Review Article

Agricultural Degradation and Human Health-An Inter District Analysis

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Abstract

Since the beginning of the times, natural resources like land/soil, air, water, forest, petroleum and minerals have been exploited in different ways. However, at any moment when these natural resources are over-exploited, the environment gets polluted, damaged or degraded.

All the aforesaid kinds of environment pollutions are playing havoc not only to human beings and animals but also to vegetative kingdom. So far as our country India is concerned, the environmental degradation in India is not only increasing over time but also growing at an increasing rate. Sustainable development is critically related with environmental degradation which takes place through land, air, water and bio-diversity, which are not judiciously managed. The worst affected sources of environmental degradation are land and water in an agrarian state like Punjab, where excessive use of chemical fertilizers and pesticides has resulted in deterioration in soil fertility and water quality day by day. The residues of pesticides and fertilizers are being regularly added not only in different food and feed commodities but also in rivers, lakes and streams making their water unfit for drinking and bathing. Consequently, human health is at stake in terms of various chronic diseases like malaria, dengue, leprosy, cancer, etc. The article highlights these facts through the data on the various variables like chemical fertilizers and pesticides being applied and their effects on human health in terms of various ailments. The article uses secondary data which has been collected from various sources like: Statistical Abstract of Punjab, Environment Statistics of Punjab, and Economic Survey. The present study, therefore, aims at highlighting the extent of agricultural degradation and resulting in health issues in the Punjab state. Appropriate policy implications have been incorporated in the last section of the article.

Keywords: Natural resources, Pollutions, Chemical fertilizers, Human health, Sustainable development, Agricultural degradation.

Introduction

Among developing countries, India holds an important place as it has achieved tremendous development in agriculture after independence with the adoption of new agriculture strategy comprising the package of HYV seeds, fertilizers NPK and pesticides with irrigation facilities. In India, over intensification of agriculture over the years along with industrialization and economic and infrastructural development has led to degradation and over-exploitation of natural resources especially land, water and bio-diversity which has stirred many public analysts to declare that the future of Indian agriculture is in jeopardy after the surface of negative externalities of GR1 in terms of high dependence of chemical inputs, heavy water requirement for crop production, degradation in soil quality and pollution of water bodies, etc. Sustainable agriculture has attracted significant attraction of policy makers and researchers. This hard fact is exhibited recently by World Health

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Organization on World Environment Day June 5, 2015. Let us have a look at where India stands in the list of most polluted places of the world. Out of 20 most polluted cities, 13 are in India. Surprisingly, it includes the national capital Delhi. Besides, the Ganga and the Yamuna have also been listed among the top 10 most polluted rivers in the world which exhibits the extent of our irresponsibility towards environmental sustainability.

Punjab is one of the leading states in terms of development and is a pioneer in green revolution. However, it is also one of the most environmentally affected states of the country. Degradation of environment is an emerging issue in the state of Punjab too. Punjab agriculture needs to be made economically and ecologically viable for conserving land, water, plant and genetic resources. The state's agriculture has reached a plateau under the available technologies and natural resource base and has become unsustainable and non-profitable. For the last few decades, dangerously toxic agricultural inputs - pesticides and fertilizers are being used blindly, mindlessly and without any scientific evidence of their actual need. The multinational corporations which are the producers and their governments have succeeded in making them indispensable for agriculture in Punjab. Most of these chemicals are persistent in nature (not easily bio-degradable). They go on accumulating in the environment with the passage of time. Their levels go on increasing in air, water, soil, food chain and bodies of animals and human beings. As their levels increase beyond certain levels, the health of all living beings is adversely affected. This stage has already reached in Punjab. Their life giving properties have been weakened. That is why their children, plants, animals and humans are falling sick and dying prematurely. Therefore, one of the important challenges is to achieve closer integration between economic policies and policies for management of natural resources and environment.

Objectives of the Study

The objectives of the study include the following:

1. To examine the changes in land use pattern of Punjab (zone-wise) for the period under study in terms of cropping intensity and fertilizer and pesticide use.
2. To examine the impact of above changes on soil and water quality in the state.
3. To study the ill effects of these changes on human health.

Data Base and Methodology

The present article is based on secondary data which has been collected from various published sources such as Statistical Abstract of Punjab, various issues of Environment Information System (ENVIS) reports such as State of Environment Punjab 2007 report by Punjab State Council for Science and Technology, Punjab ENVIS Report 2011 and Punjab ENVIS Report 2014 and various newspapers. The data has been collected relating to various aspects of the study like net sown area, cropping intensity, water salinity, consumption of fertilizers and pesticides and various diseases to human beings from Punjab health department. The reference period of the present study is 1969-70 to 2012-13. The data has been analyzed using simple statistical tools such as averages and percentages. Diagrammatic tools like pie charts have also been used for analysis of the data.

Results and Discussion

Punjab is predominately an agrarian state which is the largest single provider of food grains to the nation. The gains resulting from the success of ever-increasing food grain production during the past five decades have not been without their consequent environmental and socioeconomic costs.

The soil and water in the state are under tremendous stress; soil is facing severe degradation because of many reasons, which include soil erosion, salt-affected soil, overuse of chemicals, etc. Similarly, water quality and quantity is on decline. 80% of the total blocks of the state are now under over-exploited category. This calls for urgent steps to conserve the available ground water.

Land Use Pattern in Punjab

As shown in Table 1, in Punjab, crop ecosystem is categorized into three zones in which there prevails monoculture of wheat-rice crops which leads to soil degradation via cropping intensity, excessive use of fertilizers and pesticides, which have been exhibited through various tables and diagrams as follows:

Category	Type	Districts	Major Crops
Zone-I	Sub mountainous undulating plans	Gurdaspur, Hoshiarpur,Ropar	Wheat in Rabi & Rice-Maize in Kharif Season
Zone-II	The central Alluvial Plains	Amritsar, Kapurthala, Jalandhar, Tarn Taran, SBS Nagar, Ludhiana,Fatehgarh Sahib, Patiala, Sangrur & Mohali	Wheat in Rabi and rice growing area in Kharif season
Zone-III	South Western dry zone	Bathinda, Faridkot, Ferozpur, Mansa, Moga, Shri Mukatsar Sahib& Barnala	Ground water is saline & unfit for irrigation. Cotton is an important Kharif crop but is being replaced by rice

Source: Punjab State council for Science and Technology

Table 1.Categories of Crop Ecosystem in Punjab

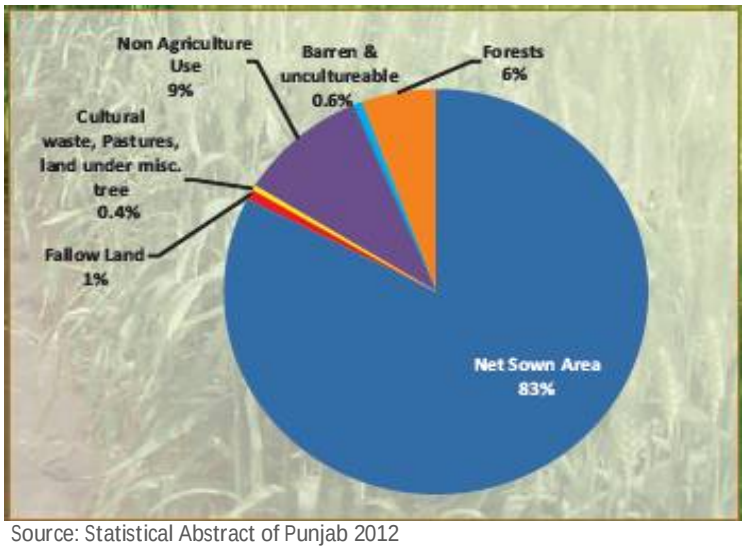
Cropping Intensity

The cropping intensity (ratio of net sown area to gross cropped area) in the state has increased sharply from 126% in 1960-61 to 190% in 2012-13 with adoption of input intensive agricultural practices. As per State of Indian Agriculture Report, 2012-13, Punjab has the highest cropping intensity in the country closely followed by West Bengal (185%), Haryana (181%), Himachal Pradesh (173%) and Odisha (162%) as compared to all India percentage of 138%. The high cropping intensity severely affects soil fertility as it leaves no time for natural rejuvenation. The cropping intensity in Punjab is of mono-culture type in various districts which is depicted in Table 2.

SN	District	Rice	Maize	Wheat
1	Amritsar	186	1	189
2	Barnala	105	@	115
3	Bathinda	107	@	253
4	Faridkot	101	@	117
5	Fatehgarh Sahib	82	@	85
6	Firozpur	258	@	397
7	Gurdaspur	204	11	226
8	Hoshiarpur	73	63	154
9	Jalandhar	163	9	169
10	Kapurthala	118	2	108
11	Ludhiana	257	@	257
12	Mansa	178	@	170
13	Moga	172	@	177
14	Shri Mukatsar Sahib	111	1	192
15	Patiala	234	23	238
16	Rupnagar	38	@	65
17	Sangrur	272	6	287
18	SAS Nagar	37	14	153
19	SBS Nagar	58	1	74
20	Tarn Taran	172	@	186
	Total	2826	133	3510

Source: Director of Land Records, Agriculture, Punjab

Table 2.District-Wise Area under Major Crops



Source: Statistical Abstract of Punjab 2012

Figure 1.Pie Chart Depicting the Cropping Intensity

Use of Fertilizers

Table 3 shows the consumption of fertilizers for the period 1980-81 to 2000-01 in the state. The initial increase in agricultural production in the state was mainly due to increase in net sown area. However, stunning rise in food grain production from 11.92 million tonnes in 1980-81 to 28.57 million tonnes in 2012-13 can be largely attributed to intensive use of farm chemicals. The state has the highest per hectare usage of fertilizers (239 kg) and pesticides (923 g) in India. High usage of nitrogenous fertilizers with relative under-utilization of other fertilizers and micronutrients has led to imbalance in micronutrients in soils of Punjab. Various studies undertaken in the state since 1970 have indicated the presence of residues of chemical pesticides like organ chlorines, organophosphates, synthetic pyrethroids and carbamates in human beings, milk, water, vegetables and other food products at levels, which are dangerous for human health.

('000' Nutrient Tonne)

Year	Nitrogenous (N)	Phosphatic (P_2O_5)	Potassic (K_2O)	Total (NPK)
1980-81	526	207	29	762
1990-91	877	328	15	1220
2000-01	1008	282	23	1313
2006-07	1299	354	39	1692
2007-08	1316	344	38	1698
2008-09	1332	379	57	1768
2009-10	1358	434	74	1866
2010-11	1403	435	73	1911

Source: Department of Agriculture, Govt. of Punjab 2013

Table 3.Consumption of Fertilizers in Punjab

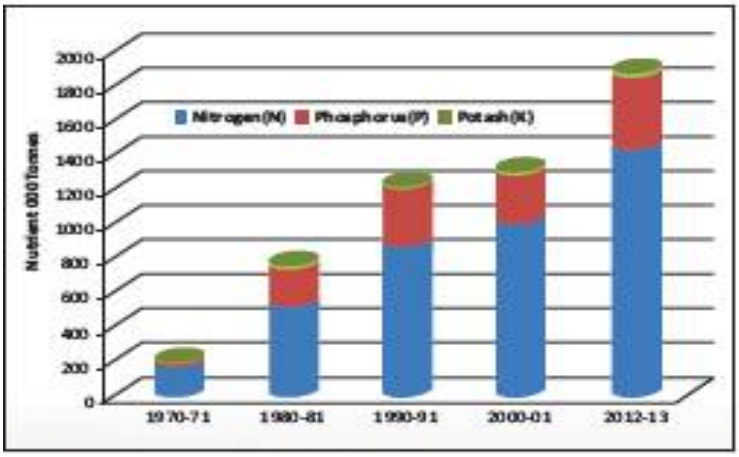
Further, district-wise use of fertilizers is shown in Table 4. From the Table, it is clear that the use of fertilizers has increased in all the districts, especially nitrogen fertilizer. Consumption of fertilizers is maximum in Ferozepur, followed by Ludhiana, thereafter Sangrur.

SN	District	2008-09	2009-10	2010-11
1	Amritsar	94	97	105
2	Barnala	66	63	57
3	Bathinda	118	122	125
4	Faridkot	62	65	64
5	Fatehgarh Sahib	47	50	48
6	Firozpur	186	195	199
7	Gurdaspur	105	110	113
8	Hoshiarpur	61	67	69
9	Jalandhar	106	119	120
10	Kapurthala	57	68	66
11	Ludhiana	152	155	167
12	Mansa	80	85	88
13	Moga	94	100	96
14	Shri Mukatsar Sahib	102	110	114
15	Patiala	133	138	141
16	Rupnagar	25	27	30
17	Sangrur	152	160	165
18	SAS Nagar	18	18	23
19	SBS Nagar	40	43	42
20	Tarn Taran	70	74	79
	Total	**1768**	**1866**	**1911**

Source: Director of Agriculture, Punjab

Table 4.District-Wise Fertilizer Consumption in Punjab (000' Nutrient Tonne)

The diagrammatic presentation of the above data is shown with the help of bar diagram (Fig. 2) as following:



Source: Department of Agriculture, Govt. of Punjab 2013

Figure 2.Fertilizers Consumption in Punjab

Use of Pesticides

The state of Punjab is one of the highest users of chemical pesticides especially after the ushering in of green revolution. The Malwa region (cotton belt) accounts for nearly 75 percent of pesticides used in the state. Pesticides not only contaminate the ecosystem but also bio accumulate in the food chain and can be traced in plant and animal tissues causing serious health hazards. As per World Health

Organization estimates, pesticides lead to one million pesticide poisoning cases and 20,000 deaths every year globally. Results of various studies conducted in Punjab indicate residues of chemical pesticides in human beings, milk, water, vegetables and other food products. Table 5 shows insecticides found in different food and feed commodities as follows:

Commodities	Samples			
	Number Analysed	Insecticides detected	Contaminated (%)	Above tolerance limits (%)
Rice	99	HCH/BHC	97.0	9.0
Fruits	27	Phosphamidon Quinalphos	85.0	11.0
Vegetables	147	Endosulfan, Quinalphos Chlorpyrifos, M. Parathion, Monocrotophos	71.0	18.0
Milk	92	DDT Lindane/HCH	2.2 53.2	Nil 53.3
Butter	16	DDT Lindane/HCH	75.0 31.3	Nil Nil
Animal Feed	31	DDT HCH/BHC Malathion	22.5 77.5 38.5	10.0 Nil Nil

Source: Singh, 2002

Table 5.Insecticide Residue in Different Food and Feed Commodities in Punjab

Most chemical pesticides are known to pose serious health effects on humans and cattle. They can affect the gastro-enteric, hepatic, renal and nervous systems when ingested, besides affecting skin, eyes and respiratory system while handling.

Many pesticides are also known to have carcinogenic effects. However, very few epidemiological studies have been carried out in the state in this regard. Consumption of pesticides is highest in Punjab.

Punjab is having 2.5% area of total agricultural land in India but it consumes 18% pesticides of the country.

Cotton belt of Malwa is consuming highest pesticides in the country, i.e., it has less than 0.5% geographical area of the country but consumes 10% of pesticides of the country. Table 6 shows the extent of increase in pesticide use in the twenty-first century.

Year	Consumption In Technical Grade (M.T.)
1980-81	3200
2000-01	6970
2012-13	6300

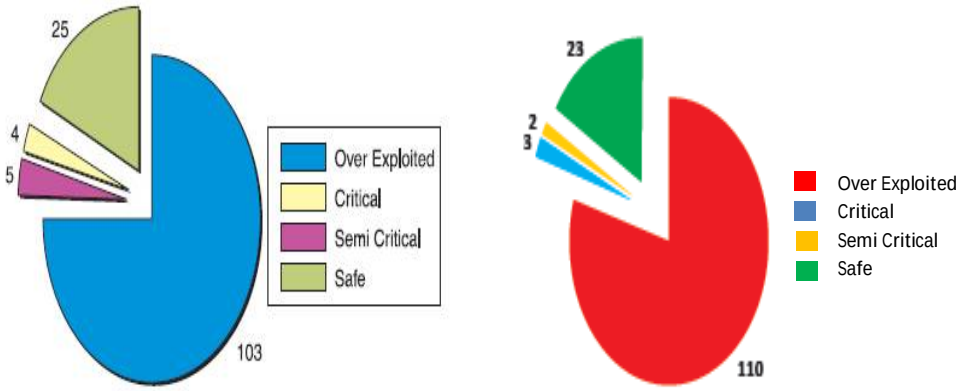
Source: Agriculture at Glance

Table 6.Consumption of Pesticides in Punjab

Water Erosion

Agriculture practices are also contributing toward non-point pollution of water in Punjab. Intensive agriculture and injudicious use of farm chemicals like fertilizers (e.g., nitrate) and pesticides further seep into the groundwater (leaching) and cause pollution. India has only 4.2 percent of world's fresh water resources to sustain 16 and 17 percent of world's human and animal populations, respectively. In India, per capita annual water availability has dropped from 5177 m^3 in 1951 to 1820 in 2001. It is predicted that by 2025, it will be only 1340 m^3 approximately. Per capita annual water availability less than 1700 m^3 is considered as "stress" level beyond which water availability gets classified as scarcity level. Below this level, availability of water is considered a severe constraint on economic development and environment quality.

The gravity of the situation can be gauged from the fact that ground water in 80% of total geographical area of the state (110 blocks) is over-exploited in terms of stage of ground water development, as exploitation in these blocks is more than 100 percent, 3% area of the state (5 blocks) is under the category of critical and semi-critical category and only 17% area (23 blocks) of the state is safe for ground water development.



Source: Ground water quality, Punjab 2005. Recent Categorization of Water Blocks
Source: CGWB 2012

Figure 3.Categorization of water blocks in Punjab on the basis of Ground Water Development

The blocks of various districts like Amritsar (16 blocks), Jalandhar (10 blocks), Moga (5 blocks), Kapurthala (5 blocks), Sangrur (12 blocks), Fatehgarh Sahib (5 blocks), Patiala (8 out of 9 blocks) and Ludhiana (9 out of 10 blocks) have been found to be over-exploited leading to sharp depletion of the water table in these districts.

Punjab has made great strides in making drinking water available to its population. However, accessibility of safe drinking water is still an issue especially in south-western districts.

If we compare both pie charts, it is very obvious that safe water blocks have reduced and over-exploitation has increased which is having severe ill health effects on the coming generation.

Health Effects

Highly toxic agricultural toxins are being used much in excess of the safe limits without any scientific rationale. Punjab with 2% of country's land is using 18% of these chemicals. Their use has increased tremendously over the last four decades. No government has ever tried to assess the damage being caused to human health and the ecosystem. The whole ecosystem is dying under the severe toxicity created by these highly persistent poisons. According to the environmental protection agency (EPA), 60% of herbicides, 90% of fungicides and 30% of insecticides are known to be carcinogenic. Large number of studies point out that cancer, Parkinson's disease, miscarriage, nerve damage, birth defects, blocking the absorption of food nutrients, etc., are because of these toxins. Even a worse picture exists in Punjab. There is a large body of evidence, which clearly shows that GM technology has the potential to prove the biggest ecological disaster. Any toxin in the environment quickly reaches food chain, water cycle and human body. It accumulates gradually to dangerous levels and produces disease state. The whole food chain in Punjab has been shattered. The poison moves from lower living beings to higher ones. Various health problems due to the above mentioned factors may include: gastrointestinal symptoms, repeated episodes of coryza: "zucaam" (coryza), lowered immunity/ immunotoxicity, muscular-skeletal disorders, neurological/psychological manifestations/neurotoxicity, reproductive system effects, kidney, skin and hair diseases, liver problems, cancers/toxin associated cancers, genetic mutations, etc.

The following statistical tables sourced out from Environmental Information System Report, 2011 of Punjab exhibits the same facts as following. As shown below in Table 7, number of malaria cases have increased over the time period 2006-2011 and maximum number of cases were found in Muktsar, Ludhiana and Mansa. Table 8 shows that in districts Bathinda, Barnala, Muktsar and Sangrur, dengue cases have increased while in Jalandhar, Hoshiarpur and Ludhiana districts, dengue cases have declined. Table 9 exhibits that cancer patients were mainly found in Muktsar, Bathinda, Mansa and Faridkot districts where maximum use of fertilizers and pesticides is made.

SN	District	Total positive cases					
		2006	2007	2008	2009	2010	2011
1	Amritsar	80	31	297	21	198	149
2	Bathinda	28	33	80	247	170	67
3	Barnala	3	0	5	4	3	5
4	Faridkot	144	241	448	375	280	321
5	Fatehgarh	6	6	7	19	18	12
6	Firozpur	585	518	346	387	259	129
7	Gurdaspur	23	6	14	23	57	23
8	Hoshiarpur	25	28	25	38	58	61
9	Jallandhar	39	39	19	78	154	87
10	Kapurthala	10	2	8	28	25	10
11	Ludhiana	192	75	67	74	319	381
12	Mansa	205	328	366	315	416	377
13	Moga	5	2	2	5	131	19
14	Mohali	104	47	73	42	63	89
15	Mukatsar	64	102	229	439	538	429
16	SBS Nagar	3	3	3	127	22	25
17	Patiala	66	46	63	74	63	90
18	Ropar	9	5	3	1	9	3
19	Sangrur	48	87	69	221	86	69
20	Tarn Taran	249	418	370	437	607	314
	Punjab	**1888**	**2017**	**2494**	**2955**	**3476**	**2660**

Source: Health Department of Punjab

Table 7.Year/District-Wise Malaria Cases Reported in Punjab

SN	District	2008		2009		2010		2011	
		Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
1	Amritsar	196	1	18	0	58	0	127	0
2	Bathinda	359	1	6	0	364	1	862	1
3	Barnala	1	1	0	0	24	0	111	2
4	Faridkot	8	0	0	0	30	0	244	0
5	Fatehgarh	62	0	12	0	61	0	19	0
6	Firozpur	23	0	1	0	47	0	85	0
7	Gurdaspur	16	0	1	0	47	0	28	0
8	Hoshiarpur	129	0	29	1	73	0	26	2
9	Jalandhar	453	0	58	0	598		63	2
10	Kapurthala	20	0	7	0	63	0	13	2
11	Ludhiana	2506	13	89	0	2150	4	1662	23
12	Mansa	1	0	0	0	19	0	106	0
13	Moga	81	1	4	0	97	2	54	0
14	Mukatsar	74	0	1	0	100	0	405	0
15	SBS Nagar	8	0	1	0	16	1	4	1
16	Patiala	189	1	1	0	83	1	22	0
17	Ropar	6	0	1	0	9	0	1	0
18	Sangrur	5	1	5	0	84	1	73	0
19	S.A.S. Nagar	211	2	5	0	89	0	16	0
20	Tarn Taran	1	0	0	0	0	0	0	0
	Total	**4349**	**21**	**239**	**1**	**4012**	**15**	**3921**	**33**

Source: Health Department of Punjab.

Table 8.Status of Dengue Cases Reported in Punjab (2008 to 2011)

SN	District	Population	No. of cancer patients	No. of cancer patients per lakh population
1	Muktsar	8,27,906	453	54.7
2	Bathinda	12,00,736	711	59.2
3	Faridkot	5,85,500	164	28.0
4	Mansa	7,31,535	420	57.4

Source: Atlas of Cancer.

Table 9.Number of Cancer Patients in Cancer Affected Districts in Punjab 2001-02

Policy Implications

Punjab agriculture demands comprehensive strategy to address sustainability, growth and fiscal concerns. The state reeling under agriculture degradation should not be brought under pressure. Rather, on the basis of regional comparative advantage in terms of weather, soil conditions and water availability, appropriate strategy should be followed.

Major Initiatives Undertaken

Diversification of Agriculture

The present scenario recommends that the state agriculture policy should attempt to identify suitable cropping systems as per different agro-climatic zones and block-wise crop adjustment programs need to be prepared taking into account crop diversification through sustainable low input agriculture. Accordingly, the state government has envisaged a diversification plan to re-orient agriculture in the state by replacing 12 lakh hectares of area from paddy to basmati and other crops like maize, cotton, sugarcane, vegetables, pulses, fruits and agro-forestry by 2017-18. The major objectives of the proposed plan are to arrest the depletion of sub-soil water table, control the mounting power subsidy bill, and break the stagnation in terms of yield in the wheat-paddy cycle.

Promoting Timely Plantation of Paddy

The state government has enacted Punjab Preservation of Sub- Soil Water Act, 2009, to preserve groundwater by prohibiting sowing paddy nursery before May 10 and transplanting paddy before June 10 to avoid the high evaporation rates in early summer. Estimates show that the Act has the potential to achieve annual savings of about 2180 million cubic meters of water (7% of annual groundwater draft) and 175 million KWH of energy used for pumping groundwater.

Resource Conserving Technologies

RCTs which are typically the part of conservation agriculture practices, when followed, result in saving of energy, cost and also reduce the environmental pollution over the conventional practices. It includes tillage practices as laser land leveling, bed plantation, zero/ minimum tillage and direct-seeded rice, straw management practices as crop residue management, other practices as tensiometer and leaf color chart.

All these RCTs are time-saving, cost-reducing, increase organic matter, and improve soil structure.

Not only this, these are having environmental benefits as reduced soil degradation, improvement of water quality by reducing pollution surface and ground water from chemicals and pesticides.

So with proper integration of cost-effective and energy-efficient RCTs, the future agriculture may be shaped to bring out the agriculture production to fulfill food security needs and achieve agriculture sustainability. Union environment minister Prakash Javadekar is also bringing up policies such as “development without destruction” and system to focus on “self-regulation” and strengthen the “polluter-pay principle” by imposing heavy penalty on those violating environmental laws. So let us move along that path which creates such Indian thoughts that, “We do not want to protect the environment. We want to create a world where the environment does not need protecting”;

References

[1] Abbott S, Chahal SS, Sharma LJ et al. Sustainability of agriculture system: Punjab scenario. *Indian Journal of Economics and Development* 11: 89-100.

[2] Azad AS. An environment toxicity hotspot heading towards death? Working President-Kheti Virasat Mission.
[3] Birthal SP. Application of frontier technologies for agricultural development. *Indian Journal of Agriculture Economics* 2013; 68(1).
[4] Chand R. Emerging crisis in Punjab agriculture-severity and options for future. *Economic and Political Weekly* 1999; 34(13): A2-A10.
[5] Economic Survey-2012-13.
[6] Economic-Survey 2013-14. Chapter 8. Agriculture and food management.
[7] Environment Statistics of Punjab 2011. Chandigarh: Govt. of Punjab.
[8] Ghuman RS. Socio economic crisis in Punjab. *Economic and Political Weekly* 2008; 43(7): 12-15.
[9] Grover DK, Kaur A. Conservation agriculture and its impact study: An overview. *Indian Journal of Economics and Development* 2015: 197-206.
[10] Hallberg RG. The impact of agricultural chemicals in ground water quality. *GeoJournal* 1987; 15(3): 283-95.
[11] Water and agriculture. *Springer Journal* 15(3): 283-95.
[12] Mishra M. Role of eco-friendly agricultural practices in Indian agriculture development. *International Journal of Agriculture and Food Science Technology (IJAFST)* 2013; 4(2): 11-15.
[13] Reddy RV. Land degradation in India: Extent, cost and determinants. *Economic and Political Weekly* 2003; 38(44): 4700-13.
[14] Sharma N. Agrarian crisis and diversification strategy for sustainable agriculture development in Punjab. *Indian Journal of Economics and Development* Jan-Mar 2015; 11: 31-40.
[15] Singh N. World environment day: Of the world's 20 most polluted cities, 13 are Indian. *Hindustan Times* 5th Jun, 2015.
[16] State of environment in Punjab-2014. Punjab State Council for Science & Technology. Supported by Department of Science, Technology & Environment, Government of Punjab.
[17] State of Environment Punjab-2007. Punjab State Council for Science and Technology. Sponsored by Ministry of Environment and Forest, Govt. of India.
[18] Statistical Abstract of Punjab 2012.
[19] Overuse of fertilizers is eating soil nutrients in Punjab. *The Tribune* Jalandhar 24th Aug 2015; 1.
[20] Yedla S, Peddi S. Agriculture and environment. *Oxford Handbook of Agriculture* 2011: 57-97.