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Sources and Methods of Irrigation in Punjab and Level of Awareness

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ABSTRACT

The present study conducted by taking a sample of 300 cultivators from 30 villages, spread over 10 districts of Punjab, supported that the electric tube wells which are used for extracting ground water has emerged as the main source of irrigation in the state. This in, turn, has resulted in an over-exploitation of sub-soil water and to an ever declining water table. The mean depth of the tube wells has been continuously increasing. There was lack of awareness among the farmers regarding this issue and their efforts for rain water harvesting or conservation of water were negligible. Hence water resource conservation technologies such as micro irrigation, laser levelling, tensiometers, direct seeding of paddy, planting on raised beds and zero tillage, etc, were need to be encouraged.

Key words: Methods of irrigation, Ground water, Tubewells, Irrigation
JEL Classification:Q1, Q150, Q53, Q56,

INTRODUCTION

Historically, Punjab has never been a water deficit state. It had five perennial rivers (Ravi, Chenab, Jhelum, Beas and Sutlej) prior to its division at the time of India's partition but was left with two and a half perennial rivers and a couple of seasonal (mainly during rainy seasons) rivers. The vast network of canals was also divided between two Punjabs. A major part of canal irrigated area and canals went to the Pakistan Punjab. Out of the total irrigated area of 6300187 hectares in undivided Punjab on the eve of independence, the Indian Punjab was left with 1773242 hectares (28.15%). The remaining 71.85 per cent (4526945 hectares) went to Pakistan Punjab (Govt. of Punjab, 1964).

The availability of assured irrigation, high yielding variety of seeds and fertilizers and highly mechanized agriculture, made Punjab a success story of green revolution. All this led to a spectacular increase in yield of wheat and rice. The per hectare yield of wheat and rice increased from 1524 kg and 1185 kg in 1966-67 to 4507 kg and 4019 kg, respectively, in 2007-08. As a consequence, the area under rice increased from 227 thousand hectares in 1961 to 2845 thousand hectares in 2013. Its share in area under kharif cereals increased from 33 per cent to 96 per cent during this period. Similarly, wheat accounted for 99 per cent of the area under rabi cereals.

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The country got food self-sufficiency at the cost of Punjab's sub-soil water and mono-crop cropping pattern.

The rest is history of success story of green revolution, existing wheat-paddy cropping pattern, India's transition from a food deficit to a food self-sufficient country, depletion of Punjab water table, fading colour of green revolution (Ghuman, 2001) and suicides by farmers and farm labourers. Nonetheless, the post-independence Indian Punjab once again became the food bowl of India and provider of food security; though at the cost of its sub-soil water (both-in terms of quantity and quality) and soil health.

The share of Punjab in India's wheat production increased from 13 per cent in 1956-57 to 19 per cent in 1965-66 and to 23.4 per cent in 1985-86. Thereafter, it remained between 20 to 22 per cent. Presently, Punjab's share in India's wheat production is hovering around 19 per cent (Govt. of Punjab).

As regards rice, Punjab's share in India's rice production was 0.9 per cent in 1965-66, but started looking up since then. In 1980-81, it was 6 per cent; increased to 9 per cent in 1991-92 and further increased to 10.3 per cent in 1994-95. Thereafter, it hovered around 9.5 per cent. Presently, it is around 10 per cent. Clearly, Punjab still continues to have a significant share in India's wheat and rice production. However, more important is its contribution to the central pool.

With only 1.53 per cent of India's geographical area, the state of Punjab has been annually contributing 60 per cent of rice and 45 per cent of wheat to the central pool of the country during 1975-2007. Even at present, it is contributing 29 per cent of rice and 45 per cent of wheat to the central pool. It is significant to mention that 83 per cent of Punjab's geographical area is under cultivation as compared to 43 per cent in India. The state's irrigation and cropping intensity is 98 per cent and 190 per cent, respectively. The corresponding figures for India are 45 per cent and 141 per cent, respectively (Govt. of Punjab).

Such a scenario increased enormous pressure on under-ground water as canal water was grossly insufficient to meet the rising demand for irrigation. The rice crop needs 22 irrigations as compared to 14 for sugarcane and 4 for wheat. The area under canal irrigation in Punjab decreased from 43 per cent in 1981 to 27 per cent in 2011. The area under sub-soil water irrigation increased from 81 per cent to 98 per cent during the same period. This led to an enormous increase in the number of tubewells, from 192 thousands in 1971 to 1384 thousands in 2013. Consequently, there was serious over-exploitation of the sub-soil water. Out of the 145 development blocks, 110 are already in the category of over-exploited blocks. The free electricity to agriculture by Punjab government aggravated the problem further.

The water table in northern and central Punjab got depleted at the rate of about 60 centimetre per year during the last about 30 years. In some of the districts, the water table is going down at an annual average of one meter during the last about 10 years. Nearly 80 per cent area of this region is already over-exploited. Paradoxically, the water table in south-west Punjab has increased during this period and led to water logging of 200

thousand hectares (Kulkarni and Shah, 2013 and GoI, 2013). The water logging has made the sub-soil water unfit for crops, human and animal consumption.

Tubewell irrigation has emerged as the main source of irrigation in Punjab. In 1960-61 out of the total irrigated area of 2020 thousand hectares, 1173 thousand hectares (58 per cent) was under canal water and 829 thousand hectares (41 per cent) was under tube wells and wells. With the advent of green revolution, the area under irrigation increased to 2888 thousand hectares in 1970-71, out of which 1286 thousand hectares (45.47 per cent) was under canal irrigation and 1591 thousand hectares (56.26 per cent) was under tube wells and well irrigation. The area under canals increased by just 113 thousand hectares while area under tube wells increased by 762 thousand hectares in one decade. The area under canal irrigation (1660 thousand hectares) reached its plateau in1990-91 and thereafter, it started declining, both in absolute and relative sense. The area under canal irrigation not only declined but stagnated at 1113 thousand hectares (around 27 per cent) since 2010-11. The additional area under irrigation after 1990-91 was being served by tubewells and hence, share of tubewells irrigated area registered a continuous increase since 1960s as high yielding variety of seeds (especially paddy) were highly responsive to water. Hence, assured supply of water was not a choice but a necessity. Interestingly, sub-soil water became very handy to the farmers. In 2000-01, the share of tubewell irrigated area increased to 76.45 per cent (3074 thousand hectares) and thereafter, its share remained around 73 per cent.

It is understandable that water is an essential input for paddy but the moot question is why did the canal irrigated area declined from 1620 thousand hectares in 1990-91 to 1113 thousand hectares in 2010-11? In 2000-01, the canal irrigated area was exceptionally low. Instead of increasing the area under canal irrigation, it witnessed a significant decline. This needs a plausible explanation both from the government, policy makers and farmers.

The provision of free electricity with effect from 1st January 1997 (as per the Punjab Electricity Board (PSEB) memo no. 50196 dated 27.12.96) to the agricultural tube well consumers, having land holding up to 7 acres provides a partial explanation of fast increase in area under tubewell irrigation . The above order was super- ceded by PSEB memo no. 95/845 dated 8th March 1997 and the facility of free electricity was extended to all the agricultural consumers with effect from 14 February 1997. As per these orders, the tube well owners were allowed to use their tube well water to irrigate the land other than in their possession. This facility of free electricity was available for loads up to 20 BHP.

Nonetheless, the area under tube well irrigation started increasing from 1970s. This was mainly necessitated by the emerging cropping pattern and facilitated by the rural electrification programme of the Punjab as well as Punjab government. It may be stated that all villages of Punjab had been provided electricity on May 31, 1976. Under the rural electrification programme, liberal electric connections were given to the agricultural

sector. The public investment and bank loans (for capital investment) also encouraged the installation of tube wells. For the last about three decades even the wells have been filled in and there were only the diesel and electric operated tube wells. Lately, it is mainly the electric operated tube well, of course supplemented by diesel engines and tractors.

The irrigation intensity also increased from 54 per cent in 1960-61 to 94 per cent in 2000-01 and further to 99 per cent in 2011-12. In other words, almost entire net sown area in Punjab is under assured irrigation in which the share of tubewell irrigation is 72.47 per cent. At the all India level, only 44 per cent net sown area is under irrigation. The rest of the area is either rain-fed or is an arid zone. The availability of sub-soil water and the appropriate soil-texture shall always be a constraint as many parts of India may not be having of sub-soil water. In certain areas there is near absence of sub-soil water.

FINDINGS FROM THE FIELD STUDY

The present sample study of 300 cultivators from 30 villages, spread over 10 districts, of Punjab has supported that the main source of irrigation is tube wells. All the three agro-climatic zones, namely, central plain zone, south-west zone and sub-mountain zone, have been covered in the sample. The sample covers seven districts from the central zone (CPZ), two districts from south west zone (SWZ) and one district from sub-mountain zone (SMZ). Thus, there were 21 villages from CPZ, six from SWZ and three from SMZ. In all the 30 villages under study, tubewell irrigation was the dominant source of irrigation.

Main Sources of Irrigation in the Sampled Villages

Being a hundred per cent electrified state; it was the electric tubewells which were used for extracting ground water (Table 1). In the central plain zone (CPZ), all the 21 villages had electric tubewells and there were diesel operated pump sets. However, farmers used tractors to operate the motors to extract water when there was shortage of electricity, particularly in during kharif season, to irrigate the paddy crop. In three villages, farmers also used canal water as a main source of irrigation. A combination of canal and electric tubewells was also being used in three villages of the CPZ. In two villages, it was the combination of canal and diesel operated

TABLE 1: MAIN SOURCES OF IRRIGATION IN SAMPLED VILLAGES ACROSS THE AGRO-CLIMATIC ZONES IN PUNJAB

(No. of villages)

Zone	Electric Tubewell	Diesel Operated Pump set	Canal Water	Canal Water/ Diesel Operated Pump set	Canal Water/ Electric Tubewell	Canal Water/ Electric Tubewell/ Diesel Operated Pump set	Diesel Operated Pump set/ Electric Tubewell	Total Villages
CPZ	21	0	3	0	3	0	2	21
SWZ	3	3	6	1	5	1	2	6
SMZ	3	3	0	0	0	0	2	3
Total	27	6	9	1	8	1	6	30

Source: Field Survey 2013-14.

TABLE 2: DISTRIBUTION OF SAMPLED FARMERS ACCORDING TO SOURCE OF IRRIGATION ACROSS THE ZONES IN PUNJAB

(No. of farmers)

Zone	Electric Tubewell	Diesel Operated Pumpset	Canal Water	Canal Water/ Diesel Operated Pumpset	Canal Water/ Electric Tubewell	Canal Water/ Electric Tubewell/ Diesel Operated Pumpset	Diesel Operated Pumpset/ Electric Tubewell	Total No. of Farmers
CPZ	187 (89.05)	-	7 (3.33)	-	14 (6.67)	-	2 (0.95)	210
SWZ	6 (10.00)	7 (11.67)	34 (56.67)	1 (1.67)	8 (13.33)	2 (3.33)	2 (3.33)	60
SMZ	15 (50.00)	11 (36.67)	-	-	-	-	4 (13.33)	30
Total	208 (69.33)	18 (6.00)	41 (13.67)	1 (0.33)	22 (7.33)	2 (0.66)	8 (2.67)	300 (100.00)

Source: Field Survey 2013-14.

Note: Figures in brackets are row-wise percentages.

pump sets in this zone.

In south-west zone (SWZ) canal water was the main resource of irrigation in all the six villages under study. Electric tubewells, along with diesel engines, were being used in 3 villages for irrigation. A combination of canal and electric tubewells had also been reported by the farmers of five villages in this zone. It was significant to note that some of the districts in this zone were facing a serious problem of water logging and the sub-soil water was not fit for irrigation due to salinity and alkaline water. The people were facing a problem even for potable water. The water was not even fit for animal consumption. Consequently, canal water was the main source of irrigation and drinking. However, the excessive use of canal water and the flowing of various canals through this region had aggravated the problem of water logging in this region. In fact, the water table had come up in this region and the problem of salinity and alkalinity had also increased. In the sub-mountain zone (SMZ) the main source of irrigation, however, was the sub-soil water which was being extracted through electric as well diesel operated pump sets. Canal irrigation was almost negligible in this zone. The sub-mountainous topography was one of the significant reasons for such a situation.

The data given in table 2 revealed the zone-wise sources of irrigation of the sampled farmers. Out of the 210 farmers in the CPZ, 89 per cent used electric tubewells as the main source of irrigation. About seven per cent farmers used a combination of canal and electric tubewells. Only 3.33 per cent farmers used only canal water. Clearly, 97 per cent farmers in this zone mainly used sub-soil water for irrigation.

Contrary to it, nearly 57 per cent farmers in the south-west zone used canal water for irrigating their fields. About 12 per cent used diesel operated pump sets and 10 per cent used electric tubewells. Nearly, 13 per cent used a combination of canal and electric tubewells. Three per cent used the combination of canal water, electric tubewells and diesel operated tubewells. Similarly, three

per cent used a combination of diesel and electric operated tubewell. Though, canal water was the major source of irrigation in this zone, yet more than 40 per cent farmers used sub-soil water in a substantial manner.

In the sub-mountain zone, almost all the sampled farmers used underground water for irrigation. Electric motor was the single most important source of irrigation as 50 per cent farmers were solely dependent on this source. A sizeable proportion (36.67 per cent) of farmers used diesel operated tubewells. A little more than 13 per cent used a combination of diesel operated and electric tubewells.

Mean Depth and Operation of Tubewells

It was clear from the foregoing discussion that underground water had emerged as the main source of irrigation in Punjab. As a consequence, the number of tubewells had witnessed a manifold increase over the period of time. This in, turn, had resulted in an over-exploitation of sub-soil water and to an ever declining water table. The mean depth of the tubewells had been continuously increasing (Table 3). In the central plain zone, it had gone down to 128 feet during 2001-13, from 49 feet during 1960-70. Interestingly, the decade of 1970s witnessed a marginal increase in water table as the mean depth of tubewells came up by five feet. This was the decade when paddy cultivation was becoming popular with the farmers.

The 'persuasion' to grow more wheat and paddy to meet the demand for food grains, played a decisive role in promoting paddy crop in Punjab. The minimum support price and assured market clearance were the policy instruments behind it. When paddy cultivation assured a full bloom revolution, the mean depth of tubewells went down to 113 feet during 1991-2000, 37 feet in a decade. A really mind boggling decline in water table took place in the decade of 1990s. The mean depth of tubewells in this zone further went down to 128 feet during 2001-13, from 113 feet in the decade of 1990s.

One may wonder that the mean depth of the tubewells in the south-west zone came up by 29 feet during 1980s as compared to the proceeding decade. It, however, went down to 93 feet in 1990s, from 71 feet during 1980s. It again came up to 74 feet during 2001-13. This was a classic example of dancing water table in south-west Punjab (Singh, 2007). The non-irrigation worthy sub-soil water and the massive use of canal water not only led to such a situation but also resulted into a large scale disturbance of water table in this region of Punjab. Interestingly, this traditionally non-paddy zone turned into a paddy zone over the period of time. The phenomenon of dancing water table was also visible in the sub-mountain zone (Table 3). The mean depth of tubewells went down to 145 feet during 1980s from 87 feet in the proceeding decade. Strangely, it came

TABLE 3: CHANGING MEAN DEPTH OF TUBEWELLS OWNED BY THE SAMPLED FARMERS ACROSS THE ZONES IN PUNJAB

Zones	Initial Depth (Feet)				
Years	1960-70	1971-80	1981-90	1991-2000	2001-13
CPZ	49	44	74	113	128
SWZ	NA	100	71	93	74
SMZ	NA	87	145	101	67

Source: Field Survey 2013-14.
NA: Not available.

up to 101 feet in the decade of 1990s and further to 67 feet during 2001-13. This again was a mystery.

The study revealed (Table 4) the operation of tubewells during kharif and rabi season. At the aggregate level, farmers operated tubewell for 256 days in a year, 188 days during kharif and 69 days during rabi season. It was limitation of the data that farmers could not tell about how many hours (average) in a day they operate tubewells. However, an estimate was possible as electricity supply for irrigation was normally for eight hours in a day during kharif season and four to six hours during rabi season.

In central plain zone, farmers operated tubewell for 105 days in a year whereas, in south-west zone, only for 46 days in a year and sub-mountain zone, for 106 days in a year. In CPZ, tubewells were operated for 78 days during kharif season, while in south-west zone and sub-mountain zone the tubewells were operated for 30 days and 80 days during the kharif season, respectively. During rabi season, tubewells were operated between 16 days (SWZ) and 27 days (CPZ). Clearly, duration of tubewell operation was much higher during kharif season. It was mainly because of paddy crop during the kharif season. On an average, paddy required 22 irrigations whereas, wheat needed four irrigations. Sugarcane required 14 to 16 irrigations but was whole year crop. Both cotton and maize needed four to six irrigations. Groundnut needed only two irrigations.

TABLE 4: OPERATION OF TUBEWELLS DURING KHARIF AND RABI SEASON (DAYS)

Zones	Khariff	Rabi	Total
CPZ	78	27	105
SWZ	30	16	46
SMZ	80	26	106
Total	188	69	256

Source: Field Survey 2013-14.

In response to a question regarding growing or not growing paddy if the free power is withdrawn, the farmers across the zones responded in a different fashion (Table 5). At the aggregate level, nearly 58 per cent respondents said that they would continue to grow the paddy crop even if free electricity supply is withdrawn. On the contrary, 41.33 per cent farmers responded that in such a situation they may stop cultivating paddy. Clearly, free power supply was a great incentive for about three-fifth of the farmers. In central plain zone, free power or priced power did not matter to nearly 70 per cent of the farmers, as they were strongly inclined towards paddy cultivation. It may be construed that the farmers in the central zone had no alternative crop which could give the

TABLE 5: FARMERS' RESPONSE FOR PADDY GROWING IN THE ABSENCE OF FREE POWER

Zones	Continue to grow paddy		Total
	Yes	No	
CPZ	148	62	210
	(70.48)	(29.52)	(100.00)
SWZ	12.00	48.00	60.00
	(20.00)	(80.00)	(100.00)
SMZ	16	14	30
	(53.33)	(46.67)	(100.00)
Total	176	124	300
	(58.67)	(41.33)	(100.00)

Source: Field Survey 2013-14.

Note: Figures in parentheses are row-wise percentage.

same return as was given by paddy or priced power supply was not a deterrent for them. Nevertheless, about 30 per cent farmers were such to whom stopping of free power did matter and may stop growing paddy in that case.

Contrary to it, 80 per cent farmers in south-west zone would not like do paddy cultivation in case the practice of free power supply is stopped. Only 20 per cent farmers were such who responded in favour of paddy even if free power supply is withdrawn. In the case of sub-mountain zone, about 53 per cent farmers were in favour of continuing with paddy even in the absence of free power supply while the remaining 47 per cent responded otherwise.

Awareness about Depleting Water Table and Water Related Problems

As regards the awareness about declining water table, 79 per cent farmers were aware about it while remaining 21 per cent expressed ignorance about it (Table 6). The farmers in the central plain zone were highly aware about this problem as about 90 per cent responded positively. In fact, this was the zone where water table had gone down significantly.

The farmers of the sub-mountain zone were rather more aware as 93.33 per cent respondents said that they were aware about the problem of declining water table, though the pace of decline was much slow in this region, as compared to the central plain zone. The level of awareness was much low in the south-west zone as only 35 per cent respondents were aware about it and 65 percent were unaware (Table 6).

In case of water related problems, the level of awareness was quite high in the sub-mountain zone (93.33 per cent), followed by the central plain zone (84.29 per cent). The respondents in the south-west zone were less aware (35 per cent) about the water related problems. At the aggregate level, nearly 75 per cent respondents were aware and the remaining 25 per cent were not aware about water related problems.

The farmers were also aware about their future water requirement as two-third

TABLE 6: AWARENESS ABOUT DECLINING WATER TABLE AND SOURCE OF AWARENESS ACROSS ZONES IN PUNJAB

Zones	Water Table		Water related Problems		About Future		Source of Awareness			
							Radio		T.V.	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
CPZ	188	22	177	33	161	49	88	122	112	98
	(89.52)	(10.48)	(84.29)	(15.71)	(76.67)	(23.33)	(41.90)	(58.10)	(53.33)	(46.67)
SWZ	21	39	21	39	19	41	38	22	39	21
	(35.00)	(65.00)	(35.00)	(65.00)	(31.67)	(68.33)	(63.33)	(36.67)	(65.00)	(35.00)
SMZ	28	2	28	2	18	12	3	27	11	19
	(93.33)	(6.67)	(93.33)	(6.67)	(60.00)	(40.00)	(10.00)	(90.00)	(36.67)	(63.33)
Total	237	63	226	74	198	102	129	171	162	138
	(79.00)	(21.00)	(75.33)	(24.67)	(66.00)	(34.00)	(43.00)	(57.00)	(54.00)	(46.00)

Source: Field Survey 2013-14.

Note: Figures in parentheses are in percentages.

respondents answered in an affirmative manner. However, it should be a matter of concern as the other one-third was unaware about it. Across the regions, the farmers in the south-west zone were having a very low level of awareness, as only 32 per cent of the respondents said 'yes they were aware about the future water needs'. In other words, 68 per cent were still unaware about the emerging water scenario in their region. Incidentally, the level of education was also low in this region. One may attribute to the educational backwardness or low level of educational attainment in the region. However, in an educationally advanced region of sub-mountain zone, 40 per cent of the farmers were not aware about their future water needs. The farmers in the central plain zone, however, were more aware about it as nearly 77 per cent respondents expressed awareness about future demand for water.

Significantly, radio and television (TV) were the main sources of awareness as is evident from Table 6. The newspaper was the least source as a very low proportion of the respondents (about 27 per cent) were newspapers readers. Low level of educational attainment was another reason for it. At the aggregate level, 43 per cent listened to radio and 54 per cent TV Some farmers might be viewing TV as well as listening to radio but they told that their main source of information was radio. However, it was a matter of concern as majority of respondents (57 per cent) did not listen to radio, 46 per cent did not watch TV and 73 per cent did not read any newspaper. It became all the more serious near absence of physical extension services in agriculture.

Across the agro-climate zones, radio was the main source of information for 63 per cent of the respondents in the south-west zone. The corresponding proportion in the central plain zone and sub-mountain zone was 42 per cent and 10 per cent, respectively.

In other words, radio was conspicuously absent in the sub-mountain zone while it had its significant presence in the south-west zone. Significantly, TV viewership too was not very high as 63 per cent respondents in sub-mountain zone and 47 per cent in central plain zone did not watch TV. This explained low level of awareness. Besides, the farmers might be aware but not sensitised about the depleting water table, water related problems and the emerging water scenario. The sensitivity level of the government and its machinery, too, was not high in view of the free power supply and near absence of extension services in the agricultural sector.

Methods of Sowing and Irrigating Paddy

The age old and traditional method of plantation of paddy also supported the above mentioned observation. Puddling still was the main method of paddy plantation among the farmers who were cultivating paddy and flooding was the only method of irrigating paddy (Table 7).

At the aggregate level 77 per cent paddy growers in Punjab used the puddling method. About 16 per cent did not cultivate paddy and only seven per cent used non-puddling method to grow paddy. At the zone level, 84 per cent farmers used puddling method to replant paddy, 8 per cent did not cultivate paddy and nearly eight per cent did not go in for puddling. In the sub-mountain zone, too, all the paddy growers planted paddy with

TABLE 7: METHODS OF SOWING PADDY AND IRRIGATION ACROSS ZONES IN PUNJAB

Zones	Sowing Paddy			Irrigation Method
	Puddling	Without Puddling	Not Sowing Paddy	Flooding
CPZ	177 (84.29)	16 (7.62)	17 (8.09)	210
SWZ	24 (40.00)	6 (10.00)	30 (50.00)	60
SMZ	30 (100.00)	-	-	30
Total	231 (77.00)	22 (7.33)	47 (15.67)	300

Source: Field Survey 2013-14.
Note: Figures in parentheses are in percentages.

puddling method. As compared to it, 50 per cent farmers in the south-west zone did not grow paddy crop but 40 per cent grow paddy with puddling method. Another 10 per cent grow paddy without puddling. Significantly, among the paddy growers, the proportion of those who grew paddy without puddling method was very low. This needs to be noted so that non-puddling method was promoted among the farmers. It was, thus, clear from table 7 that a long distance was yet to be covered in discouraging the puddling method and promoting the non-puddling method.

As regards the methods of irrigation, all the sampled farmers used flooding method of irrigating the paddy fields. This was true across all the three zones. Clearly, there was an urgent need to make the farmers about the alternative methods of irrigation. An alternative to flood irrigation method also needs to be encouraged. This would require the high sensitivity quotient among the government, policy-makers and farmers.

Awareness about the Fact that Paddy is Water Guzzling Crop

In response to the question about higher consumption of water by paddy, about 59 per cent respondents answered affirmatively but 41 per cent expressed ignorance about it (Table 8).

At the zone level, the awareness level was as low as 10 per cent in south-west zone to as high as high as 76 per cent in central plain zone. In the sub-mountain zone, only one-third of the respondents were aware about it. Such a scenario was disappointing as leaving aside the central plain zone, large number of farmers were not even aware that paddy was water guzzling crop. It needs to be remembered that awareness is the pre-requisite to sensitivity. As such, there was an urgent need to make them aware so as to sensitise them about the emerging water crisis.

Diversification of cropping pattern was a much talked of issue but nothing on ground had taken place, in spite of the fact that two reports by the government appointed

TABLE 8: AWARENESS ABOUT HIGHER WATER CONSUMPTION BY PADDY AND CROP DIVERSIFICATION

Zones	About Paddy		Crop Diversification	
	Yes	No	Yes	No
CPZ	160 (76.19)	50 (23.81)	84 (40.00)	126 (60.00)
SWZ	6 (10.00)	54 (90.00)	5 (8.33)	55 (91.67)
SMZ	10 (33.00)	20 (67.00)	1 (3.33)	29 (96.67)
Total	176 (58.67)	124 (41.33)	90 (30.00)	210 (70.00)

Source: Field Survey 2013-14.
Note: Figures in parentheses are in percentage.

committees had been submitted long ago (GoP, 1986 and 2002). Field level findings, also, supported this fact. Even after about four decades, when paddy emerged as a major crop in Punjab, 70 per cent of the farmers were not aware about the need for diversification, not to talk of actual diversification. Significantly, 96.67 per cent farmers in the sub-mountain zone were not aware about diversifying the cropping pattern. This proportion in the south-west Punjab was 91.67 per cent and in the central zone Punjab 60 per cent. Astonishingly, the advice of diversification was coming without giving any alternative crop combination which could give the same or more income to framers The need is to look into the circumstances and recall the policy set under which the Punjab has been advised to grow more and more of food grains, especially paddy. The massive public investment in agriculture, assured irrigation, assured supply of high yielding variety of seeds and MSP regime were mainly responsible for success of green revolution in Punjab, Haryana and Western Uttar Pradesh. But now the advice was coming without the compatible policy set. Farmers at their own cannot go in for diversification.

Nonetheless, the government, policy makers and farmers need to understand that food grain output (particularly rice) was going to increase in other states of India. Along with this, declining share of Punjab's rice in the central pool was another major indicator that Punjab needs to shift area from under paddy in a significant manner. For the last about 40 years, Punjab had been exporting its underground water in the form of supplying rice to the central pool and other states of India. It is, thus, the high time that the writings on the wall should be read and diversify our cropping pattern.

Water Harvesting and Conservation

Harvesting and conservation of water are significant measures to enhance the supply of water. Saving of water by using it optimally and efficiently works both on the supply and demand side management. In fact availability of water does not depend solely on its supply; water saved also adds to the quantity of available water and hence enhances the supply. It is like saying that one's savings do not depend only on one's income but also depends on the use of income. So, optimal and efficient use of water is very important for sustainability.

The information in table 9, however, did not present any encouraging picture regarding harvesting, conservation and saving of water. About 89 per cent farmers were neither doing any rain water harvesting nor any conservation of water. Across the zones, not even a single farmer in the south-west zone

TABLE 9: RAIN WATER HARVESTING AND EFFORTS TO SAVE WATER

Zones	Rain Water Harvesting		Saving Water	
	Yes	No	Yes	No
CPZ	28	182	52	158
	(13.33)	(86.67)	(24.76)	(75.24)
SWZ	0	60	4	56
	0	(100.00)	(6.67)	(93.33)
SMZ	6	24	9	21
	(20.00)	(80.00)	(30.00)	(70.00)
Total	34	266	65	235
	(11.33)	(88.67)	(21.67)	(78.33

Source: Field Survey 2013-14
Note: Figures in parentheses are in percentage.

was doing rain water harvesting and conservation. In the central plain zone, only 13.33 per cent were doing some efforts in harvesting and conservation of water. In the sub-mountain zone, 80 per cent of the respondents did not do any rain water harvesting and conservation.

The picture on the water saving front too, was far from satisfactory. A little more than 78 per cent farmers (respondents) were not doing any effort to save water. At the zone level, 93.33 per cent farmers in south-west zone did not use any water saving measures. In the central plain zone, this proportion was 75 per cent while in the sub-mountain zone, 70 per cent farmers fall in this category (Table 9). Clearly, there was much to do on the harvesting, conserving and saving of water.

The quality of sub-soil water, according to farmers' perception seemed to be good, as was evident from table 10. At the aggregate level, 87 per cent farmers perceived that the quality of water was fairly good. Only 13 per cent said that water was not of good quality. The perception about quality of water in the central plain zone was quite high as nearly 97 per cent respondents said that quality of water was good. In the sub-mountain zone, all the sampled farmers' perception about the quality of water was good. However, 53.33 per cent respondents in the south west zone said that quality of water was bad. In fact, the south-west Punjab had largely poor quality water, so much so in some of the districts in this zone, the water was saline and there was a serious problem of water logging. The incidence of cancer and other water related ailments were also very high in this region.

CONCLUSION

It was clear from the foregoing discussion that level of awareness of the farmers was quite low and hence there was hardly any sensitively about the water conservation and harvesting. Underground water, being extracted by the tubewells, was the predominantly dominant source of irrigation. As a consequence, the mean depth of tubewells had increased manifold. The duration (days) of tubewell operation was quite high. The farmers were not finding any alternative to paddy and hence would continue to grow paddy even if free power facility was withdrawn. To the height of it, the method of irrigation was mainly flooding the fields, especially, paddy fields. Puddling was still the main method of paddy plantation. Significantly, a sizeable proportion of farmers were not aware that paddy water guzzling crop and was the main source of depletion of water table in Punjab.

Thus, an urgent need was to adopt a multipronged approach to address the problem of rapidly depleting water table. All the stake holders will have to come on board. The government and policy makers must understand that in the absence of any formidable policy measures farmers shall not be able to diversify the existing cropping system, especially area under paddy. Rain water harvesting and conservation of water needs to be promoted in a big way. Resource conservation technologies, such as, micro irrigation, laser levelling, tensiometers, direct seeding of paddy, planting on raised beds and zero tillage, etc, need to be encouraged.

Farmers, too, need to understand that the

continuous decline in water table would increase their cost of production, especially, the cost of extraction of sub-soil water both the recurring and non- recurring costs. That, in turn, would result in decline in their net income from agriculture. It would also have an adverse effect on the man-days employment in agriculture. Agriculture may eventually become unviable. Already, a large number of farmers are looking for the opportunity to exit from agriculture. It shall put a question mark on the very sustainability of agriculture and farmers' economy.

As the issue at hand is not an individual issue, there is a need to take it at the community level. That would require community level awareness and sensitivity. The involvement of elected representatives, especially, that of the Panchyati Raj Institutions (PRIs) is sine qua non, the religious bodies and NGOs would also have to play their role in this endeavour. The government, civil bureaucracy and policy makers shall, however, have to play a lead role.

REFERENCES

Government of Punjab (1986) *Diversification of Agriculture in Punjab- A Report of the Expert Committee*, Chandigarh.

Government of Punjab (2002) *Agriculture Production, Pattern and Programme in Punjab for Productivity and Growth –A Report of the Expert Committee*, Chandigarh.

Government of India (2013) *Water Logging in Punjab –A Report of the High Level Expert Group,* Planning Commission, New Delhi.

Ghuman, R S (2001) WTO and Indian Agriculture: Crisis and Challenges – A Case Study of Punjab. *Man and Development* **23** (2) : 67-98.

Singh, Karam (2007) *The Dance of Water Table.* The Punjab State Farmers' Commission, SAS Nagar, Mohali.

Kulkarni, Himanshu and Shah, Mihir (2013) Punjab Water Syndrome-Diagnostics and Prescriptions. *Economic and Political Weekly* **48**(52): 64-73.

Government of Punjab (1964) *Administrative Reports for 1940-41*, Public Works Department, Irrigation Branch, Punjab.

Punjab Agricultural University, *Package of Practices for Kharif and Rabi Crops, various issues*, Ludhiana.

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