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Engaging with the Changing Policy Discourse to check Groundwater Depletion in Punjab

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Abstract

By using the primary data from 427 farmers, this study examines the awareness about groundwater resources and legal literacy amongst the Punjab farmers and relates these to important parameters of adoption of water conservation and long-term sustainability of groundwater in Punjab. There was less awareness, especially amongst large farmers on groundwater depletion, its stock, its factors, role of community organizations and legal literacy on water. However, large the farmer, larger the adoption of water conservation practices due to their better incomes, risk taking capacity and their preference for new technologies and practices. Increased awareness and legal literacy can further enhance the adoption levels and feed faster into the long-term sustainability of groundwater resources in Punjab.

Key words: Legal literacy in agriculture, Groundwater depletion, Technologies, Practices

JEL Classification: Q10, Q16, Q25, Q38, Q54

Introduction

Punjab is one of the smallest states of India, having three perennial rivers namely Sutlej, Beas and Ravi and one non-perennial river Ghaggar. The State is a flat alluvial plain with a thin belt of mountains along the northeastern border (Kandi belt 10 to 15 km wide), and stable these alluvial deposits comprise sand, silt and clays often mixed with sand *kankar*. Sandy zones of varying grades constitute abundant groundwater resources and act as reservoirs. The groundwater resources for the state have been assessed block-wise (CGWB, 2021), and the total annual groundwater recharge of the State has been evaluated as 22.80 bcm and the annual extractable groundwater resource as 20.59 bcm. The annual groundwater extraction is 33.85 bcm, and the stage of groundwater extraction is 164.42%. Out of the 150 assessment units (blocks), 117 units (78%) have been categorized as 'Overexploited', six units (4%) as 'Critical', ten units (6.67 %) as 'Semi-Critical', and 17 units (11.33 %) as 'Safe'. Compared to 2017 estimates, the stage of groundwater extraction has decreased from 165.77 to 164.42 %. The reduction in recharge is due to less rainfall, the lining of unlined canals and reduced extraction is due to a decline in paddy cultivation area from 29.3 lakh hectares to 26.3 lakh hectares. However, over the years, the groundwater table has been declining, and the area under higher depths of the water table is increasing (Kaur and Vatta, 2015). There was only 6% of the area with a water table depth of more than 15 meters in Punjab during the 1970s, and the majority area was under a depth of below 10 meters. However, after the 1970s, the water table started declining fast with the over-extraction of groundwater resources. The proportion of area under water table depth of more than 15 meters increased to 10% in 2000, 24% in 2005, 46% in 2010 and 55% in 2020. The fast-declining water table and its implications for the long-term sustainability of groundwater and the state financial resources due to the provision of free electricity for agriculture have led to a change in the policy discourse (Vatta and Taneja, 2018; Sarkar and Das, 2014). It is important to examine these changes.

Though India has no explicit legal framework specifying the water rights, the Easement Act of 1882 and the Transfer of the Property Act of 1882 give the right to the landowner to groundwater beneath his land, considering it as an easement of the land. The ownership of groundwater combines with land ownership and is transferred along with the transfer of land ownership. Such absolute ownership permits the landowners to withdraw any quantity of groundwater beneath their land. The Government of India also enacted "the Northern India Canal and Drainage Act, 1873 to control for public purposes the water of all rivers and streams flowing in natural channels, and of all lakes and other natural collection of still water; and whereas it is expedient to amend the law relating to irrigation, navigation and drainage. Punjab Government

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amended this Act by enacting The Northern India Canal and Drainage (Punjab Amendment) Act, 2014 to enable it to levy a water cess on the occupiers of land for maintenance and development of irrigation infrastructure, who use canal water for irrigation at the rate to be determined by the State Government from time to time and such occupiers, as accept the water, shall pay for water cess accordingly. For regulation of irrigation water supply from a State Tubewell, the Punjab government enacted the Punjab State Tubewell Act, 1954 to provide that except as otherwise provided, "the provisions of the Northern India Canal and Drainage Act, 1873 shall be deemed to apply in respect of any State Tubewell in like manner as if such State Tubewells were a canal within the meaning of the said Act". Despite substantial changes in the groundwater development regime over time, the legal framework for groundwater governance continued to remain the same. It has led to rapid over-extraction of groundwater and consequent depletion of water levels in several parts of India.

The Punjab Preservation of Sub-soil Water Act was enacted in 2009 (by replacing the Ordinance of 2008) prohibiting early sowing of the nursery of paddy or its transplantation before the date notified by the State Government. The date of transplanting paddy nursery was notified as 10th June in 2009 and 15th June in 2014. The effective enforcement of the 'change in crop calendar' by delay in the transplanting helped reduce the depletion of the water table by about 30 cm (Singh,2009). Further, to enable farmers to lay underground irrigation pipelines through the land of other holders, the Punjab Government enacted Punjab Act No. 25 of 2017, which incorporates an amendment (a new Section 14-A in Chapter III) to the Punjab Land Improvement Schemes Act 1963. The amendment gives the 'Right of Way' to the Soil and Water Conservation Department and the farmers against payment of compensation for crop damage or damage to any structure, as per prevailing market rates. It has enabled the Department or the concerned farmers to lay underground irrigation pipelines in other land holders' land at a depth of 3 feet beneath the land's surface as per approved alignment. A district-level committee under the chairmanship of the Deputy Commissioner is to be formed to determine the amount of compensation to be paid to the landholder. The groundwater governance suffered from the division of responsibility due to the involvement of multiple agencies without any coordination among themselves. A new Directorate of Groundwater Management was created in October 2017, focusing on designing policies, programs, and strategies for the utilization, conservation, and management of groundwater resources in the state in an equitable, judicious, and sustainable manner.

Further, the government enacted 'The Punjab Water Resources (Management and Regulation) Act, 2020' to ensure the management and regulation of state water resources to ensure the prudent, equitable, and sustainable utilization and management thereof. It had the provision for setting up the Punjab State Council for Water Management and Development to consider and steer the policies and programs of the State to supply quality water to all persons at affordable costs and prices and ensure judicious utilization of water resources of the State. It also provided for the establishment of the Water Regulation and Development Authority to ensure the development, management, and conservation of the State's water resources in accordance with Integrated State Water Plan (ISWP). Also, the Act provided for the Advisory Committee on Water Resources comprising up to five experts having knowledge and experience in the fields of Hydrogeology, Environment, Water Resources, Agriculture, Management or Economics and up to ten ex-officio members from various Government Departments.

In light of the above changes in the policy discourse in Punjab aimed at ensuring judicious, equitable and sustainable groundwater use, the present paper attempts to examine farmers' awareness of such policy instruments. It examines the socio-economic profile of the farmers, the state of groundwater resources, and farmers' awareness of climate change and groundwater depletion. It tends to relate it with their legal literacy on groundwater resources in Punjab. As there are considerable differences in the characteristics of small, medium and large farmers, their irrigation water use and legal literacy, this paper has undertaken the analysis per various landholding size categories to draw meaningful conclusions.

Data Sources and Methodology

This study is based on the primary data collected from the farmers of Punjab by using multistage random sampling procedure (Table 1). One block was randomly selected from each of the 22 districts of Punjab at the first stage of sampling.

Table 1. Sampling framework of the study

Particular	Number	Remarks
Selection of districts	22	All the districts were selected
Selection of blocks	22	One block, selected from each district
Selection of villages	22	One village, selected from each block
Selection of farmers	427	Selected nearly 20 farmers from each village

At the second stage, one medium size village was randomly selected from each of the selected block. A complete list of the farming households was prepared for each selected village 18-20 farmers were selected randomly for this study. Overall, the total sample of this study pertained to 22 blocks, 22 villages and 427 farmers. The details of the districts, blocks, villages and sample size is given in Table 2.

The study sample contained about 45 per cent small farmers (below 5 acre), 37 per cent medium (5-15 acres) and 17 per cent large farmers (15 acres and above) (Figure 1).

A detailed information was obtained about the landholdings, income sources, electric motors, groundwater depletion and groundwater table and the adoption of various water conservation practices by the farmers. Apart from that, farmers' perception of climate change impacts and their legal literacy was also obtained for drawing useful lessons for long-term sustainability of groundwater resources.

Results and Discussion

Operational holdings, income sources and access to irrigation

The overall size of the operational holding was 8.9 acre,

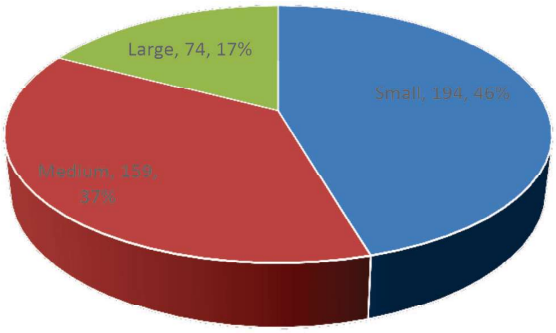


Figure 1. Distribution of sample size across various farm size categories

which is close to the average size of operational holding of the state. It confirms the representativeness of the study sample (Table 3).

The farmers were leasing-in more than 1/3rd of their operational land. The proportion of leased-in land increased substantially with an increase in the land-size category as only about 10 per cent land was being leased-in by the small farmers and it increased to 28.7 per cent by the medium and almost 44 per cent by the large farmers. The extent of leasing-

Table 2. The details of districts, blocks, villages and sample size for the study

District	Block	Village	Sample Size
Amritsar	Ajnala	Kamalpura	20
Barnala	Sehna	Nainewala	18
Bathinda	Rampura	Ramniwas	20
Faridkot	Kotakpura	Dal Singh Wala	18
Fatehgarh Sahib	Bassi Pathana	Nandpur	20
Fazilka	Fazilka	Abhun	20
Ferozepur	Gurharsai	Jandwala	19
Gurdaspur	Kahnuwan	Tugalwal	20
Hoshiarpur	Bhunga	Daffar	31
Jalandhar	Bhogpur	Buttaran	19
Kapurthala	Dhilwan	Bhandal Bhet	20
Ludhiana	Jagraon	Chimna	23
Mansa	Budhlada	Lakhmerr Wal	20
Moga	MogaII	Sadda Singh Wala	20
Mohali	Dera Bassi	Janetpur	20
Muktsar	Kot Bhai	Surewala	22
Nawan Sehar	Nawan Sehar	BarnalaKalan	12
Pathankot	Sujanpur	Baroi	20
Patiala	Bhunerheri	Ghuram	17
Roopnagar	AnandpurSahib	Surewal	20
Sangrur	Malerkotla	Mannki	13
Tarn Taran	Chola Sahib	Marhana	13
Total Sample Size			427

Table 3. Details of operational holdings across various farm-size categories in Punjab

Particular	Average area in acre			
	Small farmers	Medium farmers	Large farmers	Overall
Owned land	2.34 (105.4)	6.09 (75.1)	15.54 (56.3)	6.02 (67.6)
Leased-in land	0.23 (10.4)	2.33 (28.7)	12.08 (43.7)	3.06 (34.3)
Leased-out land	0.35 (15.8)	0.31 (3.8)	-	0.17 (1.9)
Operational land	2.22 (100.0)	8.11 (100.0)	27.62 (100.0)	8.91 (100.0)

Note: The figures in parentheses are percentage of total operational land in that category
Source: Primary Survey

out had inverse relationship with the size of operational holding. The average size of operational holding was 2.22 acre, 8.11 acre and 27.62 acre for the small, medium and large operational holdings, respectively. Relatively smaller proportion of leased-out land was due to the fact that most of the leased-in land came from the absentee land owners.

The overall annual income of a farm household was estimated at Rs 463634. The respective income of small, medium and large farm household was Rs 215604, Rs 423014 and Rs 1201154. The household income was more diversified for small farm households and its diversity declined with an increase in the size of holding (Table 4). The dependence of medium and large farms was mainly on the crops and livestock, which reflected that the diversification to non-farm sources was mainly less remunerative and distress driven. On average, the proportion of income from crops was 29.6 per cent for small farmers, 64.6 per cent for medium farmers and 76.7 per cent for large farmers, respectively and that of livestock income was 16.9 per cent, 15.7 per cent and 19.7 per cent on these farm categories. The small farm households derived more than 40 per cent for their income from wages, salaries and other non-farm income sources. They had even much higher dependence on (7.3%) on transfer income such as pensions, which was less a case for medium and large farm households.

Very high dependence of farmers on crop incomes to sustain their livelihood (as evident from 62.6 % income from crop income and 17.8% from livestock income) reflects that any significant shock to the farm income will have a much adverse impact on the farming households. It also justifies the farmers' reluctance to shift from paddy to less water consuming crops which may endanger their overall income and build distress. Generating awareness and building resilience of medium and large farm households may help in ensuring long-term sustainability of groundwater resources in Punjab.

On average, each farmer owns one electric motor for irrigating his crops (Table 5). The number of electric motors per acre

Table 4. Income distribution of farming households (Rs/annum)

Income source	Small farmer	Medium farmer	Large farmer	Overall
Crop income	63878 (29.6)	273301 (64.6)	921061 (76.7)	290412 (62.6)
Livestock income	36366 (16.9)	66559 (15.7)	237168 (19.7)	82408 (17.8)
Rental income	11611 (5.4)	1704 (0.4)	-	5910 (1.3)
Pensions	15699 (7.3)	9915 (2.3)	5384 (0.4)	11758 (2.5)
Wages/Salary/others	88050 (40.8)	71535 (16.9)	37541 (3.2)	73146 (15.8)
Total household income	215604 (100.0)	423014 (100.0)	1201154 (100.0)	463634 (100.0)

Note: The figures in parentheses are percentage of total operational land in that category
Source: Primary Survey

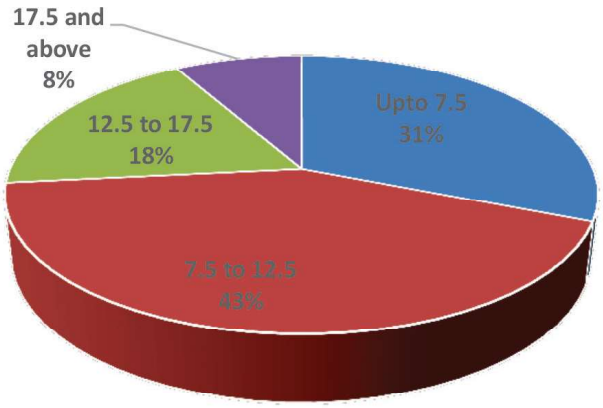
Table 5. Ownership and other details of electric motors on various categories of farms

Particular	Small farmer	Medium farmer	Large farmer	Overall
Average number of electric motors per farmer	0.68	1.03	1.78	1.01
Number of electric motors per acre	0.31	0.13	0.06	0.11
%age of farmers owning electric motors	59.3	84.9	90.5	74.2
%age of farmers owning >1 electric motor	47.4	34.6	73.0	47.1
Average horse power per electric motor	8.76	9.41	9.67	9.13

Source: Primary Survey

are 0.11. While 74.2 per cent farmers own motors, almost 47 per cent of the farmers own more than one motor with the average horse power of about 9.13.

Although, relatively lesser proportion of small farmer own electric motors for irrigation (59.3%), the average number of motors per acre is quite high at 0.31 as compared to 0.13 on medium farms and 0.06 on large farms. The proportion of farmers with electric motors increased with the increase in farm size. More than 70 per cent of the large farmers owned more than one electric motors for irrigation. The average horse power of motors increased with an increase in farm size from 8.76 hp on small farms, 9.41 hp on medium farms and 9.67 hp on large farms. It is evident that majority of the electric motors for irrigation are owned by the medium and large farmers and hence their share in total water usage in agriculture and extraction of groundwater resources is relatively much higher than the small farmers. It is also evident from Figure 2 that majority of the electric motors (>73%) were upto 12.5 hp. While the proportion of 12.5 to 17.5 hp motors was 18.3 per cent, more than 8 per cent of the electric motors were of the horse power of more than 17.5 hp. It is also worth mentioning that the horse power of electric motors varied across districts, although large farmers were owning electric motors with relatively more horse power as evident from Table 5 also.



Source: Primary Survey

Fig. 2. Distribution of electric motors in Punjab

Awareness on groundwater depletion, legal literacy and adoption of water conservation

As discussed above, medium and large farmers usually apportion major part of groundwater for use in agriculture. The perceptions and awareness of climate change and adaptation options can play an important role in long-term sustainability of resources and incomes (Nyong *et al*, 2007; Bryan *et al*., 2009; Mertz *et al*, 2009; Deressa *et al*, 2011). It is worth examining whether the perceptions about groundwater depletion, its factors and the role of village level institutions in their long-term sustainably also follow the same pattern across different farm-size categories or not. The perceptions about the climate change and its effects on factors relating to the groundwater sustainability are given in Table 6. It is evident that majority of the farmers agree to the fact that rainy days have declined with a decline in average annual rainfall, untimely rain events have also increased, temperature is rising and incidences of heavy rains have declined over time.

Only about 13 per cent of the farmers are aware of the adverse effects of groundwater depletion on groundwater stock, which is not a welcome sign. Further disturbing is the fact that the proportion of awareness declined with an increase in farm size (Table 7). It means that large farmers are relatively lesser aware of this fact. On the other hand, about 72 per cent of the farmers agreed to the adverse effects of groundwater depletion and the proportion increased with an increase in farm size. Further, majority of the farmers agreed to the fact that paddy and wasteful use of water were key reasons for over-exploitation of groundwater and depletion of the groundwater table in Punjab. About 56 per cent of the farmers agreed that farmers' cooperatives can play a constructive role in encouraging judicious use of groundwater and its long-term sustainability. However, less than one-fourth of them were in favor of these cooperatives playing an active role. Such proportion was considerably lower at 12.2 per cent for large farmers as compared to 20 per cent and 30 per cent for small and medium farms, respectively. Although more than 90 per cent of the farmers reported that they were aware of the rules relating to the regulation of groundwater in Punjab, only two-third reported to be following them.

Table 6. Perceptions about climate changes and related factors affecting groundwater sustainability in Punjab (% response)

Problem	Small farmer	Medium farmer	Large farmer	Overall
Kharif Season				
Decrease in number of rainy days	91.2	90.6	86.5	89.7
Decline in average rainfall	92.3	94.3	93.2	93.2
Increase in untimely rain events	97.4	100.0	100.0	98.8
Rise in temperature	99.0	98.7	96.0	98.8
Decline in incidence of heavy rains	97.9	100.0	96.0	97.9
Rabi Season				
Decrease in number of rainy days	85.6	93.1	89.2	89.0
Decline in average rainfall	92.8	91.2	90.5	91.2
Increase in untimely rain events	98.5	99.4	97.3	98.6
Rise in temperature	95.6	100.0	98.7	98.4
Decline in incidence of heavy rains	94.8	97.5	95.9	96.0

Source: Primary Survey

In nutshell, awareness is poor about the adverse effect of groundwater depletion on groundwater stock. Despite awareness about the ill-effects and the causes of groundwater depletion, the willingness or action for sustainability is relatively poor. The large farmers have shown even less willingness and this may not go well with the long-term sustainability of groundwater resource in Punjab.

We examine the extent of legal literacy in terms of various Acts and regulations as explained in the beginning of this paper across various farm size categories and tend to identify any class wise differences and their implications for the groundwater sustainability in Punjab. Table 8 provides information about legal literacy on across various farm size categories. Almost two-third farmers reported awareness on Sub Soil Water Act in Punjab and 70 per cent of the farmers agreed that cultivation of paddy after June 15 is viable. Despite awareness, only 15.5 per cent farmers reported any decline in the area under paddy after this Act and the proportion was 12.9 per cent for small farmers, 22 per cent for medium farmers and the lowest at 8.1 per cent for large farmers. Owing to relatively much higher profitability of paddy as compared to alternative less water consuming crops, the farmers might be reluctant to shift the area away from paddy. This was mainly the case for the large farmers who account for larger share of groundwater use in agriculture. However, a large majority agreed that the Act has been able

Table 7. Farmers' awareness and perceptions about groundwater depletion and its conservation

(% response)

Particular	Small farmer	Medium farmer	Large farmer	Overall
Aware of adverse effect of groundwater depletion on groundwater stock	11.3	18.2	6.8	13.1
Groundwater depletion adversely affects agriculture	67.3	76.5	73.8	72.0
Groundwater depletion is due to increased area under paddy	58.7	69.1	58.2	62.7
Groundwater depletion due to wasteful use of water	65.3	73.2	62.5	67.8
Farmers' cooperatives can help reduce wastages of groundwater	59.3	52.8	56.8	56.4
Farmers favoring the role of cooperatives in groundwater sustainability	20.1	30.2	12.2	22.5
Awareness of laws/rules to regulate groundwater use	93.3	85.5	93.2	90.4
Do the villagers follow them?	69.6	59.8	74.3	66.7

Source: Primary Survey

to check the pace of groundwater fall in the state and the proportion agreeing to that was 71.6 per cent, 60.4 per cent and 75.7 per cent of the small, medium and large farmers, respectively. About 58.8 per cent of the farmers also agreed that this strategy of transplanting paddy after June 15 has contributed to recharge the groundwater in Punjab. Many farmers also reported that the delayed transplantation of paddy as stipulated by the Act has a positive effect on the Monsoons in Punjab as early transplantation was causing a delay in their onset. However, almost half of the farmers need a refinement of this Act, which possibly is the advancement of date to June 10. The proportion reporting it was 43.3 per cent, 50.3 per cent and 47.3 per cent for small, medium and large farmers, respectively. Contrary to relatively much higher awareness on Sub Soil Water Act, which is a recent one, the awareness on Groundwater Authority Act and Canal and Drainage Act is very low. The overall awareness about these two laws is only 20.1 per cent and 15.5 per cent, respectively. While 19.1 per cent of small farmers, 29.6 per cent of medium farmers and 8.1 per cent of large farmers are aware of Groundwater Authority Act of Punjab, the respective proportions of awareness of Canal and Drainage Act are 12.9 per cent, 22 per cent and 8.1 per cent. It is striking to note that the awareness is particularly less amongst the large farmers. Such lower levels of awareness, especially among large farmers can jeopardize the long-term sustainability of groundwater in Punjab. In addition, most of the farmers do not believe that the state is appropriately maintaining the drainage work. The proportion of small, medium and large farmers agreeing to this fact is only 6.2 per cent, 11.3 per cent and 5.4 per cent, respectively. In a similar manner, a smaller proportion of farmers had access to canal water for irrigation and reported to receive timely compensation in the case of damage of their crops from floods. Also, the problem of soil erosion was also reported less by the farmers.

The awareness of the groundwater issues and legal literacy about water may decide the future path of groundwater sustainability as it may significantly affect the adoption of water conservation practices by the farmers. The adoption of smart water saving technologies, practices and water efficient crops can pave the way for sustainable agriculture in Punjab (Perveen *et al*, 2008; Sidhu *et al*, 2010; Green *et al*, 2021; Bhogal and Vatta, 2021). The information related to the adoption of such practices is given in Table 9. It however emerges that despite relatively lower level of legal literacy, the large farmers have adopted the water conservation technologies and practices more than their small and medium counterparts.

More than 72 per cent of the farmers have adopted laser land leveling in their fields (Table 9). The percentage of small, medium and large farmers adopting the laser land levelling is 61.1 per cent, 76.8 per cent and 93.2 per cent, respectively. However, the adoption of other options such as direct seeding

Table 8. Legal literacy on water across various farm size categories in Punjab (% response)

Particular	Small farmer	Medium farmer	Large farmer	Overall
Do you know about Sub Soil Water Act?	67.5	58.5	67.6	64.2
If yes, is it viable to cultivate the paddy fields after 15 June?	67.9	73.1	70.0	70.0
Do you think the area under paddy cultivation decreased after implementing this act?	12.9	22.0	8.1	15.5
Do you observe the groundwater depth fall has been checked after the Act?	71.6	60.4	75.7	68.1
Does this policy increase the density of electric tube wells?	43.3	50.3	47.3	46.6
Does this strategy of restricting the paddy cultivation before 15 June is helpful to recharge the groundwater?	62.4	54.7	58.1	58.8
Is there a monsoon shift?	74.7	67.3	79.7	62.8
Does this act need any refinement, please specify?	43.3	50.3	47.3	46.6
Do you know about the groundwater authority act?	19.1	29.6	8.1	20.1
Do you know about the canal and drainage act 1873?	12.9	22.0	8.1	15.5
Does the state govt is appropriately maintaining the drainage work?	6.2	11.3	5.4	8.0
Do you observe approachability of canal water in your fields?	23.5	19.5	17.6	20.2
Do you receive timely compensation for crop damage due to floods?	20.9	18.4	19.1	18.9
Have you faced the problem of soil erosion due to canal water in your field?	12.9	22.0	8.1	15.5

Source: Primary Survey

Table 9. Adoption of water conservation technologies and practices by the farmers (% response)

Particular	Small farmer	Medium farmer	Large farmer	Overall
Land Laser Levelling	61.1	76.8	93.2	72.8
Direct seeding of rice	-	2.9	4.8	2.1
Rainwater harvesting	7.5	5.1	-	5.8
Sprinkler irrigation	0.7	1.0	4.9	1.3
Drip irrigation	2.6	2.2	-	1.9

Source: Primary Survey

of rice, rainwater harvesting, sprinkler and drip irrigation is very low at 2.1 per cent, 5.8 per cent, 1.3 per cent and 1.9 per cent, respectively. While none of the small farmers opted for direct seeding of rice, 2.9 per cent of the medium and 4.8 per cent of large farmers adopted it. Similarly, 7.5 per cent of small and 5.1 per cent of medium farmers adopted rainwater harvesting. While 0.7 per cent of small, 1 per cent of medium and 4.9 per cent of large farmers adopted sprinkler irrigation, the respective adoption of drip irrigation was 2.6 per cent and 2.2 per cent only. As large farmers show higher adoption levels of water conservation practices due to their better incomes, risk taking capacity and their preference for new technologies and practices, increasing awareness and legal literacy and further enhance the adoption levels and feed faster into the long-term sustainability of groundwater resources in Punjab.

Conclusion and Policy Implications

Owing to intensive agricultural practices and dominance of paddy-wheat system, Punjab is facing faster depletion of its groundwater resources. The annual groundwater extraction at 33.85 bcm far exceeds the annual groundwater recharge of 22.80 bcm. It is the reasons for majority fo the development blocks in Punjab reporting over-extraction of its groundwater resources and hence depletion in their water table. A number of Acts have been introduced in Punjab which aim at the grieving situation of groundwater and to ensure its long-term sustainability. The present study aimed at examine the awareness about groundwater resources and legal literacy amongst the Punjab farmers and related these to important parameters of adoption of water conservation and long-term sustainability of groundwater in Punjab. The study is based on the primary data collected from 427 farmers selected from 22 villages spread across 22 blocks in 22 districts of Punjab. The large farmers were leasing-in relatively more land than other farmers and their household income was much less diversified than the small farmers. They showed much higher dependence on land and income from crop farming. They also had, on average, double the number of electric motors than other farmers and almost three-fourth of them owned more than one electric motor for irrigation.

The awareness about the groundwater depletion, its stock, its factors, role of community organizations and legal literacy was less among the farmers and especially lower among large farmers. It can jeopardize the long-term sustainability of groundwater in Punjab. The awareness of the groundwater issues and legal literacy about water may decide the future path of groundwater sustainability as it may significantly affect the adoption of water conservation practices by the farmers. As large farmers show higher adoption levels of water conservation practices due to their better incomes, risk taking capacity and their preference for new technologies and practices, increasing awareness and legal literacy and further enhance the adoption levels and feed faster into the long-term sustainability of groundwater resources in Punjab.

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