

# Land Degradation in the Developing World: A Case Study of Land Degradation in Punjab

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**Abstract:** Increasing population and economic development are derogating the environment. In the modern era uncontrolled growth of urbanization and industrialization, more and more intensive cultivation and the destruction of natural habitats are the results of unsustainable development. Due to rapid growth in population, environment policy makers are facing the challenges of sustained development without environmental degradation. Land degradation has become a big challenge before environmentalists. It is a concept, which has no single accessible-distinguishable feature, but instead describes how one or more of the land resources (soil, water, vegetation, rocks, air, climate, relief) has changed for the worse. Increasing trend in land degradation may pose serious threats to food production, environment, and health. For sustainable developments, appropriate policies are required to encourage land-improving investments and better land management in developing countries to meet the sustainable food needs of their populations. Rapid population growth and poverty are adversely affecting the environment of all over the world. Increasing population and levels of consumption per capita in the 21st century are the main cause of depletion of natural resources and degrading the environment. The main objective of this paper is to review the conditions and current problem of land degradation in Punjab, an agricultural state of India.

**Keywords:** Degradation, below ground level, Metric Tonne, Hectares, Glasod.

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## 1. INTRODUCTION

Rapid population growth and poverty are adversely affecting the environment of all over the world. The growth of people and rising levels of consumption per capita are depleting natural resources and degrading the environment. The world's population was estimated at 6.056 billion in mid- 2000 and projected 7.936 billion in the year 2025 and 9.322 billion in the year 2050. If the population continues to multiply, the impact on the environment could be devastating. Not only will this but the rise in population increase to such an extent in future that it will cause overall scarcity of resources. The deficiency of natural resources will furthermore create environmental hazards in the world. Indian agriculture dominant state, Punjab has made considerable economic progress after Independence. Wheat, Paddy, Sugarcane, and Cotton are main crops of Punjab. The initiative of Green revolution (a major agricultural initiative) has been keenly taken forward by the people of Punjab. The population of Punjab was 2,77,43,338 as per census of India 2011. The decadal change i.e. increase in population from 2001 to 2011 was 13.73%. Punjab state covers an area of 50,362 square kilometers. After Partition, Punjab had made great progress in almost every field of life but still there remain the shortage of a lot of things because population continued to increase more rapidly. But the problems like environmental pollution, land degradation, groundwater, soil contamination and drinking water is increasing day by day due to increase in Population.

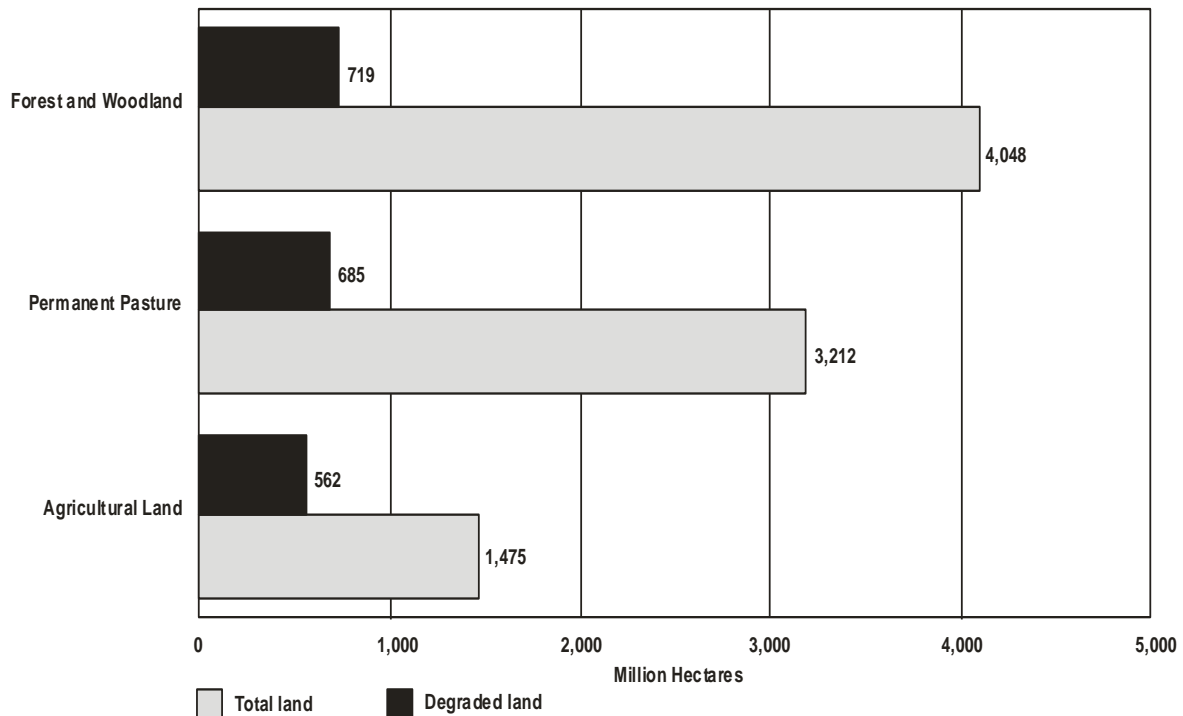
## 2. METHODOLOGY

The study is based on the primary and secondary data collected from various government publications particularly Statistical Abstracts of Punjab for relevant years. Data were obtained from different publications of Punjab Pollution Control Board, Water supply and Sanitation department, Irrigation department, Department of Soil and Water Conservation, forest department Punjab. The informal discussions were also held with public and political representatives and environment researchers. Secondary data was collected from municipal corporation's journals, official records,

broachers, books, etc. Data relating to the land degradation and Pollution was collected at the secondary levels, whereas primary data was collected at household's level. It was also examined as to how the agriculture practices are polluting land.

**Existing Land degradation scenario:**

The degradation of the Earth's surface (i.e. land degradation) is one of the most severe problems of our times. Land degradation is a concept that originates from soil degradation and it is often used as a synonym for soil degradation. 'Land' includes not only the soil resource, but also the water, vegetation, landscape, and microclimatic components of an ecosystem. Land degradation may be defined as a temporary or permanent decline in the productive capacity of the land or its potential for environmental management. Global Assessment of Human-induced Soil Degradation (GLASOD) study as shown in Figure-1 estimated that of 8.7 billion hectares of agricultural land, pasture, forest, and woodland, nearly 2 billion hectares (22.5 percent) have been degraded since mid-century. Some 3.5 percent of the total has been degraded so severely that it is reversible only through costly engineering measures, if at all. Its 10 percent has been moderately degraded and is reversible only through significant on-farm investments. Another nearly 9 percent is lightly degraded and easily reversible through good land husbandry practices. Globally, GLASOD indicates that nearly half of this vegetated area is under forest, of which about 719 million (18 percent) is degraded; 3.2 billion hectares are under pasture, of which 685 million (21) percent is degraded; and nearly 1.5 billion hectares are in cropland, of which 562 million (38 percent) is degraded.



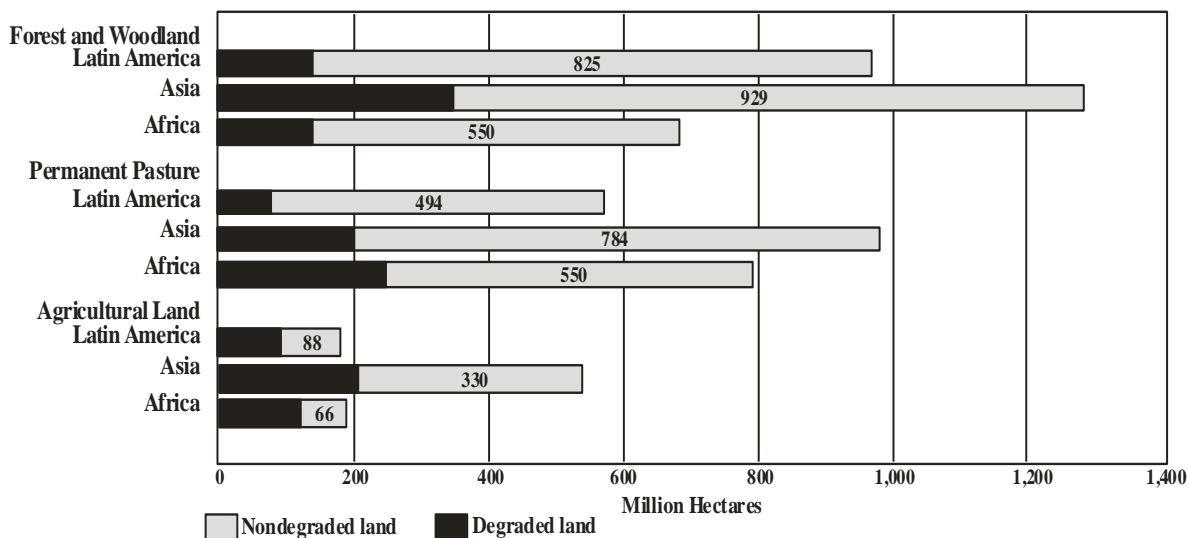
Source: Oldeman 1992; Hakkeling and Sombrock 1990.

*Note: Figures are cumulative over slightly, moderately, strongly, and extremely degraded land*

**Figure: 1**

As per Figure-1, land degradation under agriculture land is a severe problem. Land degradation under agriculture is at highest with 38 percent. As per GLASOD estimates, as shown in figure-2, degradation of cropland appears to be most extensive in Africa, affecting 121 million hectares (65) percent of cropland area, compared with 92 million hectares (51 percent) in Latin America and 206 million (38 percent) in Asia. Degradation of pasture is also most extensive in Africa, affecting 243 million (31 percent), compared with 197 million hectares (20 percent) in Asia and 78 million (14 percent) in Latin America. Forestland degradation is most extensive in Asia, affecting 344 million (27 percent) of forestlands, compared with 130 million (19 percent) in Africa and 137 million hectare (14 percent) in Latin America.

### Land degradation by type of land use: A regional perspective



**Figure: 2**

#### **Land Degradation in Punjab:**

Punjab is an agrarian state of India. It is situated in the north-west part. The name of the State of Punjab is made of two words Panj (Five) + Aab (water). This word denotes the state as the land of five rivers. These five rivers of Punjab are Sutlej, Beas, Ravi, Chenab, and Jhelum. Only Sutlej, Beas and Raavi rivers flow in today's Indian Punjab and Chenab and Jhelum rivers are now part of west Punjab, situated in Pakistan. The Punjab State is divided into three regions: Majha, Doaba, and Malwa. Agriculture is the mainstay of Punjab's economy.

As shown in Table-1.1, except for the periods 1901-11 and 1941-51 during which the population decreased, it has been increasing steadily. However during the period 1901 to 1911 because of droughts and epidemics (plague etc.) and during 1941-51 as a result of large migration, deaths, etc. resulting from the partition of the country, the population of Punjab decreased. The population of Punjab in 1901 was 75.45 lacs. It rose to 91.6 lacs in 1951. The first census of reorganized Punjab in 1971 recorded its total population as 1,35,51,000. It increased to 1,67,88,915 in 1981 and to 2,02,81,969 in 1991, 2,42,89,296 in 2001 and 2,77,400 in 2011. With the increase in population, density of population also increased. Population density in Punjab was 269 sq.km in 1971. Increasing trend in density of population still continue. Population a density of Punjab was 551 per sq. km 2011, which was higher than national population density (382 per sq. km). Due to this density of citizens are facing the problem of basic amenities. Density of population is also becoming the big reason of land degradation.

**Table 1.1: Growth of Population in Punjab**

Growth of Population of Punjab 1901-2011 year	Population (lacs)	Percentage Change	Percentage Change for India	Persons per Sq.Km. (2011) Punjab	Persons per Sq.Km. (2011) India
1901	75.45	-	-		
1911	67.32	-10.78	5.75		
1921	71.53	6.26	-0.31		
1931	80.12	12.02	11		
1941	96	19.82	14.22		
1951	91.61	-4.58	13.31		
1961	111.35	21.56	21.51		
1971	135.51	21.7	24.8	269	177
1981	167.89	23.89	24.66	333	216
1991	202.82	20.81	23.5	403	267
2001	242.89	19.76	21.34	484	325
2011	277.04	13.73	17.64	551	382

Source: Statistical abstracts of Punjab/ Census of India

**Crop Rotation:**

Punjab state has 5.03 million hectare geographical area out of which 4.23 million hectare is under cultivation. About 75% of its population depends directly in agriculture. Since the advent of green revolution, the state has made rapid strides in agricultural production. As shown in Table-1.2, total production of food grains has increased over the years. It was 192.18 lacs metric tonnes in 1990-91 and showed increase of 38.95 percent in 2014-15 (P) i.e 267.03 lacs metric tonnes. Further, it was estimated that the production of foodgrains to be 286.05 lacs metric tonnes in 2015-16

**Table 1.2: Production of Agricultural Crops (In '000' Metric tonnes)**

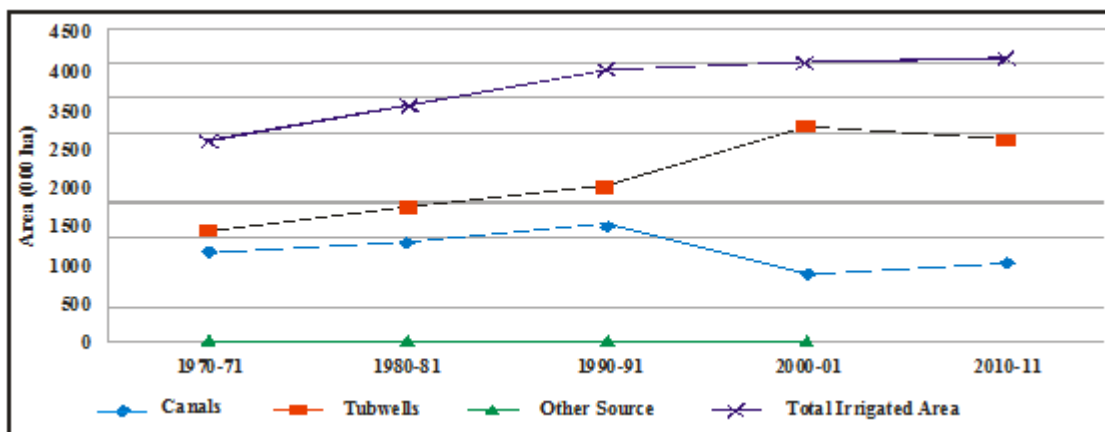
ITEMS	1990-91	2000-01	2010-11	2012-13	2013-14(R)	2014-15(P)	2015-16(E)
Rice	6506	9157	10819	11390	11259	11107	10620
Wheat	12159	15551	16472	16614	17610	15088	17100
Other Cerals	448	575	538	535	557	499	847
Pulses	105	39	17	12	17	9	38
Total Foodgrains	19218	25322	27846	28551	29443	26703	28605
Oilseeds	93	88	73	70	64	58	109
Sugarcane	601	777	417	489	552	581	663
Cotton (000 bales)	1909	1199	1822	1627	1491	1342	522

Source: Director of Land Records, Punjab (2015-16)

The production of the wheat has increased by 24.09% and the production of rice has increased by 70.72% from 1990-91 to 2014-15 (P). During 2015-16(E), the production of wheat was 171 lacs metric tons and the production of rice is 106.20 lacs metric tons. However, the production of pulses has increased from 0.09 lacs metric ton in 2014-15(P) to 0.38 lacs metric tons in 2015-16(E). The production of sugarcane has shown different trends over the years, as it decreased from 6.01 lacs metric tons in 1990-91 to 4.17 lacs metric tons in 2010-11. It increased during 2012-13 (4.89 lacs metric tons) to 2014-15 (5.81 lacs metric tons) and estimated to increase to 6.63 lacs metric tons in 2015-16. The production of cotton (cleaned) has decreased from 14.91 lacs bales in 2013-14 to 13.42 lacs bales in 2014-15(P) and further to 5.22 lacs bales in 2015-16(E). The initial increase in agricultural production in the state was mainly due to increase in net sown area. Rapid increase in rice production becomes major cause of water exploitation in Punjab.

**Water exploitation in Punjab:**

The state has a highest net irrigated area (percentage) in India and agriculture sector accounts for about 85% of water consumption in the state. Out of the total area of 4158 Thousand hectares under agriculture in the state, an area of 4070 Th. ha (97.9%) is getting irrigation from canals (27%) and tubewells (73%). However, there has been a significant reduction canal irrigated area in the state since 1990 and area irrigated by tubewells has been increasing. This is due to increased demand for water, reduction in canal capacity due to siltation and the easy credit facilities for tubewell installation with some subsidy, besides liberal facilities for electrification of tubewells. Hence, the groundwater is being overexploited to meet the increasing demands of water for irrigation intensive agricultural practices The centrifugal pumps are becoming redundant and being replaced with submersible pumps especially in central Punjab due to depletion of underground water.



Source: Central Groundwater Board

Figure: 3

As shown in figure-3 The area irrigated by tubewells became double in 2000-01. Irrigation area through tubewell was near about 15 lacs hectare in 1970-71 and covered 30 lacs hectares area in 2000-01. Irrigation area under canals falls from 1300 hectares in 1970-71 to 1000 hectare in 2000-01. As crop area under rice and wheat increased, stress on ground water also increased. Due to over-exploitation of groundwater, Most of the areas of Punjab is facing fall in groundwater level.

**Table 1.3: District wise shallowest and Deepest water level depth**

	DISTRICT	SHALLOWEST WATERLEVEL		DEEPEST WATER LEVEL	
		WATER LEVEL DEPTH	NAME OF BLOCK	WATER LEVEL DEPTH	NAME OF BLOCK
1.	AMRITSAR	5.90	AJNALA	26.20	VERKA
2.	BARNALA	19.23	BARNALA	36.40	MAHAL KALAN
3.	BATHINDA	3.80	SANGAT	29.19	BHAGTA BHAI KE
4.	F.GARH SAHIB	1.30	KHERA	37.40	KHERA
5.	FARIDKOT	1.60	FARIDKOT	16.30	KOT KAPURA
6.	FAZILKA	0.83	FAZILKA	20.45	JALALABAD
7.	FEROZPUR	3.15	GURUHAR SAHAI	27.85	ZIRA
8.	GURDASPUR	1.70	KAHNUWAN	19.12	SRI HARGOBINDPUR
9.	HOSHIARPUR	3.05	TALWARA	60.50	HOSHIARPUR-II
10.	JALANDHAR	7.70	LOHIAN	36.20	JALANDHAR-E
11.	KAPURTHALA	5.25	SULTANPUR LODHI	31.77	KAPURTHALA
12.	LUDHIANA	4.06	MACHHIWARA	29.50	LUDHIANA
13.	MANSA	2.41	MANSA	57.47	SARDULGARH
14.	MOGA	9.50	KOT ISA KHAN	32.90	MOGA-II
15.	MOHALI	2.95	KHARAR	49.85	SIALBA MAJRI
16.	MUKATSAR	1.10	MUKATSAR	6.70	KOT BHAI
17.	NAWAN SHAHR	6.20	NAWAN SHAHR	42.50	BALACHAUR
18.	PATHANKOT	2.90	DHAR KALAN	28.50	DHAR KALAN
19.	PATIALA	2.26	GHANAUR	42.15	RAJPURA
20.	ROPAR	1.04	A PUR SAHIB	50.60	ROPAR
21.	SANGRUR	20.75	LEHRAGAGA	40.65	SHERPUR
22.	TARN TARAN	7.30	VALTOHA	23.70	KHADUR SAHIB
	<b>STATE</b>	<b>0.83</b>	<b>FAZILKA</b>	<b>60.50</b>	<b>HOSHIARPUR-II</b>

Source: Central Ground water Board

As shown in Table 1.3, water level in most of the districts of Punjab falling. Talwara and Fazilka blocks of Hoshiarpur district found at deepest water level with 60.50 meter. Most of the districts are facing falling ground water level as Amritsar district has shallowest water level is 5.90 meter and deepest water level reaches at 26.20 meter level. As data shows in Table, Mukatsar district looks better as its shallows water level is 1.10 meter and deepest water level is just 6.70 meter. Most of the districts of Punjab are under threat of low ground water level. As per data available by Central Ground Water Board, in 2014, in Punjab, it was observed that in 8% of the wells, water level ranges in 0-2 m depth range. About 16% of the wells analysed have shown water level in the range of 2-5 m bgl and a major percentage of wells i.e. 21% fall in the range of 5-10 m bgl. 34% of the wells show water levels in the range of 10-20 m bgl. 22 % wells have shown water level in the range of 20-40 m bgl. The depth to water level recorded in the state during January 2014 ranges from ground level to 37.33 m bgl. Fall in water level shows how increasing trend for tubewell for irrigation have become a big threat for ground water. As per Department of Soil and water conservation Punjab, Paddy is an irrigation intensive crop, periodic record of water table in Punjab shoes a continuous fall since introduction of paddy in state. The continuous cultivation of paddy reduces soil health due to burning of straw, use of higher agrochemicals and erosion of biodiversity. In 1960's water table in Patiala, Sangrur, Ludhiana, Jalandhar, Kapurthala & Amritsar districts was above 6m. At present water table is declining at a rate of 55cm. per year. The area with water table deeper than 10m was 3% in year 1973 which

increased to 90% in year 2004 and fall in ground water is still continue. The impact is quite obvious as water requirement of paddy is 180cm as compared to 45cm to cotton, 40cm to maize & 25cm to groundnut. The shift from these crops led to six fold increase in total irrigation requirement of state. Another implication is increased demand for energy in form of electricity & diesel, 45% of the total electricity demand is consumed in paddy season. Electricity has to be diverted from other sectors mainly industry which has an adverse impact on industrial production and growth. Punjab can ill afford to continue with the existing acreage under paddy which is great drain on underground water energy and soil health.

**Soil Degradation:**

With the increase of total crop production in Punjab, the consumption of chemical fertilizers (NPK) was also increased from 1220 Thousand Tonnes in 1990-11 to 1713 Thousand Tonnes in 2013-14 and 1677 Thousand Tonnes in 2014-15(P). As shown in Table-1.4, consumption of Fertilizers also increased as production of crops increased in Punjab. High usage of nitrogenous fertilizers with relative under-utilization of other fertilizers and micro nutrients has lead to imbalance in micro nutrient in soils of the Punjab. Although agriculture production in Punjab is increasing yet consumption of pesticides and insecticides also increasing at the same pace. As shown in 1.5, consumption of insecticides/pesticides has been doubled from 1980 to 2017.

**Table 1.4: Consumption Fertilizers (000 nutrients tonne)**

(R)	(P)	1990-91	2000-01	2010-11	2011-12	2012-13	2013-14	2014-15
Total NPK		1220	1313	1911	1918	1972	1713	1677
Nitrogenous (N)		877	1008	1403	1416	1486	1364	1321
Phosphatic P <sub>2</sub> O <sub>5</sub>		328	282	435	448	462	325	326
Potassic (K <sub>2</sub> O)		15	23	73	54	24	24	30

Source: Director of Agriculture, Punjab

**Table 1.5: Consumption of Insecticides/Pesticides in Punjab**

Year	Consumption in Technical Grade (M.T)
1980-81	3200
1990-91	6500
1995-96	7200
2000-01	6970
2005-06	5970
2006-07	5975
2007-08	5900
2008-09	5760
2009-10	5745
2010-11	5600
2011-12	5690
2012-13	5725
2013-14	5720
2014-15	5699
2015-16	5721
2016-17	5843
2017-18 (T)	6374

Source: Department of Agriculture, Government of Punjab

\* Above Consumption of Insecticides/Pesticides Includes weedicides, Fungicides, Rodenticides (Poison)

Due to intensive agriculture cultivation in Punjab, not only chemical fertilizers increased in Punjab but also consumption of insecticides and pesticides increased at pace. Chemical Fertilizers and Insecticides/pesticides affected land very badly. In the year 1990 consumption of insecticides/pesticides were 3200 metric tonne as shown in Table-1.5. The consumption was at peak in 1995-96 with 7200 metric tonne since 1980. The consumption in the year 2016 was 5843 and was expected to be 6374 metric tonne in 2017-18. The various studies undertaken in the state since 1980 has indicated the presence of residues of chemical pesticides like organochlorines, organophosphates, synthetic pyrethroids and carbamates in human beings, milk, water, vegetables and other food products at levels, which are dangerous for human health. Non judicious use of pesticides has also resulted in the development of pesticide resistance in various insects and pests. Modern agriculture since green revolution has considerable contributed to soil pollution through the non-judicious use of chemical fertilizers, herbicides, insecticides, insecticides and fumigants. Pesticide residues are found in soil, air and water as well as in living organisms. Apart from killing the living organism present on the surface of the soil, they reach the deeper layers through tilling and irrigation of the land killing still more living forms. There continuous use adversely affects soil productivity.

### 3. CONCLUSION

Punjab is an agrarian state of South Asian country India. The economy of the most of the Asian countries is depending on agriculture. Population of these countries is increasing at rapid pace, So for the survival, intensive agriculture has become a part of the people. Due to intensive agriculture, Consumption of chemical fertilizers, insecticides, pesticides increasing year by year. Ground water is also under stress due to the lack of diversification of crops. Punjab has 0.25 hectare of per capita availability of land. Out of total land area of 5036000 hectare, 228840 hectare (4.54% of Total area) is suffering from different kinds soil problems. Rice is an irrigation intensive crop, periodic record of water table in Punjab shows a continuous fall since the introduction of the rice crop in the state. The continuous cultivation of rice reduces soil health due to the burning of straw. It is suggested that government of India should assures Punjab to provide a market for other cereals other than rice to protect ground water of Punjab. The state Punjab cannot afford to continue with the existing acreage under rice which is a great drain on underground water energy and soil health. It is also suggested that government should introduce organic manure with a proportional share of chemical fertilizers for the timing. Stubble burning should be ban, as due to this trend not only degrading soil but also badly affecting the health of the citizens.

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