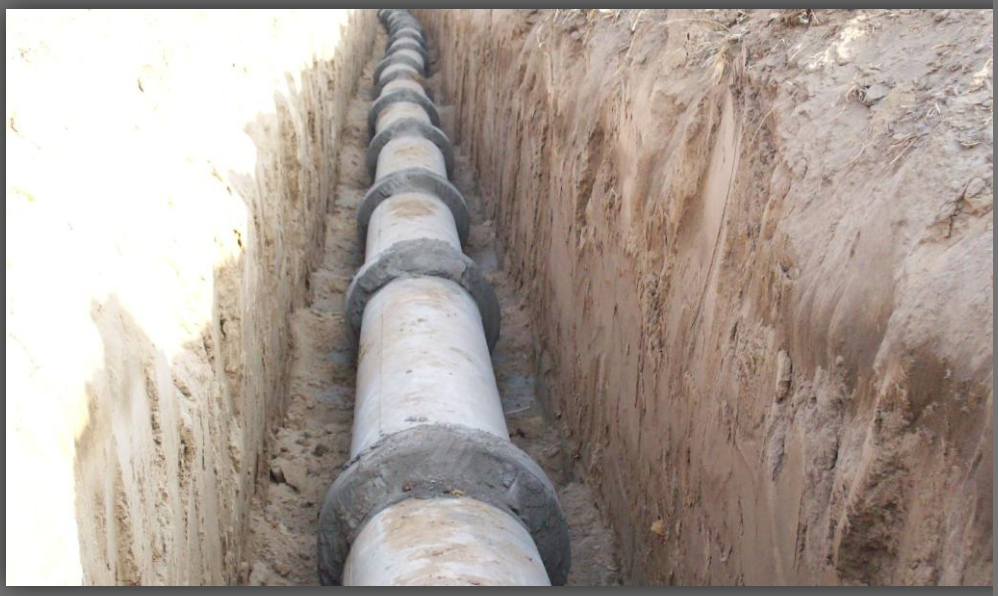
2015

IMPACT EVALUATION STUDY OF PROJECTS FOR CONSERVATION OF IRRIGATION WATER THROUGH UNDERGROUND PIPELINE SYSTEM

UNDER

RASHTRIYA KRISHI VIKAS YOJANA (RKVY)



Conducted by:

ICAR - Indian Institute of Soil and Water Conservation
(Formerly CSWCRTI)

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Executive Summary

The Indian Institute of Soil and Water Conservation (IISWC) Research Centre Chandigarh has undertaken the consultancy project on "Impact evaluation study of projects for conservation of irrigation water through underground pipelines" executed under *Rashtriya Krishi Vikas Yojana* (RKVY) by Department of Soil and Water Conservation, Punjab from 2007-08 to 2013-14

474 households of 105 villages in 16 districts were selected for sample survey. Consultants visited all the selected villages between October 2014 to April 2015 and survey formats were filled up after interviewing the beneficiaries. After introduction of RKVY 61% irrigated area came under UGPS and 86.2% rain fed area also got irrigation. With the use of UGPS about 100 sq.m land per ha was saved and 2750 cu.m /ha water was saved per year in rice-wheat system. This resulted in increase of wheat and rice yield by 3 and 3.8 quintals respectively. Conjunctive use of water (saline tube well water + canal water) in areas having brackish underground water, resulted in increase in area of paddy and wheat crops by 29 and 31% respectively. However, area under maize and cotton decreased by 18.4 and 16.6 % respectively as due to availability of assured source of irrigation water, farmers shifted to other more remunerative crops. After the project, per capita income per annum increased by 57%, mainly because of increase in area under irrigation and availability of good quality irrigation water in saline water table zones. Increase in per capita income is also attributed to the fact that availability of both dry and green fodder increased after the project, which allowed farmers to expand their livestock. As a result not only there was increase of cattle population, some farmers also purchased cattle of better breeds, resulting in overall increase of milk production by 39% in the project areas.

Besides contributing in upliftment of agriculture and socio-economic conditions of farmers, the underground pipeline is helpful in arresting declining ground water table of the State, as during study farmers informed that they are drawing less water as due to laying of UGPS fields are getting irrigated is shorter period of time. On the contrary in waterlogged areas of south-western districts, the underground pipeline has proved

helpful in checking the rising water table, as earlier farmers were not using tubewell water because of its saline nature but after laying of UGPS from canals farmers are using tubewell water also in conjunction with water from canals.

Water Harvesting Structures, Recharging structures, check dams, etc constructed by Department under RKVY in the kandi area of the State has not only helped bring degraded lands under agriculture but has also contributed in recharging of ground water, providing life saving irrigation and checking of soil erosion

Given the benefits these projects need to be promoted further. The activity, especially the laying underground pipe line both at community and individual level, needs to given a special thrust as there are large number of farmers wanting to avail this system. Special emphasis needs to be given to south-western districts of the State for promotion of conjunctive use of water through underground pipelines. While laying UGPS farmer need to be motivated for crop diversification as lot of water is needed for wheat-rice system which can be reduced with alternate cropping system like pulses and oilseeds

Consultants rate the projects undertaken and work executed by Department of Soil and Water Conservation, Punjab under RKVY as **excellent.**

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1. INTRODUCTION

The Punjab state is spread over an area of 5.036 million hectare, which constitutes 1.54% of total area of country and little over 2 per cent of the total population in the country. The economy of the state is primarily agro based. 4.268 m ha area of the total area of the State is under cultivation and commonly referred to as Bread Basket of India. It is the largest contributor of wheat (around 55 per cent) and second largest of paddy (around 42 per cent) to the central pool of the country. Punjab has one of the most fertile resources in India. Traditionally wheat-maize-cotton was grown in the State but with advent of green revolution coupled with intensive irrigation infrastructure created during the 1970's, cropping pattern was diversified. Paddy-wheat cycle became the major crop cycle of the state along with other crops like sugarcane, cotton, horticulture and vegetables started to be grown in the State. The State contributes 10.26% of India's cotton, 19.5% of India's wheat, and 11% of India's rice production. The Fazilka and Ferozepur Districts are the largest producers of wheat and rice in the state.

Green revolution sustained very well till the nineties but after that agriculture growth in the state started showing signs of stagnation. Due to over exploitation of water resources especially the ground water resources, following of same cropping pattern year after year and intensive use of fertilizers and pesticides brought soil and water resources of the state under tremendous stress. The soils in the state of Punjab are facing severe degradation, with about 39% of soils suffering various forms of degradation in form of losing fertility, salt accumulation and erosion. The stress in case of water resources is more serious and has created a near crisis like situation in the State, on one hand vast area of the State is facing depletion of ground water while on other there is severe problem of rising water table. The total water resources available in state are 3.1 million hectare meter, of which surface canals provide 1.45 million hectare meter and ground water recharge (rains and canal seepage) provides 1.68 million hectare meter of water. The demand of water for agricultural purposes is 4.37 million hectare meter and the excess demand of 1.24 million hectare meter is met through over-exploitation of ground water resources. Though there is not much change witnessed in the last few years in the surface water resources, the underground water resources have deteriorated to a large extent especially attributed to continuous following of Paddy-wheat cycle by farmers of the State. There were only 1.92 lac shallow tube wells in the State, during the year 1970, which increased to 6.00 lac in 1980, and presently there are more than 11 lacs tube wells in the state.

The replenishment of ground water resources has also decreased as rainfall which was major source for irrigation and subsequent recharging of ground water has also shown a declining graph over the years owing to climate change impacts. A study on rainfall anomaly of Punjab indicates that average rainfall of Punjab has decreased after 1997 and maximum anomaly reached up to 30%. Average annual rainfall in Punjab's sub mountainous zone i.e. the Shivaliks is 960 mm and in other parts, it is 460mm.

The ground water in Punjab is declining at an average rate of 20-30 cm per year. It is declining in 80% area of the state, where ground water quality is good and canal water supply is limited. The worst-hit districts in terms of declining water table are are SBS Nagar, Jalandhar, Kapurthala, Moga, Patiala, Ropar, Fatehgarh Sahib, Sangrur, Mansa, Bathinda, Hoshiarpur, Gurdaspur and Amritsar. There is about 14 per cent area where ground water level is rising owing to less extraction of ground water because of its brackish quality, which is unfit for use for both domestic and irrigation purposes. Rising water table area lies in Mansa, Moga, Bathinda, Sri Muktsar Sahib, Faridkot and Ferozepur districts, where the water level has gone up. In general the water level in the state ranges from 0.20 meter below ground level (bgl) in Ferozepur district to 32.28 meters bgl in Fatehgarh Sahib district.

The Department of Soil and Water Conservation, Punjab has been entrusted with the mandate of conservation and management of soil and water resources of the State. Since 1969 the Department has been implementing various programmes for soil and water conservation i.e. Construction of rain water harvesting and recharging structures, underground pipeline systems (UGPS), Drip Irrigation, Land leveling including laser leveling, Bench Terracing, Contour bunding, Gully Reclamation, Wasteland development, Watershed Management, Tapping of Hill Seepage, Lift irrigation schemes, Field Drainage, etc. All these measures have not only benefitted 7.47 lac hectares land but also are saving approx. 329 Million Cubic Meters (MCM) of water every year. For conservation of water resources Department lays major stress on improvement of on-farm irrigation water conveyance system as this system has proved to be by the far most effective method for reducing stress on ground water resources of the State. The system not only minimizes evaporation and seepage losses from field channel, but also reduces labour costs accrued maintenance of open channels besides providing farmers additional land for agriculture. The underground pipelines schemes have been promoted by providing incentives in term of subsidy to the farmers by the Department

Besides the improvement in efficiency of on farm water conveyance, other major challenge is providing safe irrigation water in south-western districts of the State which are affected by serious problem of salinity and sodicity in underground water. The underground water of this area cannot be utilized for irrigation as it is not fit for agriculture purposes unless salinity and sodicity in the water are brought to tolerable levels by mixing it with fresh or sweet water. In these areas irrigation water is being supplied to farmer's fields by conjunction of sweet water from canal outlets and brackish underground water through underground pipeline system. In many parts of these areas water is brought through UGPS from canals to farm tanks of farmers for further use in irrigation. This has been by the far most proven to be most effective exercise for providing safe irrigation water in salt affected areas.

Rashtriya Krishi Vikas Yojana

Agricultural sector showed a growth rate of 3.16 percent GDP during 1990-91 to 1995-96. These trends caused a serious concerned and this happened due to the fact that agricultural productivity in most of the states was quite low as it were, and the potential for the growth of agriculture was high, concerned by the slow growth in the agriculture and allied sectors, the National Development Council (NDC), constituted various groups to search for the probable causes of such stagnation. These reports were reviewed the Ministry of Agriculture and subsequently NDC in its meeting held on 29 May, 2007 resolved that a special additional Central Assistance Scheme (RKVY) was launched. The theme was to rejuvenate the agricultural sector with a booster dose of investment, across board and correct the planning process at the sub state level.

Objectives of RKVY

The RKVY aims at achieving 4% annual growth in the agriculture sector during the XI plan period, by ensuring a holistic development of Agriculture and allied sectors. The main objectives of the scheme are:

- To provide incentives to the states as to increase public investment in Agriculture and allied sectors.
- To provide flexibility and autonomy to states in the process of planning and executing Agriculture and allied sector schemes.
- To ensure the preparation of agriculture plans for the districts and the states based on agro-climatic conditions, availability of technology and natural resources.

- To ensure that the local needs/crops/priorities are better reflected in the agricultural plans of the states.
- To achieve the goal of reducing the yield gaps in important crops, through focused interventions.
- To maximize returns to the farmers in Agriculture and allied sectors
- To bring about quantifiable changes in the production and productivity of various components of Agriculture and allied sectors by addressing them in a holistic manner

RKVY Programme in Department of Soil and Water Conservation, Punjab

The projects under Rashtriya Krishi Vikas Yojana are being implemented by the Department in the State since 2007-08. Under this scheme, more than 1000 projects of Efficient Conveyance of irrigation water through Community Underground Pipeline System and Rainwater Harvesting/Recharging Structures have been constructed benefiting 42,386 hectares and 44,194 beneficiaries till 2012-13. The number of beneficiaries of individual projects executed in 18 districts over a period of last 6 years varies from 5 to 500. In view of the acute shortage of water in the region, soil and water conservation measures also include water resource development by increasing irrigation efficiency. Department of Punjab soil and water conservation has benefitted 55065 ha area by spending Rs.1427.7 million from 2007-08 to 2012-13. Special emphasis on underground pipeline scheme is given to south western districts of the State because of the fact that underground water in this part of the state is not fit for irrigation purposes and most of the farmers rely on canal water which they have to ferry over long distances for their agricultural related needs.

The Department is implementing following projects under RKVY

Sr. No.	Names of the Project under RKVY
1.	Conservation of Irrigation Water through Underground Pipeline System
2.	Construction of Water Harvesting/Recharging Structures

Objective of Department's RKVY Projects

- Increasing irrigation water use efficiency for agriculture; minimizing evaporation and seepage losses in irrigation water conveyance systems thereby reducing the water demand which inturn lessens stress on ground and surface water resources of the State.
- Providing assured source of irrigation especially for farmers at tail end of canal system and for farmers in the rainfed area

- Conjunctive use of sweet water with salt affected water shall reduce the salt accumulation, especially in the south-western part of the State.
- Saving of precious agriculture land by laying of underground conveyance system
- Increase in yield / production by bringing more area under irrigation systems
- Water recharging for augumenting ground water resources of the State
- Upliftment of socio-economic status of farming community

Aim of Evaluation Study

During the year 2014, IISWC, Research Centre Chandigarh was selected as third part for study on impact evaluation of project on socio economic condition of people with an outlay of Rs.9,01148. The major aim of study was to carry out impact evaluation study of underground pipe line system and soil conservation works executed under Rashtriya Krishi Vikas Yojna (RKVY) in Punjab on the basis of visits, surveys and basic input data on sample basis in the representative area for the year 2007-08 to 2012-13

The Major objectives of Study were

1. To examine the various activities implemented by Department.
2. To study the impact of Underground Pipeline for irrigation purposes
3. To study the socio-economic profile of farmers pre and post project.
4. To find out the opinion of the farmers regarding the implementation of projects.
5. To document the success stories and best practices which can be useful for replication
6. To suggest the strategies for future improvement in the programme.

Study Period

The monitoring and evaluation was conducted by covering all the districts within seven-month period during September 2014 to April, 2015 by a team of evaluation experts from ICAR (CSWCRTI)

Government of Punjab, therefore, provides 90% of the total cost of the project under RKVY for laying UGPS in the state. Further, taking note of the poor economic condition of farmers in the region, the labour work is allowed to be done by the farmers themselves on community basis in lieu of their 10% share.

2. METHODOLOGY OF EVALUATION STUDY

The evaluation study was conducted in 16 districts of Punjab following the methodology described below.

2.1 Sampling Procedure

In order to carry out impact evaluation study of projects for conservation of irrigation water through underground pipeline executed under Rashtriya Krishi Vikas Yojana (RKVY) in Punjab, 105 villages from sixteen districts of Punjab, wherein the projects have been executed were selected (No. of villages surveyed in given in Table 1). 474 households (about 10%) were randomly selected in these villages and these farmers were interviewed by team of consultants. The interview schedule was prepared and used for the study. Interview method was one of the prominent methods employed for data collection. Interview schedule included a detailed nine page performa prepared by experts on various aspects regarding pre and post project status of agriculture and others socio economic conditions. The information was physically entered into these by the interviewing consultants. One copy of such performa is enclosed as Annexure-1. All the information from field was compiled and a master sheet was prepared. From master sheet small tables were extracted as per the requirement and defined parameters. Out of 474 farmers, 454 farmers were from plain area and 20 farmers from kandi region. In kandi region the project regarding construction of water harvesting structures under the scheme was studied.

Table 1. District wise number of villages surveyed under RKVY

Sl.No.	District	No. of surveyed villages	No. of households interviewed
1	Muktsar	21	60
2	Ferozepur	2	6
3	Patiala	16	94
4	Sangrur	12	54
5	Gurdaspur	4	14
6	Bhatinda	6	57
7	Faridkot	3	19
8	Mansa	1	15
9	Tarantaran	2	17
10	Fazilka	15	44
11	Moga	2	26
12	Barnala	8	22
13	Mohali	3	9
14	Ropar	4	15
15	Hoshiarpur	3	16
16	Pathankot	3	6

2.2 Team of Experts for evaluation

The Indian Institute of Soil and Water Conservation (IISWC) Research Centre Chandigarh has undertaken the consultancy project on "Impact evaluation study of projects for Conservation of Irrigation Wate"r executed under *Rashtriya Krishi Vikas Yojna* (RKVY). The following experts from institute were involved in evaluation work:-

S.No.	Name and Designation of Consultants
1	Dr. V.K. Bhatt, Pr. Scientist (Engg.) - PI
2	Dr. S.L.Arya, Pr. Scientist (Econ.)
3	Dr. A.K.Tiwari, Pr.Scientist (Engg.) and Head
4	Dr. R.P.Yadav, Pr. Scientist (Soils)
5	Dr. Pankaj Panwar, Sr. Scientist (Forestry)
6	Dr. Sharmistha Pal, Scientist (Soils)
7	Sh. Surinder Singh, Chief Technical Officer
8	Sh. Rammurti, Astt. Chief Technical Officer
9	Sh. A.K. Nitant, Sr. Technical Officer
10	Sh. Basudeb, Technical Officer
11	Sh. A.N. Gupta, STA

2.4 Focus Group Discussions (FGD) and Participatory tools

An interview guide and check lists were prepared for FGDs. It was mainly centered on awareness knowledge, skills, adoption, opinion, implementation process and constraints, sustainability and follow-up strategies. In addition, other participatory techniques like transact walk, problem analysis etc were used. The highlights of the study FGDs were used not only by the data collectors but primarily by the team of monitoring and evaluation expert staff of ICAR to generate additional data as well as to cross check the validity of data collected through questionnaires.

2.5 Field Visits and Objectives

The evaluation team also visited the farmer's fields to have the firsthand knowledge about the impact of interventions under the project. During this process, discussions with non-beneficiaries were carried out for comparison purposes.

2.6. Secondary Data

The data for some of the variables was captured through secondary data mainly obtained from Head office or Divisional offices of the Department.

2.5 Laboratory Analysis

Irrigation water samples mainly from Patiala district were collected for analysis of irrigation water quality on various parameters.

Glimpses of Evaluation Team Visits

Pic: Evaluation team with Department officers on field visit in Distt: Patiala

Pic: Dr. AK Tiwari IISWC, Chandigarh Head in consultation with farmers

Pic: Evaluation team interviewing beneficiary farmers

Pic: Focused Group Discussion session with farmers

3. RESULTS AND DISCUSSIONS

Presently water application efficiency through surface irrigation is about 30 to 35% and approximately 1 million ha water is lost in evapo-transpiration in the open conveyance channels which are by & large unlined. Apart from it, approximately 10 thousand hectares of land surface is covered by earthen channels. In order to sustain and conserve water resources, there is an immediate need to increase water use efficiency by replacing open earthen or masonry irrigation channels with underground pipeline system (UGPS). UGPS can be used for conveyance of irrigation water either by gravity or through pumping from any available water source viz. canal, tubewell, pond etc.

UGPS minimizes water losses during conveyance from water bodies to farmers' field. Further, maintenance of irrigation channels is a big problem particularly during paddy growing season when weed intensity is at peak. By creating underground water conveyance system, the land otherwise lost in construction of open irrigation channels can be effectively brought under cultivation.

Underground Pipeline System (UGPS) not only save 15-25% of water, power & labour but also about 1% of land. There was a persistent demand among farmers for subsidy on Underground Pipeline System (UGPS) in all districts of the state. Different schemes are being implemented by the Department for laying of RCC/PVC Underground Pipe Line System (UGPS) on the agricultural fields by providing subsidy of 50 and 90% depending upon the criteria of individual or group of farmers respectively in all districts of the state. These pipes are generally laid at depth ranging from 0.75m to 0.90m, depending upon the soil structure and diameter of pipeline to be laid and are directly connected to the water source thereby minimizing water losses. Farmer also saves on electricity and fuel costs due to high velocity of water flow because of lower friction losses in UGPS, which means that lesser time is required to irrigate fields in comparison to open channels.

3.1 Demographic Data of sample Area

3.1.1 Climate

Punjab's climate is characterized by extreme hot and extreme cold conditions. Annual temperatures in Punjab range from 1 °C to 46 °C (min/max), but can reach 49 °C in summer and 0 °C in winter. The northeast area lying near the foothills of the Himalayas receives heavy rainfall, whereas the area lying further south and west receives less rainfall and experiences

higher temperatures. Average annual rainfall ranges between 960 mm in the Shivaik region and 460 mm in the plains.Punjab has three seasons:

- Summer (April to June), when temperature typically rise as high as 49°C.
- Monsoon season (July to September), when the majority of rainfall occurs.
- Winter (December to February), when temperatures typically fall as low as 0 °C.

Punjab is experiencing impact of climate change for last two decades. Long term rainfall analysis of state shows anomaly of - 45% (Fig. 1).This indicates decreasing trend of rainfall in the state. Decreasing trend of rainfall has resulted in more pressure on exploitation of ground water (Fig.2). Similarly, there has been a reduction of over 28 per cent in the canal irrigation area since 1993-94 (Fig.2). This is because only 35-40 per cent of the water entering the canal system reaches the cultivated fields. Normally the optimum efficiency for canal irrigation is 60 per cent.

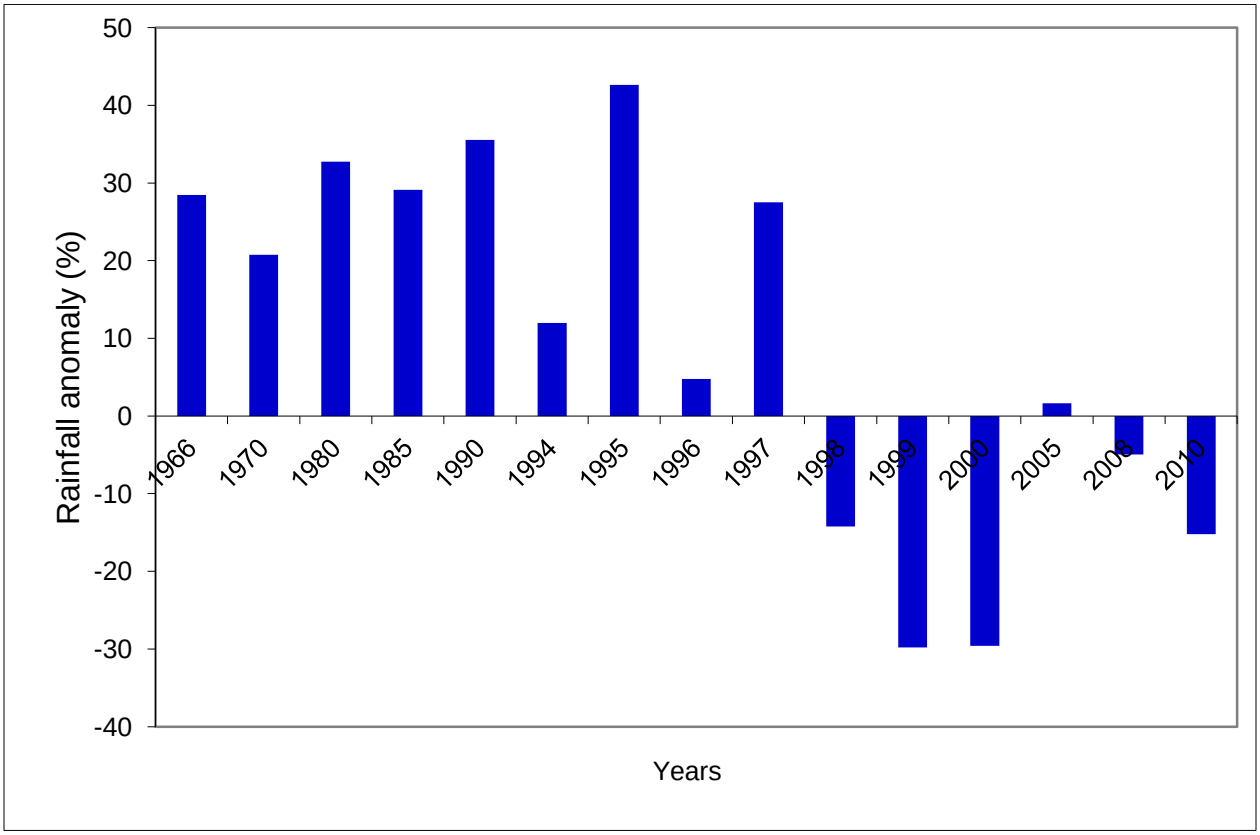

Fig.1: Anomalies in annual rainfall-Punjab

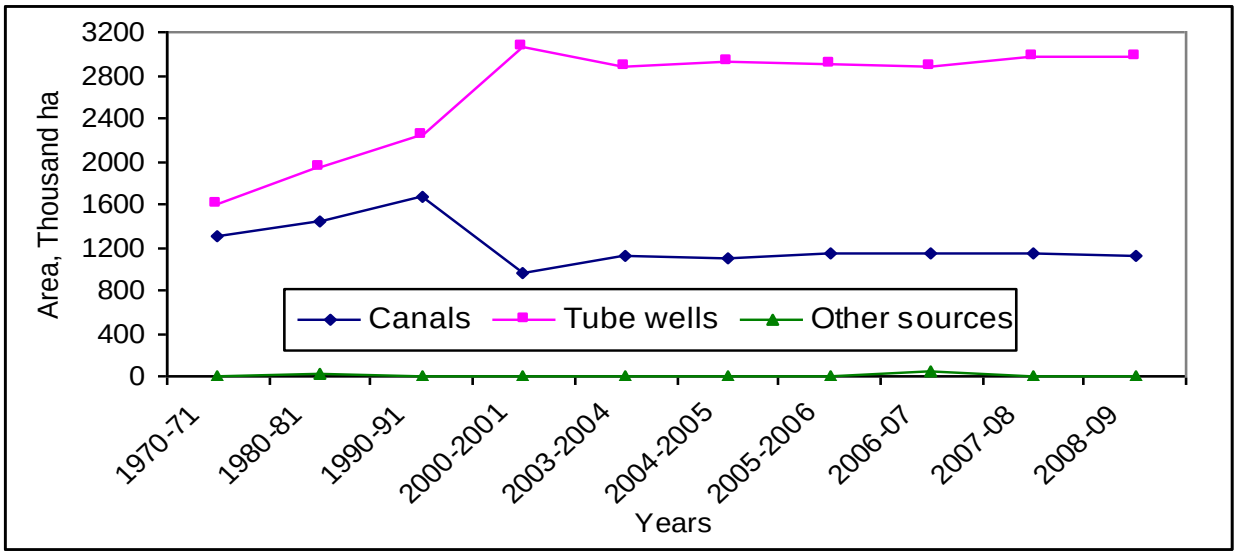

Fig.2 Area irrigated by canal and tube wells in Punjab

3.1.2 Loss of water from earthen channels

The agriculture sector is the largest consumer of water resources in India. Assured supply of water is necessary for sustainable agriculture. But, most of the farmers of our country are applying water in unscientific way to their fields which results in poor level of utilization of water at the farmer's field. The same practice is prevalent in the State of Punjab wherein the farmers are mainly using open channels for irrigation purposes. Due to conveyance of irrigation water by open channels, water use efficiencies are also quite low. Most of irrigation projects operate at a low efficiency in the range 30–40%, thereby losing 60–70% of irrigation water during conveyance and application. Thus precious water is being wasted between application and conveyance. Due to high losses of water not only crop health suffers as lesser water is available for irrigation purposes but it also creating additional stress on already diminishing water resources of the State.

Kaur et.al (2009) calculated seepage losses by measuring discharges at different locations on the tubewell as well as canal irrigation channels using a digital pygmymeter in one village of Patiala and one in Faridkot. They observed that percentage of seepage loss per 100 m length of channel in Ramgarh (Distt. Patiala) was in range 10 to 28 and in village Bargari (Faridkot) it was in the range 5–8. The high seepage losses in Ramgarh were due to unlined field channels and due to light textured sandy loam soil.

It has well documented that considerable quantity of water is lost by way of evaporation and seepage from the open irrigation channels. Under this project earthen/masonry field channels were replaced by UGPS which helped in increasing irrigation water conveyance efficiency. Also in accordance with majority of cropping pattern prevalent in the State for which flood irrigation method is mainly used, the underground pipeline system is most suitable technique that can be adopted in tandem.

3.1.3 Household Profile

The profile of sample households visited/surveyed during the evaluation study has been presented in Table 2 as per the category of work carried out under the project. In all 474 households were surveyed comprising 2538 individuals. The average family size was 5.35 ranging from 5.29 to 6.05 of the surveyed households, 93.5 percent households were studied under project for conservation of irrigation water through underground pipeline system and. 6.5 percent households were studied under the project of construction of water harvesting/recharging structures in kandi area UGPS The average size of land holding of surveyed households was reported as 4.38ha ranging from 2.48 to 5.12 ha.

Table 2.Family Details of surveyed households

S.No.	Name of the Projects	No. of families	Male	Female	Children	Total	Family Size	Av. size of land holding (ha)
1	Conservation of Irrigation Water through UGPS	443 (93.5%)	912	806	656	2374	5.55	4.07
2	Water Harvesting/Recharging Structures	31(6.5%)	63	59	42	164	5.29	2.48
Total		**474**	**975**	**865**	**698**	**2538**	**5.35**	**4.38**

3.2. Evaluation Results

3.2.1 Increase in area under irrigation through UGPS

The project for Conservation of Irrigation Water through underground pipeline had a good impact in terms of increase in area under irrigation. The tail ends of the canal system which rarely received water, got sufficient supply of irrigation water due to laying of underground pipelines. The underground pipelines in some of the projects stretch over 5 kms. Similarly the rainfed areas in kandi belt of the state got life saving irrigation facility due to construction of water harvesting structures and laying of underground pipelines from these structures. These structures also contributed in recharge of underground water. Of the total cultivated area of 2080.6 ha with the 474 households, 73 percent was found to be irrigated through tube wells before the laying of underground water pipeline and the rest 27% was reported to be rain fed (Table 3). After the implementation of the scheme, tube well irrigated area decreased by 35.2 percent. Also there 86 percent in rain fed area came under irrigation. At present 61 percent of the total area under cultivation is being irrigated with UGPS system.

Pic: Water lifted from canal being pumped into pumpstand for conveyance through UGPS

Table 3. Work wise area in ha in different head before and after the project

S. No.	Name of Project	Before project				After project				Percent change	
		Irrigation through tube well (ha)	Irrigation through UGPS (ha)	Rain fed Area (ha)	Total area (ha)	Irrigation through Tube well (ha)	Irrigation though UGPS (ha)	Rain fed area (ha)	Total area (ha)	Area increased under UGPS	Rain fed area covered under irrigation
1	Conservation of Irrigation Water through UGPS	1488.34	0	515.24	2003.6	699.2	1247	57.4	2003.6	62.24	90.30
2	Water Harvesting/Recharging Structures	21.4	0	55.6	77	32.6	22.8	21.6	77	29.6	61.1
Total:		**1509.74**	**0**	**570.86**	**2080.6**	**731.8**	**1269.8**	**79**	**2080.6**	**61**	**86.16**

3.2.2 Change in Area under crops

Cropping pattern all over the State is dependent upon availability and type of irrigation facilities available to the farmer. The traditional methods of irrigation especially in water scare areas of the State such as kandi area or tail ends of canal systems leave a little opportunity for farmers to grow crops prevalent in other parts of the State as former area is mainly dependent on rains for agriculture and in latter canal water used for irrigation rarely reaches agricultural fields. It was good to observe that for implementation of projects, Department of Soil and Water Conservation also laid major stress on these two regions. Interventions such as water harvesting structures provided life saving irrigation in kandi area whereas underground pipeline helped farmers at tail ends of canals regarding conveyance of water over distances to their fields. Implementation of project revealed that total area under kharif crops increased by 6.57 percent. Crop wise results revealed that area under maize, chari and cotton crops reduced by 22.9, 24.86 and 43.01 percent respectively whereas total area under paddy increased by 29.76 percent (Table 4). It is worth mentioning, before the facts are placed for change in cropping pattern due to implementation of irrigation project that in Punjab; wherever sufficient water is available, farmers adopt crop cycle which provide assured returns. Because of implementation of underground pipeline projects by Department, area under maize or other crops during kharif season decreased in plains of the State whereas it has increased in kandi area of the State. This is mainly attributed to the fact that due to availability of assured irrigation water, farmers in plains shifted to cultivation of paddy, which is much more remunerative crop than maize or other crops. Farming activity in kandi area of the State was very limited as it is predominately a rainfed area and irrigation of crops was dependent on rains but after soil and water conservation activities under the project mainly, construction of water harvesting structures along with underground pipeline not only recharged ground water but also helped provide irrigation facilities for agriculture and because of this farmers in the region adopted crops such as maize or other crops along with wheat in the region. After implementation of UGPS, water availability increased, hence water was diverted towards growing of paddy crop. Due to implementation of project especially the underground pipeline projects in plains, the impact of improved and assured irrigation facilities was also felt in change of cropping pattern during rabi season also as because of availability of good irrigation facilities, the area under both wheat and *barseem* crops(primary fodder crop) increased by 17.22 and 9.32 percent respectively, resulting in increase in total area by 16.65 percent (Table 5).

Table 4. Crop wise % increase/decrease in area in *kharif,* ha

S.	Name of Project	Maize		% Increase /Decrease	Paddy		% Increase /Decrease	Chari		% Increase/Decrease	Cotton		% Increase /Decrease	Total Area		% Increase /Decrease
		Before	After		Before	After		Before	After		Before	After		Before	After	
1	Conservation of Irrigation Water through UGPS	48.8	25.4	(-)52.05	1205.2	1564.2	(+)129.79	182	134.1	(-) 34.8	387.8	221	(-)56.99	1823.6	1944.7	6.64%
2	Water Harvesting/Recharging Structures	43.7	45.9	(+) 5.0	8	9	(+) 1.5	11.9	11.6	0	-	-	-	63.6	66.5	4.60%
	Total	92.5	71.3	22.9	1212.4	1573.2	(+)29.76	193.9	145.7	(-)24.86	387.8	221	(-)43.01	1887.2	2011.2	6.57%

Table 5. Crop wise % increase / decrease in area of *Rabi*, ha

S.No.	Name of Project	Wheat			Barseem			Total area		
		Before	After	%Increase / decrease	Before	After	%Increase / decrease	Before	After	%Increase / decrease
1	Conservation of Irrigation Water through UGPS	1432	1684.7	17.64	132.4	143.9	8.68	1564.4	1828.6	16.9
2	Water Harvesting/Recharging Structures	56.6	60.3	(+) 6.5	7.1	8.6	(+) 21.1	63.7	68.9	8.20%
	Total	1488.6	1745	17.22	139.5	152.5	9.32	1628.1	1899.3	16.65%

3.2.3. Saving of land

UGPS prevents water losses due to evaporation and seepage during conveyance from water bodies to outlets at farmers' fields. Further, maintenance of earthen irrigation channels was a bigger problem particularly during paddy growing season when weed intensity is very high. Farmers revealed that in field irrigation channels at least 1.00 m width of field is lost due to construction of earthen/masonry channels. By laying underground pipe line system, this additional land has been brought under cultivation which was otherwise lost on account of construction of open channels on surface of land. In most parts of the area visited by evaluation experts it was noticed that earthen channels are being used for conveyance of irrigation water, which meant that water loss on account of infiltration and evaporation were quite high along with these channels being prone to damage by livestock etc. Thus not only about 1% valuable agricultural land is saved with UGPS but water availability is also increased. Summary of some benefits of UGPS in the resurveyed area is given in Table 6.

Table 6. Saving of land, irrigation water and increase in yield due to UGPS

Sl.No.	Particulars	Total annual benefits per hectare
1	Land saving	100 sq.m
2	Saving of irrigation water during conveyance in rice-wheat system	@ 25% = 1100 to 2750 cu.m (according to interview with farmers total irrigation applied to wheat – paddy system = 11000 cum)
3	Increase in yield due to land saving and conjunctive use of water	Wheat: 3qtl Paddy:3.80 qtl

Pic: Open Channel: Wastage of Land and Weed Infestation

3.2.4 Increase in cropping intensity and crop production

Availability of irrigation facilities helped farmers grow more crops. Farmers at tail ends or in kandi region wherein mono culture was prevalent shifted to growing two to three crops per season due to assured irrigation facilities available. The south-western region having brackish underground water which is unfit for irrigation of crops recorded maximum jump in cropping intensity as with availability of good quality irrigation water, made possible by laying of pipelines from canal outlets, the farmers of the region started growing crops as prevalent in other parts of the State. The activity of using brackish underground water in conjunction with good quality canal water through underground pipelines provided a major thrust to agriculture in South-western region.

Overall there has been significant increase in crop productivity due to implementation of underground pipeline projects. The increase was 18.4% for maize, 25.5 percent for paddy 29.7 percent for *chari* and 16.6 percent for cotton crops during kharif season (Table 7). Maximum increase in maize yield was reported under renovation of ponds system whereas in case of paddy, 40 percent increase in yield per ha was reported under conjunctive irrigation through UGPS. Similarly, yield of wheat and *barseem* increased by 31.05 and 15.32percent respectively (Table 8). Consequently, cropping intensity increased from 169 to 188 percent (Table 9 and 10) after the implementation of scheme. Increase in cropping intensely is also due to more availability of water along with improved varieties of crops. Invariably, cropping intensity increased in all kinds of water management systems.

Table 7. % increase / decrease in yield of *kharif* crops, q/ha

S.No.	Name of Works	Maize			Paddy			Chari			Coton		
		Before	After	% Increase/ decrease	Before	After	%Increase / decrease	Before	After	%Increase / decrease	Before	After	%Increase / decrease
1	Conservation of Irrigation Water through UGPS	55.40	65.80	(+)18.77	123.00	160.70	(+)30.65	180.80	232.40	(+)28.54	51.00	59.50	(+)16.67
2	Water Harvesting/Recharging Structures	20.1	23.4	(+) 16.4	34.6	37.2	(+) 7.5	73	96.8	(+) 32.6	-	-	-
Total		**75.5**	**89.2**	**(+)18.4**	**157.6**	**197.9**	**(+)25.5**	**253.8**	**329.2**	**(+)29.7**	**51**	**59.5**	**(+)16.6**

Table 8. % increase / decrease yield of Rabi crops, q/ha

S.No.	Name of Works	Wheat		% increase / decrease	Barseem		% increase / decrease
		Before	After		Before	After	
1	Conservation of Irrigation Water through UGPS	110.3	147	(+)33.27	362.9	429.6	(+)18.38
2	Water Harvesting/Recharging Structures	28.8	35.3	(+) 22.5	118	125	(+) 5.9
Total		**139.1**	**182.3**	**(+)31.05**	**480.9**	**554.6**	**(+)15.32**

Table 9. Works wise Cropping intensity before project (%)

S.No.	Name of Works	Cropped Area				Cropping intensity (%)
		Total Cultivated Area (ha)	*Kharif*	*Rabi*	Total Cropped Area	
1	Conservation of Irrigation Water through UGPS	2003.6	1823.6	1564.4	3388	170
2	Water Harvesting/Recharging Structures	77	63.6	63.7	127.3	165
Total		**2080.6**	**1887.2**	**1628.1**	**3515.3**	**169**

Table 10. Works wise Cropping intensity after project (%)

S.No.	Name of Works	Cropped Area				Cropping intensity (%)
		Total Cultivated Area (ha)	Kharif	Rabi	Total Cropped Area	
1	Conservation of Irrigation Water through UGPS	2003.6	1944.7	1828.6	3773.3	190
2	Water Harvesting/Recharging Structures	77	66.5	68.9	135.4	176
Total		**2080.6**	**2011.2**	**1897.5**	**3908.7**	**188**

As a result of implementation of various scheme under RKVY area under irrigation as well as number and amount of irrigation increased which resulted in increased productivity. Productivity also increased due to improved agricultural practices and adoption of improved varieties of wheat and paddy. Total production of different crops before and after implementation of RKVY programme is given in Table 11. This table further indicates that production of paddy and wheat increased tremendously by 75 and 63 percent respectively after the project implementation. The results reveal that although the average yield of maize, cotton and *chari* increased per unit area but area under these crops reduced. The farmer preferred irrigated crops. Hence total production of maize, *chari* and cotton declined by 12, 37 and 11 percent respectively. As indicated earlier, area under *barseem* increased from 139 to 153 ha and overall green *barseem* fodder production increased from 86580 quintal to 108711 quintals showing an increase of 25.56 percent. Overall 32.69% increase in production taking all crops together was recorded.

Table11. Total area (ha) and production in (q) before and after project

Particulars	Before						
	Maize	Paddy	Chari	Cotton	Wheat	Barseem	Total
Area	92.5	1212.4	193.9	387.8	1486.6	139.5	3512.7
Total production	1794	49514	58131	7100	53459	86580	256578
	After						
Area	71.3	1573.2	145.7	221.0	1745.0	152.5	3908.7
Total production	1576	86633	51710	4523	87306	108711	340459
% increase/decrease in production	(-)12.15	+ 74.97%	(-) 11.04	(-)36.62	(+)63.31	(+)25.56	(+)32.69

3.2.5 Change in composition of cattle population.

In the previous section, it has been reported that yield of all crops food grain as well as of fodder increased after the implementation of UGPS. Increase in dry and green fodder availability from the fields enabled the benefitted households to bring about change in cattle population dynamics. The animal population (both cows and buffaloes) increased by 22 percent - which further resulted in increased milk production from cows by 52 percent and buffaloes by 35 percent (Table 12). Total annual milk production increased from 1925 thousand litres to 2677 thousand liters from 474 households. Per household milk production on daily basis increased from 11 liters to 15.4 liters.

Table 12. Work wise Cattle population and total production of milk (Lit / day)

S.No.	Name of work	BEFORE						AFTER					
		Cows			Buffaloes			Cows			Buffaloes		
		T	M	P	T	M	P	T	M	P	T	M	P
1	Conservation of Irrigation Water through UGPS	262	205	1475	951	714	4508	324	260	2134	1141	867	6163
2	Water Harvesting/Recharging Structures	25	18	107	63	60	327	52	41	269	67	58	359
	Total	287	223	1582	1014	774	4835	376	301	2403	1208	925	6522
				7.09 Lit/Day/Cow			6.2 Lit/Day/Buffalo			7.9 Lit/Day/Cow			7.0 Lit/Day/Buffalo
	Total Production, liters (300 Days)			474600Lit./Annum (A)			1450500 Lit./Annum (B)			720900 Lit./Annum (A)			1956600 Lit./Annum (B)
	Total, thousand liters A+B							**1925**		**52% Increase**	**2677**		**35% increase**

T –Total, M – Milking, P –Production, liters

3.2.6 Fodder availability and requirements

Fodder production and its utilization depend to a great extent upon cropping pattern, irrigation intensity and type of livestock. The dry fodder also increased due to increase in grain production. The dry fodder availability was estimated on the basis of crop residues and grain to straw ratio. Green fodder availability was estimated directly from fodder crops grown in the field like *barseem* and *chari*. Although the green fodder availability increased by 19.63 percent after the project but still the gap between requirement and availability increased by 2 percent. The gap could not come down after implementation of the programme due to increase in the number of cattle population. It can be inferred from the analysis that more area should be diverted to the production of green fodder crops. However, in case of dry fodder, gap between requirement and availability decreased by 14.5 percent (Table 13) but still there is lot of scope for increasing dry fodder production.

Table 13. Requirement, availability of Green Fodder, Dry fodder, tones/annum

Particulars	Before	After	% increase/decrease
	Green Fodder		
Requirement	13493	16688	23.67
Availability	8098	9688	19.63
Gap %	(-)39.9	41.9	2%
	Dry Fodder		
Requirement	4260	5195	21.94
Availability	6684	7399	10.69
Gap (%)	(+)56.9	42.4	14.5

3.2.7 Increase in income from Agriculture and animal husbandry sector

Net income from agriculture sector was worked out by deducting cost of cultivation of crops from the gross income from various crops as indicated in Table 14. A perusal of table revealed that net income from cultivated area per ha before the project implementation was Rs.35391/ha which increased to Rs.50464 (43 percent) after the project period. Similarly, income from animal husbandry sector was worked out taking as standard livestock unit. Net income per milking animal increased from Rs.31082 to Rs.38240 after the project thereby indicating increase by 23 percent. The net income per household increased from Rs.3,24,487 to 5,10,186 (Table 15) after the project per capita net income per annum increased by 57% from Rs.60602 to 95283.

Table14. Increase in Net income from Agriculture and animal husbandry sector

	Gross income, million Rs.	Cost of cultivation, million Rs.	Net income, million Rs.	Net income thousand/ha
From Agriculture				
Before	217.11	92.79	124.32	**35.39**
After	301.70	104.44	197.25	**50.46**
Livestock				
Before	53.00	23.42	29.59	**31.07**
After	73.12	28.54	44.58	**38.24**

Table 15. Income from Agriculture and animal husbandry

Particulars	**Before (Rs.)**	**After (Rs.)**
Gross income from Agriculture and Animal husbandry (million Rs.)	270.01	374.81
Total cost (million Rs.)	116.21	132.98
Net income (million Rs.)	153.81	241.83
Net income per household per annum Rs.	3,24,487	5,10,186
Per capita net income in Rs.	60,602	95283
% increase in net income		**57%**

3.2.8 The benefit cost ratio of the project

The BC ratio of the project on the basis of benefits calculated from the surrogated area of 2080.6 ha was worked out taking into account the cost and benefits from this area as a result of project implementation. On the cost side, the total cost incurred through project, cost of the agriculture and animal husbandry incurred by farmers was taken into account. On the other side the benefits both from agriculture and animal husbandry sector were taken into account. The B:C ratio worked out was 1:1.88 (Table 16) which is highly favorable for these types of project and reflects the economic viability of the project.

Table 16. Benefit cost Ratio of the project

Particulars	Cost, million Rs.	Gross income, million Rs.
Project cost	66.23	-
Agriculture sector	104.45	301.70
Animal husbandry	38.54	73.12
Total:	199.21	374.81

$$\textbf{B.C.Ratio : } \frac{374813140}{199211048} \textbf{ = 1:1.88}$$

3.2.9 Groundwater quality aspects

Groundwater is one of the most vital natural and fresh sources of water on earth which is used for drinking and irrigation purposes. Various processes affecting the water quality may be natural like evaporation and weathering and or anthropogenic activities like agricultural activities, and domestic-industrial effluents. The agriculture in the Punjab State is dependent on heavy requirement of water. The State's surface water resources are limited and fully utilized. To meet the ever-growing demand for agriculture, urban and rural population and industry, dependency on groundwater has been increasing tremendously.

The water samples of tube wells were collected from few villages of Patiala district for analysis of water quality parameters. The results of analysis are listed in Table 17. The result shows that the ground water is moderately alkaline in nature. The pH values range from 7.37 to 9.20. The EC values ranges from 0.22 to 2.53 mmhos/cm. The water with EC values of above 1 mmhos/cm is critical and may hamper the germination and yield of crops. This high EC value in certain water samples may be attributed to dissolved salts. The saline water, presently used for irrigation is to be replaced with good quality water to sustain crop yield and soil quality in the region. Some farmers are using saline water in conjunction with canal water or water from ghaggar River for irrigating their crops in order to improve crop production. Another approach may be the use of suitable crop variety with salt tolerance capacity.

In order to meet the demand of groundwater for diverse purposes, there is a need (1) to ascertain the depth up to which native groundwater is fresh/ fit for use (2) depth/aquifer wise quality of native groundwater. Farmers are being confronted with the need to move to deeper wells with inevitable increase in cost of farming, making it especially difficult for small and marginal farmers. Subsidized agricultural power supply is putting an additional and

unsustainable burden on state budgets. This precarious situation calls for a mix of regulatory, technological, and economic instruments to address groundwater management in Punjab besides high level policy reform.

Table 17. Water quality in Patiala District

S. No.	Location of samples	pH	EC (mmhos/cm)
1.	Kotla	7.64	0.94
2.	Gathiya	7.69	1.29
3.	Karanpur	7.81	1.30
4.	Batta	8.19	1.31
5.	Karanpur	7.80	2.32
6.	Kotla	7.37	1.16
7.	Batta	7.50	2.28
8.	Gathia	8.62	1.98
9.	Karanpur	7.75	1.25
10.	Batta	8.12	2.53
11.	Gathia	8.56	1.87
12.	Gathia	8.54	1.62
13.	Karanpur	8.01	2.22
14.	Batta	7.64	1.23
15.	Batta	9.20	1.12
16.	Mehergarh Batti	8.42	0.88
17.	Karanpur	8.12	1.59
18.	Canal Water	8.34	0.22
19.	Ghaggar River	7.82	0.54

4. OUTCOMES

Impact evaluation of following projects implemented under *Rashtriya Krishi Vikas Yojna* (RKVY) was undertaken:

Sr. No.	Names of the Project under RKVY
1.	Conservation of Irrigation Water through Underground Pipeline System
2.	Construction of Water Harvesting/Recharging Structures

The evaluation team assessed the following activities executed by the Department of Soil and Water Conservation, Punjab under the above mentioned projects:

- Laying of Underground Pipeline System for group of farmers(community projects);
- Laying of Underground Pipeline System for individual farmers;
- Conjunctive use of irrigation water by mixing saline underground water with canal water especially in south-western districts of the State
- Construction of Water harvesting structures and laying of UGPS for irrigation
- Construction of Water Recharging structures
- Renovation of Village ponds
- Reclamation of degraded soils

The major outcomes of evaluation study are as follows

- Due to laying of underground pipeline, not only the conveyance losses have minimized but there has been considerable saving for farmers on labour and energy costs besides the additional availability of land for cultivation otherwise lost on account of construction of open channels
- After introduction of RKVY 61% irrigated area came under UGPS and 86.2% rainfed area also got irrigation through UGPS.
- Conjunctive use of water resulted in increase in area of paddy and wheat crops by 29 and 31% respectively. However, area under maize and cotton decreased by 18.4 and 16.6 % respectively.
- After laying UGPS about 100 sq.m land per ha was saved and 2750 cu.m /ha water was saved per year in rice-wheat system. This resulted in increase of wheat and rice yield by 3 quintal and 3.8 quintal respectively besides the increase in fodder crops.
- Implementation of RKVY project has lead to increase in cropping intensity from 169 to 188% according to sample survey

- Availability of both dry and green fodder increased after project due to availability of assured and good quality of irrigation water as a result of which there has been a considerable increase of cattle population. Some of the farmers have purchased cattle of better breed which give more milk. All these factors have together contributed for increasing of milk production by 39% in the project areas.
- After the project per capita net income per annum increased by 57% from Rs.60602 to 95283. This is mainly due to farmers getting assured source of irrigation especially in rainfed area and areas falling at tail end of canal system, along with the fact that farmers not only benefitted in terms of more availability of land for cultivation but also due to savings accrued on labour and fuel costs. Other major factor of increase in income is that due to assured supply of irrigation water many of the farmers have shifted to paddy crop in lieu of maize as paddy is much more remunerative crop and fetches higher profits to farmers. Besides this famers have ventured in allied activities like livestock etc in the project areas as due to availability irrigation facilities, agriculture in no more a risky proposition, which has also helped raise income level of the farmers.
- Water quality analysis of ground water, canal water and water of ghaggar River was also done at several locations. It was found that ground water alone is not fit for irrigation as its EC value is more than one. But canal and water of ghaggar River are safe for irrigation. As such there is need to bring more area under conjunctive irrigation.
- The underground irrigation water conveyance by pipelines have a very longer life span ranging from 25-50 years depending upon the type of pipeline i.e. RCC or PVC/HDPE and require minimum maintenance in comparison to earthen open channels which are required to be built every season. The brick lined or pucca channels also require regular maintenance.
- Due to construction of Water Harvesting and Recharging structures, agricultural activity has got a major boost in the kandi area of the State because of improvement in underground water level and availability of irrigation water from these structures. Earlier the agriculture in these areas was solely dependent upon rains. This has not only contributed in socio-economic upliftment of local community but has also reduced migration as now more people are involved in agricultural and allied activities.

- Value of land has also increased in some of project areas. The value of land has increased from 3 lacs to about 15-20 lacs per acre in project area in Pathankot because of availability of assured irrigation facility and higher yields from land.
- Benefit cost ratio of the project was calculated and it comes out to 1:1.88

As per survey conducted, the evaluation team analyzed the following benefits of underground pipeline w.r.t. open channels on various aspects

Aspect	Open Channel	Underground Pipeline
Water Losses	Heavy Losses in form of Evaporation and Seepage	No to negligible losses
Land	Land Required for construction Channels	Underground Pipeline is beneath the land, no land wasted
Labour Costs	Labour Costs involved in maintenance of channels	Negligible Maintenance Costs
Life Span	Very Short, *Kaccha* channels have to be built every season, Repair required on *pucca* channels continuously	Very Longer Lifespan (25-50 years)
Livestock threat	Being on surface are prone to damage by livestock or others	No Such threats involved
Flow	Reduced Velocity, more time period required to irrigate	Piped flow leads to increased velocity hence lesser time taken to irrigate
Energy consumption	More Power and fuel required for pumping due to less velocity and increased friction in water conveyance	Less Power and fuel consumption due to Lower friction losses and increased velocity

5. OBSERVATIONS

1. The experts of evaluation agency, involved in evaluation work are of the view that laying of underground pipeline in agricultural fields have been immensely beneficial for the farmers and rate the work as excellent.

2. All the beneficiaries either in underground irrigation pipeline projects or water harvesting/recharging works in kandi area of the State unanimously appreciated the work done by Department of Soil and Water Conservation under RKVY.

3. The beneficiary farmers are extremely satisfied with the quality of work executed by the Department under these projects.

4. In south-western part of State, especially in Mukatsar district, the crop yield was very poor because of saline nature of ground water but due to intervention of conjunctive use of ground water with canal water under the UGPS projects not only the yield has gone up by 25-30% but the quality has produce has also improved.

5. The water user committees formed by the Department for distribution and management of community underground pipeline irrigation projects and for managing of water harvesting structures by the Department are functioning very well.

6. The beneficiary farmers appraised the experts, that earlier their fields used to get irrigated @ 1acre/hr, but now due to laying of underground pipeline, the same area is being irrigated in 35 minutes friction losses.

7. A very interesting fact came in to notice of evaluators in a village of District Patiala, wherein during group discussion villagers told team of evaluators that earlier people from other areas of the State were unwilling to marry their daughters in this village because of the fact that this village had almost negligible agricultural activity because of lack of irrigation water resources as the ground water being deep was uneconomical to exploit and the distance from nearest river water source i.e. Ghaggar was considerable. The problem of this village was compounded by the fact that the farmers having lands in between were not willing to allow construction of open channels for conveyance of this rivulet water.

8. In a village of Gurdaspur a pond was dugout, water from which is subsequently used for irrigation through UGPS. The farmers revealed that the catchment area of the pond is entire village and lots of insecticide, pesticides and fertilizer used by the farmers in the fields come to pond as runoff and the pond water which is being used for irrigation is not of good quality. They demanded that something needs to be done in order to check this pollution.

9. All the farmers surveyed unanimously told the experts, that earlier system of irrigation water conveyance through open channels wasted a lot of water in terms of seepage and evaporation besides loss on account of their maintenance costs. They further informed that earlier time taken for irrigation was also more due to reduced velocity Now, due to laying of underground pipelines not only 25% water as well as energy is saved.

10. As now farm machinery is deployed for agricultural activities on large scale in the State. It was also observed that due to laying of underground pipelines operation of farm machinery has become easier as open channels especially the masonry channels was a hindrance in operation of machinery especially the heavier such as combines etc. for agriculture purposes.

6. SUGGESTIONS/RECOMMENDATIONS

1. Given the benefits of underground pipeline to the farming community and to address the issue of depleting water resources of the State, this programme needs to be promoted on very large scale across the State
2. The budget provisions under RKVY especially for community projects in State needs to be increased as it was felt by evaluators that there are large numbers of farmers willing to install underground pipeline but the present budgetary provisions are not sufficient to cater to their need.
3. Separate programme for underground pipeline may be formulated for south-western districts of the State, as this area is mainly irrigated by canal system and conveyance of water from these, requires an efficient system like UGPS as water has to be carried over to considerable distances in numerous number of cases.
4. In waterlogged areas of the State, underground pipeline projects should also be implemented for drainage of excess water, a special project may be formulated which shall lay emphasis on drainage along with irrigation.
5. In most of the cases the water user committee formed in community projects do not charge any amount for irrigation water distributed. In case committee charges some amount for distribution of irrigation water, the same can be utilized for repair and maintenance and future expansion of the project.
6. While laying UGPS farmers, need to be motivated for crop diversification as lot of water is needed for wheat-rice system which can be reduced with alternate cropping system like pulses and oilseeds or other cropping patterns as suggested by PAU
7. In kandi region of the State, Department has constructed number of water harvesting/recharging structures, check dams, retaining walls, which have helped spruce up agricultural activity in the region, by providing life saving irrigation facility besides improving the socio-economic conditions of the farmers. These activities needed to be given a thrust especially in Hoshiarpur and Pathankot Districts.
8. The local community informed that of late the Forest Department of Punjab is not allowing construction of water harvesting structures and other soil/water conservation activities in kandi area which is predominately a forest area. The evaluators suggest that some sort of mechanism may be worked out by State Govt, which shall allow such activities in forest

areas as these activities besides beneficial for agriculture also help in improving forest cover in the region.

9. A specific problem noticed and needs immediate attention of State Govt in kandi region is that laying of underground pipeline is not being permitted by Forest Department from water harvesting structures. It is recommended that this activity should be allowed as it causes absolutely no disturbance to forest cover and is life saver for agricultural activity in the region.
10. There is need to provide more funds to Pathankot and Hoshiarpur districts for soil and water conservation works under RKVY in order give benefit to more farmers.
11. Some of the farmers were of the opinion that the contract of laying UGPS should be given to the village contractor. In this system work would be got done in a better way and will generate employment in rural area.
12. Most of the beneficiaries requested to increase area under UGPS and for construction of more number of outlets.
13. In most of the cases the irrigation water was supplied to the limited farmers, it was suggested that whole village should be covered so that All farmers are benefitted. In some village only 30% farmers are getting irrigation water through UGPS.
14. Some of the farmer raised the voice regarding disposing of factory waste in the canals which is deteriorating quality of canal water. It is suggested that immediate steps be taken by authorities to control the unregulated flow of hazardous water and wastes in to these canals.
15. Most of farmers are using tractors or diesel pumpsets for pumping of water from canals which not only proves costlier but is also contributing to pollution levels. It is suggested that electric connections may be provided to those lifting water from canals or ponds for irrigation purposes.
16. Water application efficiency in the fields can be increased through adoption of modern irrigation methods viz. drip and sprinkler irrigation. UGPS can be used in tandem with these systems for increasing irrigation water use efficiency.
17. Awareness camps should also be organized along with execution of projects to make farmers aware about irrigate water usage and alarming situation of water resources in the State along with demonstration of various techniques for water management and conservation of irrigation water.

7. SUMMARY OF IMPACT EVALUATION OF RKVY PROJECT

S.No.	Particulars	Unit	Before	After	% Increase / decrease
1	Area under maize	ha	92.5	71.3	(-) 22.9
2	Area under paddy	ha	1212.4	1573.2	29.8
3	Area under *chari*	ha	193.9	145.7	(-) 24.9
4	Area under cotton	ha	387.8	221	(-) 43.0
5	Area under *kharif*	ha	1887.2	2011.2	6.6
6	Yield of maize	q/ha	18.9	22.3	18.0
7	Yield of paddy	q/ha	39.4	49.5	25.6
8	Yield of *chari*	q/ha	63.4	82.3	29.8
9	Yield of cotton	q/ha	12.7	14.9	17.3
10	Area under wheat	ha	1488.6	1745	17.2
11	Area under *barseem*	ha	139.5	152.5	9.3
12	Area under *rabi*	ha	1628.1	1897.5	16.5
13	Total area under crop	ha	3512.7	3908.7	32.7
14	Cropping Intensity	%	169	188	11.2
15	Total production of maize	q	1794	1576	(-)12.1
16	Total production of paddy	q	49514	86633	75.0
17	Total production of *chari*	q	58131	51710	(-)11.0
18	Total production of cotton	q	7100	4523	(-)36.6
19	Total production of wheat	q	53459	87306	63.3
20	Total production of *barseem*	q	86580	108711	25.6
21	Number of cow	No.	201	250*	24.4
22	Number of buffaloes	No.	620	743*	19.8
23	Total milk production	Thousand	1925	2677	39.0
24	Green fodder requirement	litre	13494	16688	23.7
25	Green fodder availability	t/yr	8098	9688	19.6
26	Dry fodder requirement	t/yr	4260	5195	21.9
27	Dry fodder availability	t/yr	6684	7399	10.7
28	Per capita net income	t/yr Rs.	60602	95283	57.0

*Not only number but farmers have started better breed of cattle