

# Resource Efficiency Roadmap for Agriculture in Punjab

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# 1 Introduction

With the Green Revolution, Punjab saw a rapid increase in agricultural production. The gross cropped area during the 1980s, around 6763 thousand hectare increased to 7870 thousand hectares by 2012-13 (GoP, 2014)<sup>1</sup>. The agricultural growth of the state which is largely driven by the performance of wheat and rice production has been diminishing due to the stagnating yields of rice and wheat. The contribution of agriculture and allied sectors in the Gross State Domestic Product (GSDP) Punjab was around Rs 35235.84 crore in the year 2010-11 (Department of Planning, 2013). The percentage share in the GSDP of various sub-sectors in the same year was approximately 15.09%, 7.55%, 0.24% and 0.98% for agriculture, livestock, fisheries and forestry respectively (Department of Planning 2013).

**Table 1:** Area under agricultural crops ('000 hect)

Year	Area	Year	Area
1960-61	3837	1990-91	6597
1970-71	4765	2000-01	7018
1980-81	5852	2010-11	7177

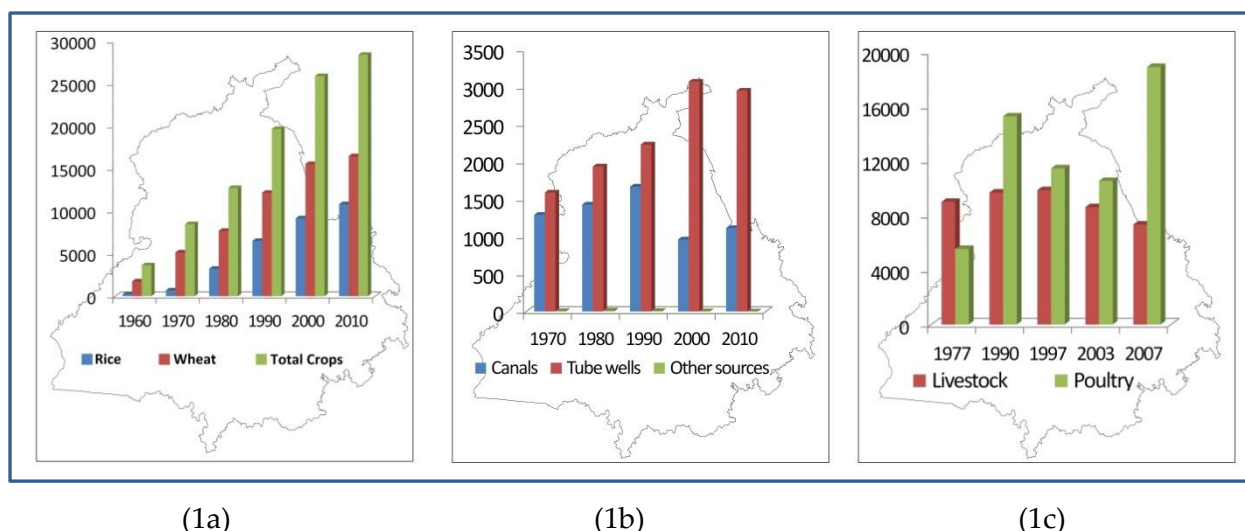
**Source:** Statistical Abstract of Punjab, various years

The total area under agricultural crops has increased from 3837 thousand hectare in 1960 to 7177 thousand hectares in 2010 (table 1). Wheat and rice, the dominant crops in the region account for almost 85% of the gross value of crop output (Sidhu 2012). There has also been an increase in the production of vegetables and horticultural crops in the last few decades. Area under wheat, rice, maize, fruits and vegetables were recorded around 3510, 2830, 138, 69.81 and 102.89 thousand hectares (Figure 1a) in 2010-11 (GoP, 2013). The number of livestock and poultry animals has increased from 213.08 lakhs in 1997 (DADF, 1997) to 249.11 lakhs (Figure 1c) in 2012 (DADF 2012).

At present, the percentage of net area irrigated to net area sown in the state is 98.8% (GoP, 2013). The main source of ground water extraction for irrigational purpose in Punjab is through tubewells which was approximately 13.82 lakh in 2010 (DoA, 2012). Besides tubewell irrigation, Punjab also has an extensive canal network for irrigation, although the percentage share of canal irrigation has considerably reduced from 45% in 1970 to 27% in 2010 due to extensive and rapid ground water irrigation development (Figure 1b).

In terms of agriculture policy, the state has pushed for mechanization leading to increase in farm machinery from 30,000 tractors registered during 1970-71 (Planning Commission, 2013) to 62,57,000 tractors in 2011-12 (GoP 2013). The total number of other agricultural machinery including threshers, disc harrow, seed-cum fertilizer drill, knapsack spray pump, vertical conveyer reaper, tractor operated combine, straw reaper, maize sheller, potato planter, sugarcane cutter-planter, strip till drill, zero till drill, rotavator and aeroblast sprayer, was approximately 17.91 Lakh in the year 2010 (DoA, 2012).

<sup>1</sup> Provisional data



**Figure 1:** (a) Production ('000 metric tonnes) of Rice, Wheat and Other crops in Punjab (1960-2010); (b) Sources-wise Net Irrigated Area ('000 Hectares) in Punjab (1970-2010); (c) Population of Livestock & Poultry in Punjab (1977-2007)

**Source:** Base data Statistical Abstract of Punjab various years

Over the last two decades the consumption of NPK fertilizer which provide nitrogen (N), phosphorus (P) and potassium (K) for the soil, has increased significantly. The NPK consumption is usually higher in the Rabi season as compared to the Kharif season. The total NPK consumption in 1990-91, around 12.2 Lakh tonnes increased to 19.12 Lakh tonnes in 2010-11 (FAI 2011).

According to the Census 2011, the proportion of rural population (62.5%) was more than that of urban population (37.5%). There has been a slight decline in percentage of workers engaged in agricultural sector from 38.9% in 2001 to 35.5% in 2011. Whereas, there has been a 3.5% increase in the percentage of agricultural labourers from 2001 to 2011. Overall the proportion of agricultural labourers to total agricultural workers has increased from 12 % in 1951 to 32% in 1971 and reached to about 40 % by 2001 (GoP, 2014; Singh et al. 2012).

The total area under agricultural landholdings in 2010-11 has been recorded as 3967 thousand ha which is 2.49 % of total area under landholdings in India (159180 thousand ha). Medium farmers fall second when looking at the number of landholdings in Punjab, but they comprise the largest share of the area under landholdings (43%) followed by large farmers (26%), semi-medium farmers (22%), small farmers (7%) and marginal farmers (3%) (DAC 2011).

Out of the total crop area, 2516 thousand ha was kharif season crop area while 3162 thousand ha was rabi season crop area in 1970-71. In the year 1990-91, 3392 thousand ha and 4110 thousand ha were kharif and rabi crop areas, respectively. The area under kharif and rabi crops in 2010 was increased to 3959 thousand ha and 3929 thousand ha, respectively (DoA 2012). The gross area under rice has increased from 2015 thousand ha in 1990-91 to 2650 thousand hectare in 2009-10. The gross area under wheat increased from 3273 thousand ha in 1990-91 to 3450 thousand ha in 2009-10. The area under total foodgrains increased from

5668 thousand ha in 1990-91 to 6365 thousand ha in 2009-10 while the area under total oilseeds decreased from 104 thousand ha in 1990-91 to 93 thousand ha in 2009-10. Area under other major crops in Punjab including sugarcane and cotton decreased from 101 thousand ha and 701 thousand ha in 1990-91 to 85 thousand ha & 530 thousand ha in 2009-10 respectively (DoA 2012).

## 2 Resource use and status

### 2.1 Energy

The consumption of electricity in agricultural sector has increased from 5104.5 million kilowatt-hour in 1990-91 to 10469.3 million kilowatt-hour in 2009-10 (PSEB 2011). This increase is mainly attributed to the high use of electric pumps in tubewells for irrigation purposes. Out of the total of 6 lakh tubewells in 1980-81, 3.20 lakh were diesel operated and 2.80 lakh were electric operated. This number significantly increased in 2011-12 as the total number of wells became 13.83 lakh with 2.26 lakh diesel and 11.57 lakh electricity operated (GoP2013). The drastic increase in the number of electric pumps as compared to diesel pumps could be attributed to the free farm electricity subsidy provided by the government.

### 2.2 Water

Ground water as well as surface water resources are being utilized to the fullest in the state. A major portion of the ground water is utilized for irrigation. Almost 98% of the total cropped area is irrigated. The main source of ground water in Punjab is through tubewells. The net area irrigated by tubewells in 1970-71 was around 1591 thousand hectare which became almost double by 2010-11 accounting for 2954 thousand hectare area<sup>2</sup>. Punjab has a very well developed and interlinked river system and a widespread 14500 kms long canal system. The estimated value at the present price level of water resource infrastructure in the state is more than Rs.50,000 crore (Department of Irrigation Punjab, accessed 2015). Total cultivable command area in Punjab is 42.90 lakh hectares out of which 30.88 lakh hectares has been brought under command of canals networks (Department of Irrigation Punjab, accessed 2015).

However, the importance of canals has reduced over the years, due to the unreliability factor when compared to tubewells. In 1980-81, net area irrigated by canals accounted for 1430 thousand hectare which reduced to 1116 thousand hectare till 2010-11 (GoP, 2013).

### 2.3 Soil

According to the Department of Soil & Water Conservation of Punjab (ENVIS Punjab2014), the soils of Punjab are naturally alkaline having low nitrogen, medium phosphorous and high potash content. The districts in the southern region contain more saline soil. Over the years due to the practice of mono cropping (wheat and rice regime), there has been a gradual decline in soil fertility which gets augmented by burning wheat and rice straws in

<sup>2</sup> Statistical Abstract of Punjab, 1990, 2005 & 2008

the fields. These practices have not only led to deterioration of the macronutrients like nitrogen, phosphorous and potash but also of micronutrients like zinc, iron and manganese. The soils of Punjab are classified into eight major types namely

- (a) Flood plain or Bet soils- as the name suggests these are soils of flood plain area of various rivers or streams in the state. They are found along the west bank of Satluj river from the town of Ropar to that of Fazilka.
- (b) Loamy soils- these are the productive and fertile soil group in the state. They cover almost 25% area of the state and are found in a few parts of various districts including SBS Nagar, Bhatinda, Muktsar, Amritsar, Gurdaspur, Jalandhar, and Kapurthala.
- (c) Sandy soils- these soils form under semi-arid and warm to hot climatic conditions. Found in south central and south western Punjab, these soils cover parts of Bhatinda, Firozpur, Mansa, Muktsar, Patiala, Sangrur and Ludhiana districts.
- (d) Desert soils- like the sandy soils, the desert soils also develop under arid and hot climatic conditions. They cover an area of more than 11% in Punjab and are mostly found in parts of Firozpur, Bhatinda, Muktsar, Sangrur, Ludhiana and Mansa districts.
- (e) Kandi soils- these soils are suitable for dry farming activities as they are less productive and badly eroded. Found in areas of Pathankot, Hoshiarpur, Rupnagar and SBS Nagar districts.
- (f) Sierozems- Covering almost 25% of the area in the state, these soils can have good yields of wheat when given proper irrigation. Found in parts of Sangrur, Ludhiana, Patiala, Fatehgarh Sahib and Faridkot districts.
- (g) Forest soils- found along the Shivalik belt in districts of Pathankot, Hoshiarpur, SBS Nagar and Rupnagar.
- (h) Sodic and Saline soils- found in a few parts of Fazilka, Firozpur, Faridkot, Muktsar, Mansa and Sangrur districts. (ENVIS Punjab 2014).

### **3 Key issues and challenges related to resource efficiency in agriculture**

After pioneering the green revolution, Punjab is now facing the problems of stagnant agricultural yields. Prior to green revolution, the average production of total cereals and total foodgrains was around 1429 thousand tonnes and 1995 thousand tonnes<sup>3</sup> respectively. At the beginning of the revolution, during 1960's, the production of cereals and foodgrains were 2453 thousand tonnes and 3162 thousand tonnes respectively. There was a tremendous increase in production till the 1990s, after which it started falling and stagnating. In 2010-11, the production of cereals was around 27847 thousand tonnes and that of foodgrains was around 27866 thousand tonnes (MoA, 2012).

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<sup>3</sup> Statistical Abstract of Punjab 1999, Government of Punjab



Moreover, the continued rice-wheat cropping regime is responsible of slowly leeching the soil of the basic nutrients and affecting the soil health. Currently there is a soil micro-nutrients imbalance of around 70% of the total geographical area. Table 2 shows soil nutrient health status in Punjab.

**Table 2:** Soil Nutrient Health Status in Punjab

Nutrient	Percentage deficient soils	Nutrient	Percentage deficient soils
N	43.20%	Zn	16%
P	27.00%	Mg	-
K	7.90%	Mn	25%

**Source:** Punjab State Action Plan on Climate Change, 2014

An increase in the production lead to an increased use of fertilizers and pesticides due to which the soil degradation started increasing at an alarming rate. The excessive use of fertilizers is not only degrading soil but also polluting ground water resources. At present, there is an excessive use of synthetic nitrogenous fertilizers as they are important for plant growth. The generally recommended NPK ratio stands at 4:2:1 while according to Department of Agriculture statistics, the NPK consumption ratio in 1990 was around 58:22:1 (MoA 1990). This indicates excessive use of nitrogenous and phosphatic fertilizers ,this ratio was brought down in 2010 and was recorded to be 19:6:1 (MoA 2010). Table 3 shows the NPK consumption in Punjab from 1960 to 2010.

**Table 3:** NPK consumption in Punjab (In ' 000 Nutrients Tonne)

Year	Nitrogen (N)	Phosphate (P2O5)	Potassium (K2O)	Total (NPK)
1960-61	5	-	-	5
1970-71	175	31	7	213
1980-81	526	207	29	762
1990-91	877	328	15	1220
2000-01	1008	282	23	1313
2010-11	1403	435	73	1911

**Source:** Punjab State Action Plan on Climate Change, 2012

Of the total nitrogen fertilizers that are applied, crops just require and utilize 25% to 71%. The rest of it either stays in the soil or gets removed from the soil-plant system through denitrification, ammonia volatilization or leaching. A considerable quantity of the fertilizer that is applied transfers to the bottom most layers of soil as nitrate due to percolation and eventually flushes into the groundwater contaminating it (Naresh, 2014).

The rapid increase in agricultural production has come at the expense of water resources. Depleting ground water resources are a cause of major concern at the moment which also poses a threat for the future green development. According to a Central Ground Water Board (CGWB) report brought out in 2010 based on the data of stage of ground water development in Punjab, out of the 138 administrative blocks 110 blocks are overexploited, 3

are critical, 2 are semi critical while 23 block fall under the safe category (SAPCC- Punjab, 2014). Table 4 shows percentage of area under critical water-table depth in central Punjab 1973- 2007.

**Table 4:** Percentage of area under critical water-table depth in Central Punjab 1973 to 2007

Year	Percentage area > 10m	Percentage area > 15m	Percentage area > 20m
1973	3.7	0.56	0.39
1980	5.7	0.57	0.38
1990	26.7	2.95	0.38
2000	53.2	14.11	0.12
2001	65.7	21.73	1.22
2002	72.7	26.15	4.26
2003	79.9	32.73	5.73
2004	84.6	36.57	12.47
2007	93	46	19

**Source:** Agricultural Statistics, Department of Agriculture, Punjab, Chandigarh

Punjab is often threatened by drought conditions. According to National Institute of Disaster Management 2005 report, Punjab has experienced drought in 1978, 1979, 1985, 1987, 2002 and 2004 in the past<sup>4</sup>. The Indian Meteorological Department(IMD) in its Southwest Monsoon End-of-Season Report 2002 has defined a severe meteorological drought when the rainfall is more than 50% below normal and a moderate meteorological drought when the rainfall is between 26-50% below normal (IMD, 2002). IMD has listed the state amongst the frequent drought prone areas.

The state also faces threat from flooding and water logging. According to the State Disaster Management Plan report 2010-11, the area affected by floods in the year 1960 was around 4638 sq. kms which increased to 218337 sq. kms in 2010. Rivers Sutlej, Ghaggar and Ravi are one of the main causes behind flooding. The problem of water logging is also persistent in the state. The districts which are affected the most include Bhatinda, Sangrur and Ferozepur.

The subsidies provided by the government on electricity have led to the excessive use of tubewells for irrigation purpose which in turn are responsible for the decreasing ground water table in the state of Punjab (Jain, 2006; Kaur, 2012; Pandey, 2014). Punjab constitutes almost 6% (GoP2012) of the total tubewells in India. While, the central districts of Punjab alone account for approximately 70% of the total tubewells in the state(GoP 2012).

The state presently has 3271 sq. km. of the area under tree and forest cover. The state in its draft Forest Policy of Punjab as well as Green Mission for Punjab aims to increase the forest cover to 15% (i.e. 7554 sq. kms) of the total geographic area by the year 2015 (SAPCC- 2014). Another concern related to the forests is that of forest fires which become a regular feature

<sup>4</sup> <http://nidm.gov.in/PDF/DP/PUNJAB.pdf>

during the summer months due to very high temperatures and also because of farmers burning straw in their fields adjoining forests<sup>5</sup>.

Air, water and soil pollution have become widespread due to the burning of wheat and paddy straw. Approximately 18 million tons of wheat straw and 20 million tons of paddy straw is generated annually in Punjab (PSCST, 2008). The wheat straw is used as cattle feed to some extent while almost 50% of the total generated straw is burnt (Nautiyal et al., 2013; Kumar et al., 2015). On the other hand paddy straw which is not a preferable cattle feed has about 80% of the total generated or about 16.0 million tons (SAPCC-2012) burnt on site. Burning of crop residue on fields leads to loss of entire amount of carbon, 80% of nitrogen, 25% of phosphorus, 50% of sulfur and 20% of potassium existing in straw (Kumar et al., 2015). Continual burning in the field can permanently reduce the microbial population present in the soil. Straw burning is not only leading to loss of beneficial biomass, but the pollutants in the smoke act as possible health hazard triggering a range of respiratory diseases (Kumar et al., 2015).

#### **Box 1: From the monotonous Wheat-Rice regime to Beekeeping: A Success Story**

Struggling with increasing agricultural costs and dwindling farm returns, Gurcharan Singha resident of Tungwali village, Bhatinda, ventured into beekeeping after attending a young farmers course at the Punjab Agricultural University, Ludhiana. He started small with only a few boxes back in 1990 and today has a successful business with around 2500 boxes for beekeeping. Success in this venture attracted more farmers from the village as well as neighboring villages leading to the formation of a co-operative which at present has got more than 350 members from nearby villages as well as districts including Bhatinda, Muktsar and Faridkot. At an average 100 boxes for beekeeping easily fetch a farmer around Rs 2 lakh annually. Maximum percentage of the produce from the farms is being sold to a honey producing industrial unit near Ludhiana, besides that some ayurvedic companies are also occasional buyers.

**Source:** <http://www.tribuneindia.com/2008/20080530/punjab1.htm#4>

## **4 Key actors**

One of the major players in the sphere of agriculture in Punjab is the Department of Agriculture, Punjab. The main functions of the department include

- Improvement of seed replacement ratio,
- Strengthening of seed production and supply programmes; dissemination of the most recent crop production technologies;
- Promotion of micro irrigation
- Promotion of resource conserving technologies like green manuring in order to improve soil fertility;
- Improving the productivity and increasing the area under horticulture crops;

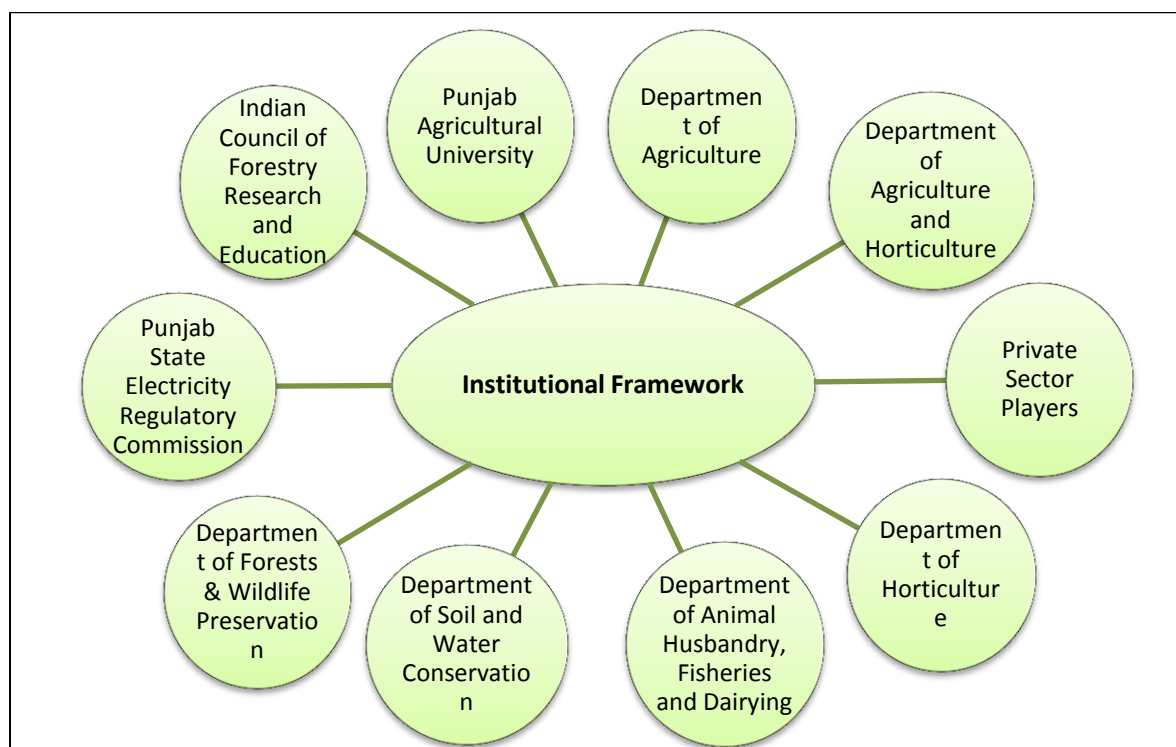
<sup>5</sup> <http://www.tribuneindia.com/2000/20000819/windows/main7.htm>

- Development of infrastructure for agricultural marketing and post-harvest management;
- Conservation of irrigation water through better on farm water use efficiency (DoA-Punjab, 2014).

Punjab Agricultural University is another key player in the sphere of research and development in agriculture and Agricultural Engineering. The various projects it has accomplished till now include evolution of a strong crop improvement programme; release of 686 crop varieties and hybrids; developed/ recommended resource conservation technologies like zero tillage, bed planting & tensiometer; introduced cultivation of crops like sunflower, summer moong, summer groundnut, winter and spring maize amongst many others<sup>6</sup>.

The Indian Council for Agricultural Research (ICAR) is mainly associated with the planning, promotions and coordination of education, research and its application in agriculture and allied sciences (ICAR, 2015). The ICAR as part of extension programmes has set up the Krishi Vigyan Kendras (KVKs) in all the districts managed by the Punjab Agricultural University, Ludhiana. A few of the mandates of the KVKs are to provide training to farmers, women, rural illiterates and youths in fields of agriculture and allied sciences; provide consultancy to farmers; plan and conduct survey of operational areas so as to prepare the resource inventory giving special importance to recognizing the training needs of the farms (ICAR, 2014).

Figure 2 shows the institutional framework in the state of Punjab



**Figure 2:** Institutional Framework

**Source:** TERI 2014

<sup>6</sup> <http://www.pau.edu/>

Three main departments viz. Department of Agriculture and Horticulture, Department of Soil and Water Conservation and Department of Animal Husbandry, Fisheries and Dairying and various sub-departments help in management and handling of the entire agricultural sector. These include Director of Agriculture, Department of Horticulture, Punjab Agri Export Corporation(PAEC), Punjab Agri Food Corporation(PAFC), Punjab State Agriculture Marketing Board(PSAMB), Punjab State Warehousing Corporation(PSWC), Punjab State Seeds Corporation Ltd.(PSSCL), Punjab Remote Sensing Centre(PRSC), Punjab State Land use and Waste and Water Land Development Board(PSLWLDB), Punjab Livestock Development Board, Punjab State Veterinary Council, Guru Angad Dev Veterinary and Animal Sciences University, Punjab Dairy Development Board and Fisheries Development Board.

The Departments responsible for water management and distribution include Department of Irrigation, Rural Development Department, Department of Public Health, Department of Water Supply and Sanitation, Punjab Water Supply and Sewerage Board, Water Resources and Environment Directorate, Punjab and Department of Agriculture. Regulation activities are over seen by the Punjab Pollution Control Board and Department of Environment. The promotion of new technologies is taken care by Department of Science and Technology and Environment, Punjab State Council for Science and Technology, Central Ground Water Board, Department of Agriculture, Department of Industry and Punjab Agricultural University.

Institutions managing forest and wildlife in Punjab include Forest and Wildlife Preservation Department which not only looks over planation of quality tree species as well as conservation of forests and wildlife but also undertakes activities to increase forest productivity, improve ground water recharge and check soil erosion; The Punjab State Forest Development Corporation; The Punjab Heritage and Tourism Development Board; and Punjab Bamboo and Fiber Development Board (PBFDB).

As for the private sector, main involvements in the sphere of agriculture involve agro food manufacturing and processing industries, agricultural machinery manufacturing industries and fertilizer and pesticide manufacturing industries. The state at present has more than hundred agricultural machinery manufacturing industries amongst which National Agro Industries is a leading industry not only in Punjab but also in India. Other known names in this sector include Vishavkarma Agro Industries, Standard Combines Pvt. Ltd. and Madho Agro Industries (ICAR, 2010). Amongst fertilizer manufacturing names like Natural Bio Fertilizer, National Fertilizers Ltd., Fertilizer Vermicompost and Bio Fertilizers are a few of the known names.

## **5 Policy and Interventions Relevant To Greening Agriculture in Punjab**

Even though agriculture comes under the jurisdiction of the state, nevertheless each state receives funds from the union government through various ministries in order to enable them to meet national objectives for agricultural development. In relation to schemes

sponsored by the center, each of these programs has specific guidelines that states need to adhere to. The funding for these schemes is borne either entirely by the union government or is shared between the union government and the state government. Schemes or programs in the agriculture and horticulture domain in Punjab that have complete or major funding from the center include Rashtriya Krishi Vikas Yojna (RKVY), National Food Security Mission (NFSM), National Mission of Sustainable Agriculture (NMSA), National Horticulture Mission (NHM). The crop diversification program funded by the union government is being implemented through RKVY.

The NMSA is a part of one of the eight missions under the National Action Plan for Climate Change (NAPCC) rolled out by the government of India. In the energy domain, Jawaharlal National Solar Mission (JNSM) under the NAPCC is also another program under which Punjab has a state scheme -SPV Water Pumping Program -where subsidy is provided for installation of SPV water pumps. The Demand Side Management (DSM) Initiative under the National Mission of Enhanced Energy Efficiency (NMEEE) is one such example that state is expected to contribute to. Here Punjab State Electricity Regulatory Commission has developed (DSM) regulations. The pilot project under Agriculture DSM has however been undertaken under the aegis of BEE with some PSERC support. Under the NAPCC, Punjab has prepared its State Action Plan for Climate Change (SAPCC) with recommendations for each of the eight missions including NMSA, National Water Mission Renewable Energy Development and Solar Mission. As part of the

Besides these there are broad guidelines/policies/ programs developed or initiated by the center that ideally states are expected to adopt at their level. The Draft Model Bill for the Conservation, Protection and Regulation of Ground water and the National Agroforestry Policy of 2014 are examples of policies which envision significant state intervention. In the former, states are supposed to use the draft bill as a model for developing and enacting state specific regulations, although it appears Punjab is yet to do so. On the other hand, Punjab has agroforestry as part of its State Forest policy and Strategic Plan. However the new National Agroforestry Policy designed by the center demonstrates the special focus that may be given to this sector, again with considerable state involvement in various aspects. Given the growth of this sector in Punjab, it may be helpful for the state to develop an action plan for this sector.

States may also devise their own schemes for agriculture and provide funding. State schemes may also receive funding from the union government through specific programs. For example state schemes are being implemented for soil and water conservation namely Assistance to farmers in underground pipe system for promotion of on farm water conservation; Project for judicious use of available water and harvesting of rain water for irrigation potential in Punjab; Community micro-irrigation project in Kandi belt and others. In the irrigation domain several initiatives for lining canals for improving water use efficiencies are also funded by the state.

## 5.1 Agriculture and Soil Health

- ***Draft Agriculture Policy for Punjab, 2013, Committee for Formulation of Agriculture Policy for Punjab State***

The draft agriculture policy seeks to enhance agricultural productivity and farmers' incomes keeping in mind the sustainable use of natural resources through focus on crop diversification and value addition and integrated farming. It recommends diverting a sizable area presently under rice cultivation to alternative kharif crops such as maize, pulses and also high value crops (Table) and suggests that appropriate policy, infrastructure, R&D, and market incentives are to be provided for this purpose. Water conservation through on-farm water management, water harvesting and regulations for enabling water use efficiency are proposed. Utilization of soil cards and integrated nutrient management are also recommended for improving soil health. Biotechnology interventions for crop breeding and establishing centers of excellence are highlighted in technology development. Organic agriculture is also recommended for horticulture in suitable regions as is agroforestry. Institutional reform particularly in extension services, government departments and credit access are suggested. Public Private Partnerships are emphasized.

**Table 5:** Alternative Crop Choices that have been proposed for enabling crop diversification

Crop	Current area (lakh ha)	Potential area (lakh ha)	Districts
Rice	28.0	16.0	Amritsar, Gurdaspur, Taran tarn, Ferozepur, Kapurthala
Maize	1.3	5.5	Traditional areas
Cotton	4.8	7.0	South-western districts
Sugarcane	0.7	2.6	Majha and Doaba regions
Guar	-	0.3	South-western districts
Kharif Fodder	4.0	5.5	Throughout the state
Arhar	Negligible	0.6	Central districts
Mungbean	0.2	0.6	Central districts
Kinnow	0.4	0.8	Traditional areas
Guava	0.1	0.2	Hoshiarpur, Ferozepur,
Agroforestry	1.3	3.0	Kandi belt and Central districts (Poplar); South-western districts (Eucalyptus)
Groundnut		0.2	Hoshiarpur, Nawanshahar
Turmeric, chilli, tomato, garlic, Capsicum, Kh. Onion	0.2	0.5	Hoshiarpur, Kapurthala, Jalandhar, Amritsar

**Source:** Draft Agriculture Policy Punjab

➤ **Crop Diversification Program for Haryana, Punjab and Western Uttar Pradesh, 2013-14, GoI implemented under RKVY, GoP**

Monoculture of cropping of rice and wheat has generated much pressure on ground water resources and soil health of Punjab besides impeding profitable returns due to stagnancy in yields. For this reason the finance minister in the year allocated Rs. 224 crore to Punjab under the “Crop Diversification Program for Haryana, Punjab and Western Uttar Pradesh” for promoting alternate crops to the paddy cultivation in the year 2013-14(DAC, 2013).The objectives of the scheme are demonstration of improved production techniques for alternate crops and enhancement of soil fertility by cultivation of leguminous crops. The program sets the goal of diversion of 5% of the acreage under paddy cultivation to be diverted by

motivating farmers to grow maize, kharif pulses, oilseeds and poplar based agro-forestry. Financial support for cluster demonstrations; site activities; farm mechanization, processing and value addition as well as awareness and training is provided. The Crop Diversification in Original Green Revolution States will be implemented through the RKVY program in the state.

As part of the crop diversification program, cluster demonstration of alternate crops such as Basmati, maize, cotton and even tree species like poplar and Eucalyptus are to be undertaken besides demonstrations for inter cropping in agroforestry. Under farm mechanization, there is subsidy provided for purchase of raised bed planter and laser land leveler, technologies that can help conserve water. In order to incentivize maize cultivation subsidy for maize thresher, maize sheller, maize harvest combine, portable maize dryers and community maize dryers are provided. Under the program soil testing will also be promoted in order to develop site specific nutrient management. Subsidy is being provided for Dhaincha seed for promoting green manuring.

RKVY also supports and is implementing an afforestation project under the crop diversification program. The aim is to shift land under wheat and paddy cultivation to eucalyptus and poplar species. In 2014, a target of 20,000 hectares was set at a cost of Rs 30 crore.<sup>7</sup>

➤ ***National Food Security Mission, DoAC, GoI***

Under this scheme, there is assistance for the production of wheat, pulses and coarse cereals in selected districts in Punjab. The objective of this program is to improve productivity and area under these crops. Restoring soil fertility is an important objective as enhancing farmer returns.

➤ ***National Mission of Sustainable Agriculture(NMSA), DoAC, GoI***

The scheme *Up-gradation of Soil Health Labs under National Project on Management of Soil Health and Fertility* has been subsumed under NMSA as part of the Soil Health Management component (GoP, 2014).

Under this program, Punjab S aims to promote Integrated Nutrient Management and improve soil health and productivity. Therefore as part of this component the following initiatives will be undertaken- creating a database for balanced use of fertilizers that is location specific; provision of soil testing kits to extension officers; strengthening soil testing and fertilizer quality control laboratories; capacity building of officials associated with soil testing and extension as well as farmers. On farm water management is also foreseen as an initiative under this scheme (GoP 2014).

➤ ***National Horticulture Mission, DoAC, GoI***

Aimed at promoting the growth of the horticulture sector NHM is a centrally sponsored scheme which is funded by the central government (85%) and the state government (15%).

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<sup>7</sup> Hindustan Times, Jan 30 2014, RKVY to fund afforestation in Punjab, targets 20,000 hectares in current year



Interventions for integrated nutrient management, organic farming, mechanization for horticulture and others can be undertaken as a part of this program.

➤ ***Scheme for Special Problematic and Degraded Land in the state under Technology Development Extension and Training***

Reclamation of degraded soils and lands through soil and water conservation works such as bench terracing, land levelling, field bounding, plantation etc. is a part of this scheme for which 60% financial assistance is provided to farmers.

➤ ***State Forest Policy and Strategic Plan, 2008-2017, GoP***

The policy was intended to support the protection, conservation and sustainable management of forests and increase of forest cover from 6.3 to 15%. There is thrust on agroforestry and accordingly emphasis on providing appropriate models, technical assistance, financial incentives and extension services for its promotion. It is perceived that besides facilitating land use/crop diversification and conservation of natural resources agroforestry can and could also serve as an alternative source of bioenergy. It recommends developing carbon sequestration methodologies for agroforestry plantations for approval from Clean Development Mechanism Authorities. It also stresses that high quality seedlings of fast growing species and clonal material from nurseries must be made available to farmers for promoting agroforestry.

➤ ***National Agroforestry Policy, DoAC, GoI***

The new policy on agroforestry, 2014 is designed to provide a new impetus to agroforestry in the country, through appropriate policy, regulations and appropriate institutional mechanism also encouraging industry participation. Given the growing interest of Punjab farmers in agroforestry and its adoption in the state due to presence of wood based industries, the national policy is of agroforestry assumes significance for the state .

The policy aims to establish an Agroforestry Board/ Mission at the helm to develop strategies and undertake various activities. A mechanism to coordinate with state level agriculture and forest departments is envisaged. Implementation of the several recommendations described in the policy will necessitate state engagement. These include addressing restrictive legislations,<sup>8</sup> creating simple regulations, establishing a secure land tenure system and also identifying species for agroforestry that are exempt from the restrictive state legislations. Decentralized institutions may be considered for regulatory roles so long as their capacities are developed for the same. States will also be involved in development of a database for land records and data collection for an MIS for this sector. Promoting research in ICAR institutes as well as SAUs and integrating agroforestry in state extension services and state led farmer training programs is also key.

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<sup>8</sup> Regulations related to restrictions on harvest and transit of trees grown on farms

➤ ***Ban on paddy and wheat straw burning, GoP***

According to a notice by the Department of Science Technology and Environment<sup>9</sup>, the state government prohibits the indiscriminate burning of left over paddy and wheat straw in Punjab under 19 (5) Air (Prevention and Control of Pollution Control) Act

➤ ***Policy for Management and Utilization of Paddy Straw in Punjab, 2013, PSCST, GoP***

The objectives of this policy is to tackle the in situ burning of paddy straw to reduce air pollution, loss of soil fertility and precious biomass by identifying and promoting various uses for paddy straw (biomass based energy, industrial raw material, fodder and manure). The document describes strategies and activities in the sphere of research and for technology development that supports its objectives. It also identifies agencies that might be involved in policy implementation.

## 5.2 Energy efficiency and conservation

➤ ***National Mission of Agriculture Extension and Technology, DoAC, GoI***

Sub-mission on Agriculture Mechanization is one of the schemes covered under this mission. This scheme is meant to extend farm mechanization to small and marginal farmers through establishment of Custom Hiring Centre. Another scheme Promotion and strengthening of agricultural mechanization through training, testing and demonstration involves design and fabrication of machinery that are crop specific, that can improve fuel efficiency and the demonstration of these technologies to farmers are the aims of this program. Another scheme, Scheme for Post-Harvest Technology and Management promotes technologies for primary processing and value addition, low cost storage and transport for commodities and crop bi-product management. It provides farmers with 40% subsidy of the total project cost. Another scheme for extension services also exists.

➤ ***Electricity Tariffs***

The State government provides power at very subsidized rates to farmers.

➤ ***Feeder Segregation***

Feeder segregation for separation of general and agricultural load has largely been completed for all feeders as part of the Urban Pattern Supply Scheme (Mukherji et al. 2012). Conversion of agriculture load feeders from Low Voltage Distribution System (LVDS) to HVDS has been undertaken in part and continues in the state. The annual plan also specifies that in the agriculture sector, the state proposes to convert (LVDS) to HVDS in agriculture sector

➤ ***New and Renewable Sources of Energy (NRSE) Policy – 2012, Department Of Science, Technology, Environment And Non-Conventional Energy, GoP***

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<sup>9</sup> Government of Punjab, Department of Science, Technology and Environment (STE Branch), 2013, Notification <http://www.ppcb.gov.in/Attachments/Notification%20and%20Office%20Orders/948officeorderpaddy.pdf>

This policy promotes the application of renewable energy technologies to maximize their share to 10% of the total installed power capacity in the state by the year 2022. Agro-residue based power generation from surplus crop residue- paddy straw and husk as well as cotton stalks is a focus area besides other forms of renewable technology (solar power generation, hydel power, solid waste based power generation). A target of more 600 MV of decentralized power generation through agro-residue to be achieved by 2022 is envisioned. Application of solar PV agri pump sets is also highlighted in the policy document amongst the various potential off grid photovoltaic interventions.

➤ *Punjab State Electricity Regulatory Commission (Demand Side Management) Regulations, 2012, GoP*

Draft regulations for DSM have been developed by PSERC and comments have been invited for the same.<sup>10</sup> The Commission will enforce DSM activities for energy efficiency in a variety of sectors. The focus in the agriculture sector is on the use of star rated energy efficient pump sets.<sup>11</sup>

➤ *Pilot Agricultural Demand Side Management (Ag- DSM) Project at Muktsar & Taran Taran, Punjab, 2010*

The Ag-DSM scheme is implemented by the Ministry of Power through BEE. This pilot in Punjab by a private agency is meant to provide an insights for energy agencies/ state distribution utility interested in investing and undertaking projects through PPP mode, for the replacement of old pumpsets with energy efficient ones. A detailed project report on the Ag DSM pilot project in Punjab describes results of the pilot in terms of performance of pumpsets, energy savings and also provides options for financing and business models for this Ag DSM initiative. The study recommends that PSEB could implement the DSM project in agriculture with direct funding from financial institutions. Amongst the different business models proposed (i) in the DISCOM mode finance PSEB can finance and implement the replacement of pumps and contract out maintenance of energy efficient ones (ii) in the ESCO mode, the energy services company with a contract with PSEB will finance and implement the project (iii) in the HYBRID mode while the ESCO will finance and implement the project the DISCOM will support capital expenditure and operating expenses and will in return share energy saving from the project

➤ *SPV Water Pumping Programme under Jawaharlal Nehru National Solar Mission (JNNSM)*

As part of this scheme, installation of 500 SPV water pumping systems is envisaged in the state. A 30% subsidy is provided on installation of solar projects that also includes solar water pumping systems of capacities ranging between 0.5 KWp to 5 KWp.

<sup>10</sup> PSERC, Draft Regulations. Available at <http://www.pserc.nic.in/pages/Public%20Notice/Draft-regulation-notice.pdf>

<sup>11</sup> [http://www.pserc.nic.in/pages/Public%20Notice/DSM%20Regulations\\_Final%20Draft.pdf](http://www.pserc.nic.in/pages/Public%20Notice/DSM%20Regulations_Final%20Draft.pdf)

- *Scheme for "Supplying, Commissioning and Maintaining Solar Photovoltaic (SPV) Pump sets at Farmers fields at in Punjab"<sup>12</sup>, Department of Soil and Water Conservation, GoP*

The DSWC is currently running a scheme that provides farmers having micro-irrigation system on their field the opportunity to procure SPV at 75% of the cost, subject to a maximum<sup>13</sup>. The farmer would need to choose from an empanelled contractor and deposit his share as a beneficiary to avail the subsidy.

- *Biomass projects -Punjab Energy Development Corporation,*

PEDA has commissioned biomass based power projects in Punjab and until 2014 the cumulative achievement in relation to capacity was 62.5 MV.<sup>14</sup>

### 5.3 Water Efficiency and conservation

- *Draft State Water Policy, 2008, GoP*

The document highlights the present challenges of water resources in Punjab- declining availability, over-exploitation and deteriorating quality and proposes many interventions to improve water use efficiency, conservation, equitable distribution and management in the state. Advanced on farm water management techniques (drip and sprinkler methods), conjunctive use of surface and ground water especially for reclamation of saline and water logged soil, command area development, development and rehabilitation of ponds as well as reuse of treated water is foreseen. Monitoring of quality and quantity of ground water and ground water recharge projects are envisioned. Institutional framework for development and regulation of water resources is suggested along with participatory approach to water management and water pricing.

- *AP policy Guidelines for Release of Agricultural Pump set Connections in the State of Punjab for the year 2013-14*

Given the critical situation of groundwater resources in the state due to continuous exploitation, the Government of Punjab has fixed the target for the number of agricultural pumpset connections that can be released by Punjab State Power Corporation. In the year 2013-14, the proposed target was 25000 agricultural pump connections. Besides this, another 50000 additional connections which could not be released in 2012-13 were also proposed to be released in 2013-14. It was recommended that all the prospective tubewell connections will be of BEE 4 Star label and ISI Marked Motor Pump and that they will be released under High Voltage Distribution System (HVDS)

<sup>12</sup> DSWC, Scheme for "Supplying, Commissioning and Maintaining Solar Photovoltaic (SPV) Pump sets at Farmers fields at in Punjab" [http://dswcpunjab.gov.in/contents/data\\_folder/solar\\_pumps.htm](http://dswcpunjab.gov.in/contents/data_folder/solar_pumps.htm)

<sup>13</sup> Terms and Conditions for Installation of SPV Pumps [http://dswcpunjab.gov.in/contents/pdf\\_forms/Terms%20and%20Conditions-SPV%20Pumps.pdf](http://dswcpunjab.gov.in/contents/pdf_forms/Terms%20and%20Conditions-SPV%20Pumps.pdf)

<sup>14</sup> <http://www.peda.gov.in/Bio-massPower.html>

➤ ***The Punjab Preservation of Subsoil Water Act, 2009, GoP***

In order to check the over exploitation of ground water resources, the act prohibits sowing nursery of paddy before the 10th of May in Punjab except the areas which have water logging where the depth of groundwater table is less than one meter.

➤ ***On Farm Management component of National Mission of Sustainable Agriculture, GoI***

The National Mission on Micro Irrigation that has promoted the adoption of micro-irrigation in Punjab has been subsumed under the On Farm Management component of NMSA. Subsidy for installation of micro-irrigation has been provided for farmers under this scheme. Under this scheme, small and marginal farmers are provided 45% subsidy for small and marginal farmers and 35% for other farmer communities. As a part of this scheme running since 2005-06, 28000 ha have been covered under micro-irrigation with an emphasis on vegetable and Kinnow plantations.

➤ ***Assistance to farmers in under Ground Pipe System (UGPS) for Promotion of on-Farm Water Conservation***

Improving water application efficiency of surface irrigation through replacement of low-efficiency kutchra field irrigation channels with underground pipeline systems is the main objective of this state scheme which can translate to 15-25% of water savings. Subsidy of 50% is provided to farmers for laying underground pipeline systems on individual fields.

➤ ***Project for judicious use of available water and harvesting of rain water for enhancing irrigation potential in Punjab***

Under this scheme, 90% financial assistance is provided for establishing community underground pipeline system projects in specific districts whereas entire funds would be provided for setting rain harvesting structures in Kandi area.

➤ ***Community Micro Irrigation Project in Kandi Belt of Talwara and Hazipur blocks of district Hoshiarpur***

Micro-irrigation systems such as drip and sprinkler systems are proposed to be installed in farmers' fields for supply of irrigation water from Kandi canal.

➤ ***Project for laying of underground pipeline for irrigation from sewage treatment plants of various towns/cities***

Treated sewage water from 33 cities or towns is envisaged for use as irrigation water supplied through a proposed network of underground pipelines.

➤ *Other schemes for lining canals*

There are several schemes that provide financial assistance for lining canals that can prevent water seepage that results in water logging especially in the south-western districts of Punjab and thus improve water use efficiencies in irrigation.

➤ *Draft Model Bill for the Conservation, Protection and Regulation of Groundwater, GoI*

Envisioning the sustainable use, development and equity in the management of ground water resources in the country, the union government has put forward this bill for states to discuss and enact the said regulations in their state legislatures. It proposes an institutional framework from local to state level characterized through gram and block panchayat ground water committees (in rural contexts) as well as district and state ground water councils with requisite mandates. Development of de-centralized groundwater security plans is proposed that focus on measures for use, conservation and regulation of ground water in addition to duties and management responsibilities.

In relation to agriculture, the plan may include sanctions against cultivation of water intensive crops and incentives for water conserving technologies, measures for establishing artificial recharge structures and promoting energy efficient pumps. The bill also proposes a permit system based utilization of groundwater for major or medium irrigation projects which may also be subject to a water cess. In known areas of ground water over-exploitation (designated Groundwater Protection Zone 2) and where cultivation of water intensive cash crops exists, the bill recommends obtaining an undertaking for shift from water intensive crops which must also be reflected in the permit. Rainwater harvesting is promoted whereas social and environmental impact will be mandatory for industrial and commercial use.

Although the model bill could have vast impacts and implications for Punjab, it appears that the state is yet to implement the model ground water bill

## 5.4 Climate Change

➤ *Punjab State Action Plan on Climate Change, PSCST, GoP*

The Draft Report has specific targets as part of strategies devised under missions for water, agriculture, renewable energy etc. to combat climate change impacts. Under the water mission, drafting a state water policy for integrated water resource management is envisaged alongside other activities for augmenting ground water, surface water bodies and improving water use efficiency, reducing floods and water logging. Improving the institutional framework for water conservation and governance and establishing effective research and monitoring activities are also prioritized. Under the Agriculture Mission, activities for crop diversification, soil water and energy conservation and crop residue management are highlighted. Agro-forestry is one of the focal activities under the Green Mission. Promotion of DSM activities by way of energy efficient pump sets is a part of the Mission on Enhanced Energy Efficiency.

## 5.5 Other cross cutting policies

### ➤ Fertilizer subsidy

Fertilizer subsidy is provided to all farmers by the Government of India which facilitates purchase of fertilizer at subsidized rates.

**Table 6:** Policy Targets Set by Government of Punjab in relation Greening Agriculture Sector

Policy/Program/Scheme	Target set for Punjab
Draft Agriculture Policy Punjab	According to the draft agriculture policy, PAU has estimated that paddy can be cultivated in 1.6 million hectares without adversely impacting ground water levels. Therefore given that paddy was cultivated in approximately 2.8 million hectares in 2011-12, it is estimated that an area of 1.2 million hectares under paddy cultivation must be diversified to other crops. The policy lists alternate crop choices as maize, cotton, sugarcane, soybean, pulses, groundnut etc. In order to meet any losses that may occur for alternate crops in relation to MSP and procurement, the state also recommends a Price Support Operation Fund of Rs.5000 crore. This fund was created over a period of five years with financial assistance of Government of India. In relation to agroforestry, the draft policy envisions planting 0.4 lakh ha annually with harvest cycle of 5-6 years in order to cover approximately 2-2.5 lakh ha.
Crop Diversification Program for Haryana, Punjab and Western Uttar Pradesh implemented under RKVY	As on 2013-14, target was at least 5% of the area under Paddy. Area of 140 thousand ha out of 2579.2 thousand ha to be diverted. In 2014, a target of 20,000 hectares was set for shifting wheat and paddy cultivated land to forest <sup>15</sup>
Project for judicious use of available water and harvesting of rain water for enhancing irrigation potential in Punjab	An outlay of ` 20.00 Cr is provided in the Annual Plan 2014-15 to cover area of 14000 ha.
Community Micro Irrigation Project in Kandi Belt of Talwara and Hazipur blocks of district Hoshiarpur	Project target from 2011-12 upto 2013-14 was 658 ha. Target achieved up until 2013-14 was 134 ha.
Project for laying of underground pipeline for irrigation from sewage treatment plants of various towns/ cities	Total project target in the period 2011-12 to 2013-14 was 7306 ha out of which 1635 ha was achieved. For the year 2014-15 a revised target of 2000 ha has been provided.
On farm Water Management Component under National Mission of Sustainable Agriculture	A target of 4716 ha has been laid for 2014-15

<sup>15</sup>Hindustan Times, Jan 30 2014, RKVY to fund afforestation in Punjab, targets 20,000 hectares in current year

Policy/Program/Scheme	Target set for Punjab
SPV Water Pumping Programme under Jawaharlal Nehru National Solar Mission (JNNSM)	There is a target of installing 500 SPV water pumping systems in the state
AP policy Guidelines for Release of Agricultural Pumpset Connections in the State of Punjab for the year 2013-14	In the year 2013-14, the proposed target was 25000 agricultural pump connections. Besides this, another 50000 additional connections which could not be released in 2012-13 were also proposed to be released in 2013-14.
New and Renewable Sources of Energy (NRSE) Policy – 2012	It is anticipated that by 2022 de-centralised power generation of more than 600 MW through the use of surplus agro-residue.

## 6 Barriers

Table 7: Barriers

Barrier	Energy efficiency	Water efficiency	Soil Health	Cross cutting issues
Financial	<ul style="list-style-type: none"> <li>• Cost of energy efficient pumpsets and solar water pumps;</li> <li>• Lack of adequate finance mechanisms/support for bringing about a shift from traditional pumpsets to efficient pumpsets</li> </ul>		<ul style="list-style-type: none"> <li>• Lack of financial support for management of degraded soils</li> </ul>	<ul style="list-style-type: none"> <li>• Provision of MSP on less popular crops</li> <li>• Insufficient investment in infrastructure for agriculture (Specially at village level)</li> </ul>
Technological	<ul style="list-style-type: none"> <li>• Low quality and intermittent power provided to farmers encourages continuous motor use</li> <li>• Standardized products and quality assurance as well as local manufacturers for solar pumpsets</li> <li>• Inefficient pumpsets</li> </ul>	<ul style="list-style-type: none"> <li>• Maintenance &amp; development of existing canal system/irrigation channels</li> </ul>		<ul style="list-style-type: none"> <li>• lack of storage facilities (especially cold storage)</li> <li>• lack of proper connectivity to and from remote villages</li> <li>• need of more low cost technologies which are economical for small and marginal farmers</li> </ul>
Knowledge/info gaps	<ul style="list-style-type: none"> <li>• Low awareness amongst consumers about solar pumpsets</li> </ul>	<ul style="list-style-type: none"> <li>• Promotion and spread of knowledge about water</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of knowledge amongst farmers</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of knowhow of utilization of newer technology</li> <li>• providing correct</li> </ul>



	<ul style="list-style-type: none"> <li>• Market intelligence for incentivizing private participation in solar pumpset sector</li> </ul>	<p>saving Micro-Irrigation methods</p>	<p>about ways to overcome soil micronutrient deficiencies</p>	<p>market information at user end</p>
Policy and regulatory	<ul style="list-style-type: none"> <li>• Free or subsidized electricity disincentives for farmers to conserve electricity</li> <li>• Bringing about a shift from diesel to solar pumps</li> </ul>	<ul style="list-style-type: none"> <li>• Participatory Irrigation Management</li> </ul>		<ul style="list-style-type: none"> <li>• Enhanced participation of civil society and convergence of IWMP with allied sectors</li> <li>• formation and regulation of farmer co-operatives</li> <li>• Need for a stable and long term national policy on storage and movement of agricultural produce</li> </ul>
Institutions and capacities	<ul style="list-style-type: none"> <li>• Effective implementation of a national program through institutional mechanisms</li> <li>• Capacities for maintenance of solarpumpsets</li> </ul>			

## 7 Ways Forward

Strategies planned for the future

### Short-term

- The key issues and challenges being faced by the state demand immediate attention in order to ensure sustainable development of the agricultural sector in the coming years. In this regard, initiatives such as water mission, agriculture mission, green mission, sustainable habitat, solar mission and mission on enhanced energy efficiency have been introduced in the Punjab where in the state aims to achieve a set of targets, remedying the key issues faced by the state at present for a sustainable growth by 2020.
- The government plans to change the current cropping pattern in the coming years and hence is promoting crop diversification programmes on a large scale. The government at present plans to divert 5% area under paddy i.e. 140 thousand hectare area to other

crops. The major focus is on reducing area under paddy as well as wheat and growing locally suitable alternate crops such as maize, soybean, groundnut, arhar, moong, vegetables, millet, cotton, sugarcane etc. Increasing the area under horticultural crops is also being promoted. In places with water logging problems trees like Eucalyptus having higher evapotranspiration rate are being encouraged. Also provisions for minimum support price on crops other than wheat and paddy are being made.

- Awareness programmes planned to promote formation of farmer co-operatives amongst medium, small and marginal farmers so as to reduce the input costs, maximize productivity and increase farm incomes.
- Introduction of Agriculture Market Intelligence Cell within the Department of Agriculture which would regulate the production systems every year in accordance with the market demands. Additionally the Cell would provide information on markets available domestically and internationally to the farmers and constantly monitor prices of agricultural/horticultural crops and farm animal products in the national and international market so as to advise the farmers accordingly.
- Improvement of the Public Distribution Systems and the existing storage capacity in order to accommodate the surplus grains. Also in order to evade the waste of agriculture produce, undertake value addition activities which consume the leftover grains and convert them to other processed foods including biscuits, chips, paper etc.
- To promote conservation of soil, water and energy resources through promotion of integrated nutrient management in soils, installation of automatic weather stations, ensuring the continuance of preservation of sub soil water policy, promotion of less water intensive basmati rice, direct seeding in moist soil and promotion of rice cultivars for water logged areas.
- Proper management of agricultural crop residue which requires actions including promotion of crop diversification so as to produce less wheat and paddy straw, encouragement of straw mulching practices, providing machinery to tackle the problems of wheat or paddy straw like rotavator, happy seeder or zero till drill at subsidized prices, setting up of agriculture machinery service centers, promoting biomass power plants in order to use up the excess agriculture residue, organization of awareness campaigns explaining farmers the ill effects of burning straw.
- Establishment of agro processing units in rural sector.
- Pest, weed and disease management in crops through development of integrated pest, weed and disease management packages, mapping of pests and diseases already present in various crops, development of weather based pest and disease early warning system and monitoring of pests and diseases through e-pest surveillance GPS based devices.
- Generate energy from livestock manure by promotion of biogas plants for generation of electricity using dairy farm waste and mandatory installation of biogas plants for farmers with more than 4 hectare land or more than 5 animals which can be used for milking.

- Management of livestock health through mapping of the already existing disease profile for several livestock, development of advance warning systems to tackle pest and disease attacks and development of integrated pest and disease management packages which would encompass advance warning systems, preventive measures, remedial measure etc.
- Ensuring there is adequate livestock feed, development of new fodder seed varieties and encouragement of mechanization in cultivation of fodder to lower the costs.
- Sustainable fish production through renovation and rehabilitation of ponds, development of new ponds and tanks in saline affected areas, supplying of quality fish seeds and increasing multiple use of water.
- Formation of a State Water Policy for integrated water resource management at basin level in order to conserve water, ensure equitable distribution and minimize wastage. Ensuring through the policy regular monitoring of ground water, water use efficiency, creating provisions for preventing excess irrigation, providing water meters to all the households etc.
- A good strategy to improve the quality and quantum of power supply to agriculture would be introduction of feeder segregation, which has particularly been successful in Gujarat (Shah, et.al, 2008)
- In order to maintain the already existing forests and increasing forest & tree cover the state has started working on Green Punjab Mission under which the state aims to increase the area under tree and forest cover to 15% by 2022 (SAPCC - Punjab, 2014) and enhance the forest density in the already existing forest by bringing the forests under moderately open forests and open forests categories to dense forests category.
- Management of ground water resources through monitoring and metering ground water extraction, augmenting ground water levels in critical and semi critical areas, enhancement of surface water structures in order to accommodate excess rainfall and runoff, conservation of wastelands in the state, enhancing water use efficiency by almost 20%, management of floods, tackle water logging especially in south west districts of the state and take measures to reduce water pollution.
- Promotion of Laser land leveling to conserve irrigation water. Provisions for 50% assistance on micro irrigation system like drip and sprinkler in general and 60% assistance on micro irrigation scheme to small and marginal farmers.

**Table 8:** Cost implications for various strategies formulated

(Rs in Crore)

	12th plan (2012-2017)	13th plan (2017-2022)	Total Cost
Crop Diversification	5045	5080	10125
Farmer Cooperatives	5.5	-	5.5
Agriculture Market Intelligence Cell	5	5	10
Improve Storage capacity & PDS; promote value addition activities	224	225	450
Conservation of soil, water and energy resources	1400	1750	3150
Pest, Weed and Disease Management	15	5	20
Crop Residue Management	137	137	274
Energy from Livestock Manure	233	281	514
Livestock Health Management	20	10	30
Adequate Livestock Feed	131	125	156
Fisheries Management	46	47	93
Water Management	775	1859	2634
Upgradation of Surface Water Structures	1928	3573	5501
Enhancing Water Use Efficiency	290	3525	3815
Flood Management	63	150	213
Water Logging Management	1970	330	2300
Reduction of Water Pollution	3500	3500	7000
Forest Cover Enhancement	2654	3091	5745
Improving Energy Efficiency	1869	1866	3735

**Source:** Punjab State Action Plan on Climate Change, 2012

### Mid-term

- Development of water harvesting structures so as to constantly recharge the ground water resources and maintain ground water levels.
- Maintenance of canal network to reduce dependence on tubewell irrigation.
- Financially support crop diversification alternatives like providing M.S.P. of crops other than rice and wheat, initial support for venturing into pisciculture or bee keeping or floriculture etc.
- Promotion of agro-forestry practices on large scale so as to shift from wheat-rice regime.
- Develop a strong network of wood mandi's all across the state, where the farmers can sell agro-forestry produce at fair prices.
- Slowly phase out agricultural subsidies one at a time.
- Promotion of drought resistant crops suitable for growing Punjab and which are economically viable.

- Promote organic farming and provide assistance to farmers.
- Increase area under forest and tree cover to 15%.

### **Long-term**

- Ambitious research and development, training and capacity building programs
- Maintenance of canal network to make it more reliable and reduce the dependence of farmers on tubewells and shift towards canal irrigation.
- Completely phase out agricultural subsidies.
- Development and maintenance of crop storage structures and cold storages
- Maintenance of water harvesting structures
- Emphasis on development options for agriculture in accordance to climate change adaptation plans and constant convergence and exchange of knowledge between climate science community and farmer community.
- Adaptation of new crop species or hybrids in agreement to the changed climate scenario.
- Increase area under forest and tree cover to 20%.

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