern in leading green revolution states of Punjab and

Haryana has not witnessed significant change and remained skewed towards wheat-paddy monoculture which has created ecological problems in the long run sustainability of agriculture.

Why Review of literature is necessary?

Reviewing of literature is an important exercise in the overall research process. Every study requires a review of concerned literature to know about the conceptual overview, the methodology, results of previous studies and gaps so that further research work can be done. It helps in avoiding repetition and in creating new dimensions to the existing research knowledge in the concerned area. Review reflects the gap between the plan and actual study of the researcher on the basis of which the researcher can find new directions for their research work. Present study is devoted to the review of literature related to the issues of sustainable agriculture in India. There has been tremendous growth in the literature on sustainable agriculture during recent years. That's why it is just not possible to review all available literature on the subject. Keeping in mind the limitation of research scholar in terms of time and resources, we briefly review the some of the earlier relevant studies on sustainable agriculture in India.

REVIEW OF LITERATURE

Chaudhary and Aneja (1991) have tried to find out the extent of utilization of land and water resources and their impact on long term sustainability of agricultural production in Haryana state. The study was based on secondary information from statistical abstract of Haryana for 1966-67 and 1988-89. There was a huge increase in the cropping intensity during the study period. With the availability of High Yielding Variety (HYVS), fertilizer, pesticides and increased irrigation facilities have made a considerable shift in area from coarse cereals, pulses and oilseeds to rice and wheat. Therefore the similar type of cropping pattern (rice-wheat) has led to raise the problems of weeds and pests in the crops. Further, there was noticed the decline soil fertility in terms of soil nutrients and organic matter. The adoption of rice-wheat cropping system on large scale has resulted in deterioration of soil texture and structure in the Haryana state. Due to the over exploitation of ground water, declining of ground water level has become a serious problem in the north-eastern region. On the other hand, water logging and salinity problems have arisen due to the increase in water table in some districts (like Jind, Rohtak, Bhiwani, Hisar and Sirsa). Further the problem was aggravated because the water of these districts is sodic/saline.

Joshi and Tyagi (1991) have studied about sustainability of existing farming system in the Punjab and Haryana states. The issue of sustainability has been studied during the green revolution period (1972-73 to 1979-80) and post green revolution period (1980-81 to 1987-88). On the basis of quality of ground water level, two categories of districts have been selected (from Punjab and Haryana), one with good water quality and other with poor water quality. Deteriorating soil health and stagnation of new technology have been found the main constraints in the production system. Over-exploitation of ground water has been observed in all the district of Punjab and in Karnal and Kurukshetra in Haryana for maintaining the existing production levels. There has been noticed a continuous rise in water table in the poor quality groundwater areas. The problem in these areas is taking a serious turn in terms of loss of production and decline in farm income. Because of continuous decline in water table in many parts of these two states has resulted in decline in water discharge over the years. If the situation remains as it is, then a stage will soon be reached when shallow tube wells will be ineffective. Therefore appropriate policy should be adopted regarding subsidy on

irrigation saving devices rather than on water extracting mechanism in order to save land and water resources for future generation.

Singh and Sankhayan (1991) have studied about the sustainability of water resources during the post green revolution period in Punjab. Punjab state has been divided into five zones for the estimation of irrigation water requirements and available supply of water in different zones. The study was based on secondary data from 1980-81 to 1989-90. The study points out that there was a shift in cropping pattern from other crops towards rice, wheat, sugarcane and cotton in different zones. The study reveals that there was a considerable increase in water requirement of water in different zones due to larger requirement of water for the growth of these crops. The problem of declining water table has remained more serious in the entire sweet water zone of the state. The requirement of water for irrigation facility has been increasing but not the supply. Therefore agricultural price policy should be changed in such a manner that it may suitably steer the cropping pattern in the state, for ensuring the sustainability of water resources.

Marothai (1997) examined the environmental consequences of agricultural technologies. The study was based on the data provided by Commission for Agricultural Costs and Prices (CACP), Ministry of Agriculture (1997), Centre for Science and Environment (CSE 1985) and Indian Council of Medical Research (1993). The study states that imbalanced fertilizers use has affected the growth of agricultural production and also damaged the physical and chemical structure of soil. The agricultural sector accounts for about two-thirds of the total pesticides consumption in India. Nearly 70 % of all the pesticides consumed by Indian farmers belong to banned or severely restricted categories in developed countries. Soil Micro-organism system have been adversely effected by pesticides. The toxic effect of pesticides and herbicides in the form of food and water contamination and pollution has adversely affected human and animal health and eventually influence their overall productivity. A large part of the rain fed area in country has actually suffered from soil erosion.

Chand and Haque (1997) looked at the problem and issues related to the crop system especially in the Gangetic and trans-Gangetic plans, where rice and wheat farming is widely practiced with the help of data provided by Indian council of Agricultural Research and Agricultural Statistics at a Glance, Directorate of Economics and Statistics. The study states that Punjab is facing a serious problem of ground water for rice and wheat cultivation. Similarly, in some places of Haryana, though the magnitude of area under salt-affected land has considerably declined there are signs of rapid depletion of ground water which threatens the rice and wheat system. In some upland areas of West Bengal and Bihar there are also reports of ground water depletion due to over exploitation of water, particularly in tube well irrigated areas. Moreover there are reports of declining factor productivity under rice based cropping systems, including rice-wheat system. It has been reported that due to continuous rice and wheat rotation, the intensities of pests, diseases and weeds increased. The other environmental problems associated with rice and wheat system include water logging related salinity, pollution of ground water due to leaching of chemical fertilizer and pesticides and pollution due to burning of rice straw in many places.

Singh et al (1997) highlighted the pace of growth and variability in the production of major crops in different agro-climate regions of Haryana, based on secondary data on area, production and yield of major crops collected from various issues of the statistical Abstract of Haryana. The study is based on two time periods viz. (I) 1966-67 to 1978-79 (II) 1979-80 to 1994-95. The results indicate that the pace of growth in the production and area of crops, mainly rice and wheat had slowed down

considerably during the second period of the green revolution, which gave an indication of technological stabilization (HVY technology). It is emphasized that under the changing agricultural scenario, it is important to check the ongoing phenomenon of crop specialization by introducing better crop-soil-water management strategies and efforts should be made to exploit the potential of new areas through proper resource management.

Praduman et al (1998) have examined the sustainability of rice-wheat based cropping system in Indo- Gangetic Plains (IGP) region of India. The study was based on secondary and primary information. Total Factor Productivity (TFP) has been used for quantifying the sustainability of Rice-Wheat based cropping system (RWCS). Production growth rate of rice and wheat has remained slower during 1985-95 in comparison to 1972-85 in Punjab and Haryana. The study reveals that the use of inorganic fertilizers has remarkably increased, but the use of organic sources of nutrients, namely farm yard manure and legumes have declined. The use of modern inputs (like adoption of high yielding varieties, irrigation, chemical fertilizers, pesticides etc.) in IGP has already achieved a high level during the study period. On the other hand, organic sources of nutrients, like organic manure and legumes area, have rapidly declined in the RWCS. Despite the positive effect of legumes in the TFP of RWCS, the area has declined under legumes, as these have been substituted by high profitable crops (Rice and Wheat). The higher growth in yield and production of RWCS can only be achieved through better management of existing soil and water resources. Therefore, authors have suggested that adequate support by public and private sector may encourage the farmers about the sustainability issues of Rice-wheat Cropping System and role of legumes.

Sidhu et al (1998) have studied about sustainability implications of burning rice and wheat straw in Punjab. A survey has been conducted of 237 farmers which are randomly selected from 11 districts out of 14 and 48 blocks out of 137, dominating in rice-wheat cropping system. The study has also analyzed the farmer's perception about the crop residue, preparation and use of farmyard manure (FYM) and about the use of chemical fertilizer. The survey has been conducted during month of September-October in 1996. Simple tabular analysis has been carried out to understand various issues related to existing crop residue use and its future prospects. It has been observed the majority (82%) of the farmers burnt rice straw and about 48% burnt the wheat straw. It has also been noticed that farmers commonly sell the wheat and rice straw or give free to the requesters, particularly for fodder. Farmers do not like to decompose rice and wheat straw into manure, because process requires long time period. This type of practice is not liked by farmers who find it very convenient to burn and clear the field for next crop. The study also reveals that no special efforts are made by the sample farmers to prepare FYM and none of them applied FYM to their field every year. Farmers do not follow the recommended level of nitrogen, phosphorus and potassium (NPK) for a particular crop. The authors have suggested that introduction of legumes into the rice-wheat cropping system can break the cereal-cereal cycle and help the low fertility fatigued soil of Punjab. Farmers should be acquainted about the proper method for preparing FYM.

Jha (2000) analyzed the extent of natural resource degradation, particularly of soil and water in the wake of green revolution. The study was based on the data provided by Statistical Abstracts of Haryana and Deputy Director of soil, Government of Haryana. The study is related with Kurukshetra district and states that the use of chemical fertilizers in the district quadrupled in twenty years (1970-90). There is deterioration in on the organic carbon content of the soil, resulting in deterioration in the physical health of soil. The study also indicates that only one-third of the total nitrogenous

fertilizer applied in the soil is absorbed by the plant. The study shows deterioration in the micro-nutrient status of soil and depletion in organic matter content. Decline in ground water have also been noticed. The situation becomes more serious during 1980's and ground water is over exploited. The decline in micro and macro nutrient status of soil has led an increase in the cost of production, as the farmers use larger quantities of chemical fertilizers. The organic matter content of soil influences a large number of physical and chemical characteristics of soil, which affect soil productivity.

Roy and Datta (2000) have studied about rice-wheat production system in Haryana. Kaithal and Karnal districts have been purposively selected due to dominance of rice-wheat crop sequences. They have also tried to find out the production constraints and technological constraints that cause significant production losses. The study was based on primary as well as secondary information. Production loss has been calculated by the estimation of intensity of constraints and yield gap. Crop wise analysis was not possible, as same set of constraints affect the entire region irrespective of crop or crop system. Therefore a list of socio-economic constraints was given to the farmers and was asked to rank the constraints as per their severity. The results of estimates illustrated the considerable yield gaps in both rice and wheat crops. As the yield losses are not comparable among crops. Therefore total value losses due to various constraints have been calculated for rice-wheat system. Further, the study reveals that higher proportion of production losses was attributable to the technical constraints in rice-wheat zone in Haryana (RWZH). If we talk about the socio-economic constraints, the ten topmost damaging problems are irregular power supply, non-availability of labour during peak period, high cost of plant protection chemicals, high wage rate of labour, high cost of chemical fertilizers (mainly NPK), non-availability of chemical pesticides, timely availability of quality seeds, price risk, non-availability of canal water and low price of farm products. The technical constraints were found more responsible for limiting the yield than socio-economic and infrastructural constraints. But a sizable amount of value production (23% of total loss) was foregone due to the existence of socio-economic constraints.

Yadav and Rai (2001) conducted a study to examine the utilization pattern of land, water and agro chemicals in perspective and to reschedule the resource use pattern for sustainable production. The study was primarily based on secondary data that include Statistical Abstracts of Haryana for the year 1981-82 to 1996-97, publications of Department of Agriculture and Irrigation, Government of Haryana and of Haryana Agricultural University, Hisar. The study states that area under forests did not increase over the year but intensity of cropping has increased. Consumption of nitrogenous fertilizers increased at much faster rate than that of phosphatic and potashic fertilizers. In all, the continuing crop and input use patterns have resulted in accentuating the area under problematic soils and disturbing the hydrological balance.

Singh and Kalra (2002) have analyzed the rice production in Punjab taking into consideration growth, area, productivity and sustainability aspect of the crop. The study was based on primary and secondary data from 1970's to 2000. The study reflects that farmers are sowing/transplanting the rice crop before sowing time. Although, they know the fact that rice yield would be highest when transplanted in the first fortnight of June or July. This has created the serious problem of ground water depletion and excessive use of power in agriculture. The study also throws light on the aspect of fertilizer consumption. The study reveals the fact that only some farmers were aware about their proper use and other were using them in unbalanced way for getting more yield.

Further analysis has been done regarding sustainability of rice crop in the state. Total factor productivity of rice has been regressed on the area under rice. About 57% farmer said that they were using more fertilizers because of declining yield levels. Most of the farmers have not envisaged any alternative to rice in the near future.

Kundu and Amita (2003) have made an attempt to evaluate the impact of the present cropping system on the natural base of agriculture in Haryana. They have suggested the appropriate technology and policy measures for making agriculture development economically and ecologically in Haryana. The study was based on secondary data covering the period from 1966-67 to 1998-99. The study reveals that rice – wheat cropping pattern was emerged as main and dominating cropping pattern. The area has increased under the rice and wheat crops. As a result of it, the area has decreased under the other crops like –gram, jowar, bajra, barley, maize, etc. The study further reveals that 61% of total area in Haryana is experiencing a serious problem of decline in water table. The major part of the decline ground water level has fallen under the districts of Ambala, Yamunanagar, Kurukshetra, Kaithal, Karnal, Panipat and Sonipat. This continuous rice-wheat cropping pattern supported by modern technology has adversely affected the natural health of soil and the water table in the State. The author have suggested that the ecological significance of gram cultivation because of the fact that it increases the level of nitrogen in the soil, which is facing depletion due to wheat cultivation. Therefore, gram may be suggested as the effective alternative to wheat both on economic and ecological grounds. The main problem with the cultivation of rice is that it has adversely affected the ground water table. Maize and jowar crops have been suggested as the alternative to the rice crop. As, both the crops require comparatively less water than rice.

Shetty (2004) studied the effect of the use (or misuse) of pesticides on the farming system, health of farmers and pest resistance. The study was based on primary data. The field investigation was carried out in few districts in Karnataka, Andhra Pradesh, Maharashtra and Punjab to obtain information on the use of pesticides. These districts were selected randomly based on the crops grown and pesticide consumption pattern. The study focused on crops such as paddy, cotton and vegetables because pesticides are extensively used on these crops. The study states that farmers rely heavily on pesticides for pest control. However, over application and indiscriminate use of pesticides has had several adverse consequences and deepened agrarian distress. While accepting important role of pesticides in India's food security, proper education, adoption of safety norms and integrated pest management practices should be encouraged to maximize the gains from the use of pesticides.

Haque (2006) has studied about the resource use efficiency in Indian agriculture. The study was based on the data of comprehensive scheme for cost of cultivation of principal crops, Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. Factor production has shown a fluctuating and declining trend over the years in different regions and states. There also exist large yield gaps in respect of almost all crops and in case of all regions. The results of the study indicated that farmers in several cases do not need the input mix optimally. The study suggests that each region should adopt such production strategy, in which it has relative advantages in terms of cost, yield & prices and also ecologically in comparison to other regions. In some states like Haryana and Punjab there is scanty rainfall and water table is also declining, But farmers in these states are more interested in rice-wheat cropping pattern which require more water availability. On the other hand, cost, yield and assured price considerations are encouraging them for doing so. As such

incentive was not given to other crops. Crops like pulses, oilseeds and coarse cereal may be more eco-friendly in Punjab and Haryana. The returns from paddy-wheat cropping pattern are more than other crops. Therefore, farmers would not be ready to shift their cropping pattern. The author suggested that farmers should be induced to replace paddy by other low water requiring crops such as cotton, maize, soyabean etc. Farmer should reduce the number of irrigation in paddy by changing the time of sowing and transplanting from a high temperature month of May to mid June.

Bhalla (2007) has studied about the impact of declining ground water levels on acreage allocation in Haryana. The study was based on secondary data for all 19 districts of Haryana from 1980 to 2000. Marc Nerlove's model has been used to know the farmer's reaction on prices and other incentives for examine the supply response. This model states that output is a function of expected price, area (output) adjustment and some exogenous variables. The study reveals that there was the serious problem of declining ground water levels in various parts of Haryana. Rice, which is highly water driven crop, has been cultivated more and more over the years and has replaced the bajra, jowar and maize (dry land crops). It has been very surprising that the expansion in rice acreage has increased not only in water depleting areas, but also in those areas where water tables are rising. It is a more serious aspect that the cultivation of water intensive crops has been increasing in the regions where the water table is falling. One of the reason behind this fact is the MSP (Minimum Support Price) offered to farmers. Price is an important factor in explaining the farmer's acreage behavior. On the other hand, energy prices should also be altered so that they reflect the true cost of resources and prevent the over-exploitation of resources. Decline in water table was confined not only to those regions where cultivation of water-intensive crops is more predominant. But also to those regions where water table is falling but paddy cultivation is increasing. The study concludes that the declining water levels in many parts of Haryana may be because of other factors other than the increase in water intensive crops.

Shergill (2007) has pointed out that sustainability of wheat and rice production at the present scale has been questioned by some experts, both on economic and ecological grounds. In this direction, the author has tried to evaluate the empirical evidence on economic and ecological sustainability of wheat-rice cultivation in Punjab at the present scale. The regression analysis has been used to see the trend in minimum support price of wheat and paddy. The study covered the period from 1990-91 to 2000-01 and based on secondary information. The experts have pointed out that fast depletion of ground water resources is caused by wheat-rice cultivation on a large area. But they give evidence against this and states that it is evident from the data given in the study that the water table has actually gave up in south-west zone and in the foot-hills zone. Some fall in the water table has been seen only in the central Punjab over these three decades. Moreover, author argues that mere fall in the water table level by a few meters does not indicate that it has declined to a dangerous level. Water consumption requirement of wheat-rice rotation was also not more than other crop-rotation combination that may be cultivated in that particular area. The study clearly indicates that under current parameters and constraints, the economics of wheat-rice cultivation in Punjab is quite sound, and there is no imminent ecological threat to the

Maity and Chatterjee (2010) have analyzed the returns to scale of food grain production in West Bengal. The study was based on secondary information (1968-69 to 2002-03). Cobb-Douglas production function has been used for measuring returns to scale of food grain to different modern inputs (Fertilizers, Pesticides, Irrigation and HYVs). The results show that all the modern inputs have

significant positive impact on yield except irrigation and pesticide. The results suggest that the HYVs area has the highest impact on food grain production followed by fertilizers, pesticide and irrigation respectively.

Grover et al (2015) have highlighted the possible reasons and farmers' awareness towards crop residue burning. The study was based on primary survey which was conducted in Mirzapur village in the Kurukshetra district of Haryana. The research was carried out to identify the factors responsible for crop residue burning (CRB) and to check the awareness level among farmers regarding residual burning and its impacts on environment. During the study period, most of the respondents (96%) in the study area practiced agricultural crop residue burning after crop harvesting. The main reason behind this practice was to prepare their land for the next crop in short time and to remove pest, weeds etc. Additional factors observed behind residual burning were non-availability of man power for manual harvesting of stubble, high cost of residues removal, and low market rates of residues. About 90% of the respondents were well aware regarding air pollution caused by residual burning. However, they were unaware about specific air pollution related health problems and green house gases emissions. The farmers were also unaware about the negative impacts of residue burning on soil quality. The study reflected that the farmers had low awareness regarding CRB and its related impacts. But there are numerous options which can be practiced such as composting, generation of energy, production of bio-fuel and recycling in soil to manage the residues in a productive manner. There is a need to create awareness among farmers through *gram panchayats* (village societies), community based organizations, NGO's (Non-Governmental organization) and institutions like *Krishi Vigyan Kendras*. The use of new technologies like happy seed harvester along with composting can also be used for dealing the problem.

Singh and Jajpura (2016) have tried to analyze about sustainable agriculture as a key to the healthy food and better environment, economic prosperity for farmers and a step towards sustainable development. The study was based on secondary data (from 1991 to 2012). They have pointed out that farmers were using excessive synthetic fertilizers, pesticides, herbicides, high yielding varieties of seeds, excessive irrigation with groundwater, intensive use of non-renewable energy resources to meet the growing food demand. Though modern agricultural practices have fulfilled the food requirement of the country, but this has resulted in various environmental problems e.g. contamination of surface and groundwater with fertilizers & pesticides, food grain contamination with pesticides, lowering of ground water table, depletion of soil nutrients, loss of biodiversity and deforestation etc. There is need to promote "sustainable agriculture" in order to avoid negative consequences of modern agriculture. Sustainable Agriculture is a type of agriculture or farming which avoids the use of chemical fertilizers, herbicides, pesticides, and livestock feed additives. This system of farming rely on crop rotation, mix cropping system instead of monoculture, crop residues application, animal manures, legumes, green manure, and bio-fertilizers, mechanical cultivation and manual control of weeds etc. Hence, keeping in mind the problem created by modern agriculture to fulfill the food requirement of growing population, sustainable agriculture can be better solution which provides us organic food which is healthy, nutritious and tasty.

Conclusion

The Studies [Kundu and Amita (2003), Haque (2006), Roy and Datta (2000), Joshi and Tyagi (1991), Praduman et al (1998), Bhalla (2007), Chaudhary and Aneja (1991), Rai and Yadav (2001) and Singh et al (1997)] have stated that rice-wheat cropping pattern was emerged as the dominating cropping pattern after Green Revolution. The continuous rice-wheat cropping pattern is supported by modern technology [Kundu and Amita (2003)]. Farmers of the states (Haryana and Punjab) are more interested in rice-wheat cropping pattern which require more water availability. Although cost, yield and assured price consideration are also encouraged them for doing so. As the returns from paddy-wheat cropping pattern are more than other crops (Haque, 2006). With the availability of High Yielding variety Seeds (HYVs), fertilizer, pesticides and increased irrigation facilities have made a considerable shift in area from coarse cereals, pulses and oilseeds to rice-wheat crops [Chaudhary and Aneja (1991) and Bhalla (2007)]. There was huge increase in the cropping intensity after Green Revolution [Chaudhary and Aneja (1991)]. The unbroken rice-wheat cycle and the intensive cropping are the chief reason for loss or depletion of nutrients from the soil causing unbearable pressure on the nutritional base of the soil [Kundu and Amita (2003)]. Soil Micro-organism system have adversely effected by pesticides (Marothai,1997). It has been reported by Chand and Haque (1997) that due to continuous rice and wheat rotation, the intensities of pests, diseases and weeds have increased. The other environmental problems associated with rice and wheat system include water logging related salinity, pollution of ground water due to leaching of chemical fertilizer and pesticides and pollution due to burning of rice-wheat straw in many places. These problems also pointed out by other studies [Chaudhary and Aneja (1991), Singh and Sankhayan (1991), Praduman et al (1998), Sidhu et al (1998), Joshi and Tyagi (1999), Jha (2000) , Roy and Datta (2000), Yadav and Rai (2001), Singh and Kalra (2002), Shetty (2004), Bhalla (2007), Shergill (2007), Maity and Chattarjee (2010), Grover et al (2015), Singh and Jajpura (2016)].

References

1. Chaudhary, M. K. and Dr. Aneja (1991), "Impact of Green Revolution on Long Term Sustainability of Land and Water Resources in Haryana", *Indian Journal of Agricultural Economics*, Vol. 46, No. 3, July-Sept., pp. 428-439.
2. Joshi, P. K. and N. K. Tyagi (1991), "Sustainability of Existing Farming System in Punjab and Haryana- Some Issues on Ground Water Use", *Indian Journal of Agricultural Economics*, Vol. 46, No. 3, July-Sept., pp. 412-421.
3. Singh, Inder Pal and P. L. Sankhayan (1991), "Sustainability of Water Resources During the Post Green Revolution Period in Punjab", *Indian Journal of Agricultural Economics*, Vol. 46, No. 3, July-Sept., pp. 433-439.
4. Nadkarni, M.V. and K.H. Vedini. (1996), "Accelerating Commercialization of Agriculture: Dynamic Agriculture and Stagnating Peasants", *Economic and Political Weekly*, Vol. 31, No. 26, June 29, pp. A63-A73.
5. Vyas, V.S. (1996), "Diversification in Agriculture: Concept, Rationale and Approaches" *Indian Journal of Agricultural Economics*, Vol. 5 No. 4, pp.636-46.

6. Chand, Ramesh and T. Haque (1997), "Sustainability of Rice-Wheat Crop System in Indo-Gangetic Region," *Economic and Political Weekly*, Vol. 32, No. 1-13, pp. A 26-A 30.
7. Marothia, Dinesh K. (1997), "Agricultural Technology and Environmental Quality: An Institutional Perspective", *Indian Journal of Agricultural Economics*, Vol. 52, No.3, July-Sept, pp. 472-487
8. Johansen, C.; M. Asokan; P. K. Joshi; and Praduman Kumar (1998), "Sustainability of Rice - Wheat Based Cropping System in India: Socio-Economic and Policy Issues", *Economic and Political Weekly*, Vol. 33, No. 39, 26th Sept, pp. A-152 to A-158.
9. Sidhu, B.S., O.P. Rupela, V. Beri and P.K. Joshi (1998), "Sustainability Implications of Burning Rice and Wheat Straw in Punjab", *Economic and Political Weekly*, Vol. 33, No. 39, Sept. 26, pp. A-163 to A-168.
10. Jha, Brajesh (2000), "Implications of Intensive Agriculture on Soil and Water Resources: Some Evidences from Kurukshetra District", *Indian Journal of Agricultural Economics*, Vol. 55, No. 2, April-June, pp. 182-193.
11. Roy, B. C. and K. K. Datta (2000), "Rice- Wheat System in Haryana Prioritizing Production Constraints and Implication for Future Research", *Indian Journal of Agricultural Economics*, Vol. 55, No.4, Oct - Dec, pp. 671-682.
12. Yadav, D.B. and K.N. Rai (2001), "Perspective and Prospects of Sustainable Agriculture in Haryana", *Indian Journal of Agricultural Economics*, Vol. 56, No.1, Jan.-March, pp.100-115.
13. Singh, Karan and Sajla Kalra (2002), "Rice Production in Punjab: Systems Varietal Diversity, Growth and Sustainability", *Economic and Political Weekly*, Vol. 37, No. 30, July 27, pp. 3139 - 3148.
14. Kundu, T.R. and Amita (2003), "Towards Sustainable Agriculture in Haryana", in Surat Singh (ed.) *Strategies for Sustainable Rural Development*, Deep & Deep Publication Pvt. Ltd, New Delhi.
15. Gulati, Ashok; Laxmi Tewari; P. K Joshi and Pratap Singh Birthal (2004), "Agriculture diversification in South Asia: Patterns, Determinants and Policy Implications" *Economic and Political Weekly*, Vol. 39, No. 24, pp. 2457-2467.
16. Shetty, P. K. (2004), "Socio Ecological Implication of Pesticide Use in India", *Economic and Political Weekly*, Vol. 39, No. 49, Dec. 4, pp. 5261-5267.
17. Haque, T. (2006), "Resource Use Efficiency in Indian Agriculture", *Indian Journal of Agricultural Economics*, Vol. 61, No. 1, Jan. - March, pp. 65 -75.
18. Bhalla, Priya (2007), "Impact of Declining Ground Water Levels on Acreage Allocation in Haryana", *Economic and Political Weekly*, Vol. 42, No. 26, June 30, pp. 2701-2707.

19. Shergill, H. S. (2007), "Sustainability of Wheat-Rice Production in Punjab: A Re-examination", *Economic & Political weekly*, Vol. 42, No. 52, Dec. 29, pp. 81-84.
20. Maity, Bipasha and Bani Chatterjee (2010), " Returns to Scale of Food grains Production in India: an Empirical Test ", *European Journal of Social Sciences* , Vol. 14, No. 3, pp. 496 - 501.
21. Joshi, P.K. (2014). Agricultural diversification in India Impact for Inclusiveness. *in Presidential address for 28th National conference of the Indian Society of Agriculture Marketing* at Sardar Patel University, Gujarat on 4-6 December 2014.