Revisiting groundwater depletion and its implications on farm economics in Punjab, India

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The study identifies factors behind the groundwater depletion in Punjab (India) and examines the economics of groundwater irrigation across farm-size categories, varied groundwater levels and energy policy scenario. The farm-level evidences point out that farmers with smaller land holdings incur 2–3 times groundwater cost than those with larger land holdings. Also, small farmers are affected more adversely due to falling groundwater level. Further, financial expenses in extracting groundwater are borne equally by the society and the farmers. The withdrawal of energy subsidy is expected to reduce net returns, but at a varying rate across different crops. However, crop cultivation would still be profitable and de-subsidization will result in 29–82% savings in existing groundwater use in different crops.

Keywords: Crop profitability, energy subsidy, farm economics, groundwater depletion.

PUNJAB is agriculturally the most advanced state of India. The significant contribution of Punjab in sustaining the country's food security can be seen from the fact that it contributed 10.92% of total foodgrains production in India from only 5.20% of total area and supplied 33.8% of total foodgrains procurement by public agencies during 2013–14. Almost double the foodgrains yield in Punjab compared to the average Indian yield is an outcome of widespread adoption of green revolution technology consisting of high-yielding variety seeds, chemical fertilizers and assured irrigation. Undoubtedly, the green revolution in Punjab ushered India in achieving self-sufficiency in foodgrains production. However, a large number of studies point out that sustainability in agricultural production and natural resources base in Punjab are under threat[1–3].

Water is the most critical input for crop production. Amidst inefficient and unreliable canal irrigation systems and public tubewells[4], the Government of India encouraged private investment in groundwater extraction through provisions of subsidized credit availability and the State Government added to it through free power supply. The attractive returns from the new technology and policy support prompted farmers to invest heavily in groundwater development, making it a predominant irrigation source in the state. However, because of injudicious use of this precious natural resource, Punjab has emerged as an extreme case of groundwater overexploitation with 72% higher groundwater withdrawal than the sustainability limit of 20 billion cubic metre (BCM) per annum[5].

Depleting groundwater resources not only disrupt ecological balance, but also put heavy financial burden on farmers and give rise to socio-economic inequality in its distribution[4]. Few studies have addressed socio-economic consequences of depleting groundwater resources in Punjab at micro level[2,4]. Similarly, few studies have identified reasons for emerging groundwater crisis and have elucidated hydrological[6,7], institutional[8,9] and policy[10,11] related measures to improve groundwater sustainability in the state. Among many approaches, regulation of energy supply and its pricing is debated as an effective way to manage groundwater resources in the country[7,12–14]. The present study contributes to the existing literature in many ways. First, it tracks temporal changes and spatial heterogeneity in groundwater depth in Punjab and estimates marginal effect of different factors influencing changes in groundwater level using econometric analysis. Second, the study establishes groundwater cost and farm-size relationship and evaluates the effect of falling groundwater level on its extraction cost across different farm-size groups. Finally, the study estimates the effect of withdrawal of energy subsidy on groundwater pumping cost, crop profitability and groundwater use.

Results and discussion

Temporal changes and spatial heterogeneity in groundwater depth

The changes in groundwater depth are monitored by the Central Ground Water Board (CGWB) through a network of observation wells spread across different states. The

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groundwater depth data of observation wells in Punjab clearly reveal that average groundwater level has declined from about 8 meter below ground level (m bgl) before the year 2000 to about 15 m bgl during 2013 at the rate of about 43 cm/annum (Figure 1 *a*). Further, cumulitive distribution curve (CDF) shows that about 80% of observation wells had less than 10 m bgl groundwater level in 1980 (Figure 1 *b*). Subsequently, groundwater level declined significantly and presently only 35% of the total observation wells in the state have less than 10 m bgl water level. The downward shift in CDF implies decline in groundwater level between the years 1980 and 2013. Declining groundwater level below 8–10 m bgl puts heavy financial burden because beyond this level surface (centrifugal) pumps become ineffective to extract groundwater and farmers have to replace them with costlier submersible pumps[10].

Further, there exists wide spatial heterogeneity in groundwater level in the state. According to CGWB, groundwater level varies from near surface to about 53 m bgl (Figure 1 *b*). The district-wise diagnosis revealed that decline in groundwater level is taking place

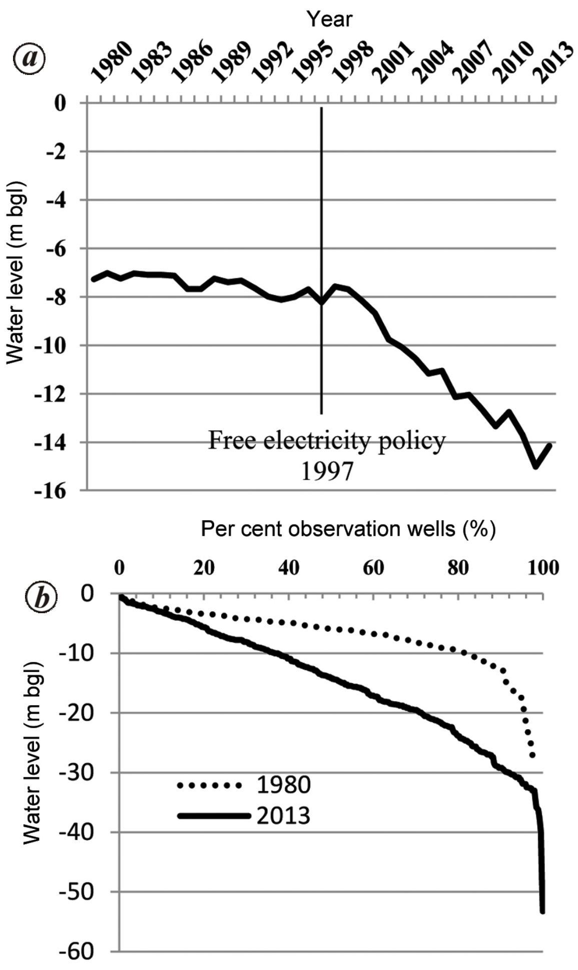

Figure 1. Trend in average groundwater level (***a***) and cumulative distribution curve of observation wells (***b***) in Punjab.

primarily in north–central region of the state (Figure 2). In the south-west region, average groundwater level is less than 10 m bgl. In fact, this region is facing problems of rising groundwater level due to extensive and prolonged use of surface water for irrigation without adequate drainage[15]. For instance, average groundwater level in Muktsar district of southern Punjab has risen from 11.54 m bgl in 1981 to 2.59 m bgl in 2013. An area is said to be potentially waterlogged if the water level is 2–3 m bgl (ref. 16) and prolonged waterlogging leads to accumulation of salts at the soil surface and renders land unsuitable for cultivation. Thus, the state is suffering from dual challenges of excessive groundwater depletion in the north–central part along with rising groundwater level in the south-west region.

Factors influencing changes in groundwater depth

Groundwater depletion takes place when withdrawal is more than its replenishment. About 97% of total annual groundwater draft in Punjab is consumed by the agriculture sector[17]. Therefore, this sector bears the sole responsibility in sustaining groundwater resources of the state. The study hypothesizes that groundwater depth depends on rainfall, pattern of available water resources utilization, existing cropping pattern and energy policy of the state. The effect of the above factors on groundwater level was tested by fitting a pooled ordinary least square (OLS) regression function. For the analysis, time-series data for the period 1980–2011 were collected for 11 unapportioned districts of Punjab. The groundwater depth was regressed with annual rainfall, share of canal in gross irrigated area, share of paddy in gross cropped area, and a dummy variable for free electricity. The State Government started provision of free electricity supply for agriculture[11] in the year 1997, which was taken as the cut-off year for free constructing a dummy variable for free electricity.

The regression analysis revealed that monsoon rainfall and canal irrigation positively contributed to groundwater depth through augmentation of groundwater supply (Table 1). However, direct association between monsoon rainfall and groundwater depth was found to be weaker than that between canal irrigation and groundwater level. This is expected because monsoon rainfall recharges only 32% of annual replenishable groundwater resources[17] due to low annual precipitation of 472 mm during a short span[18]. The bulk of groundwater recharge takes place from other sources (68.27%) such as return flow from irrigation, seepage from canal, recharge from check dams, recharge wells, ponds and water conservation structures[17]. This implies that rainfall alone cannot avert groundwater depletion and greater emphasis must be given to integrated water resources management for augmenting groundwater resources. However, synergy

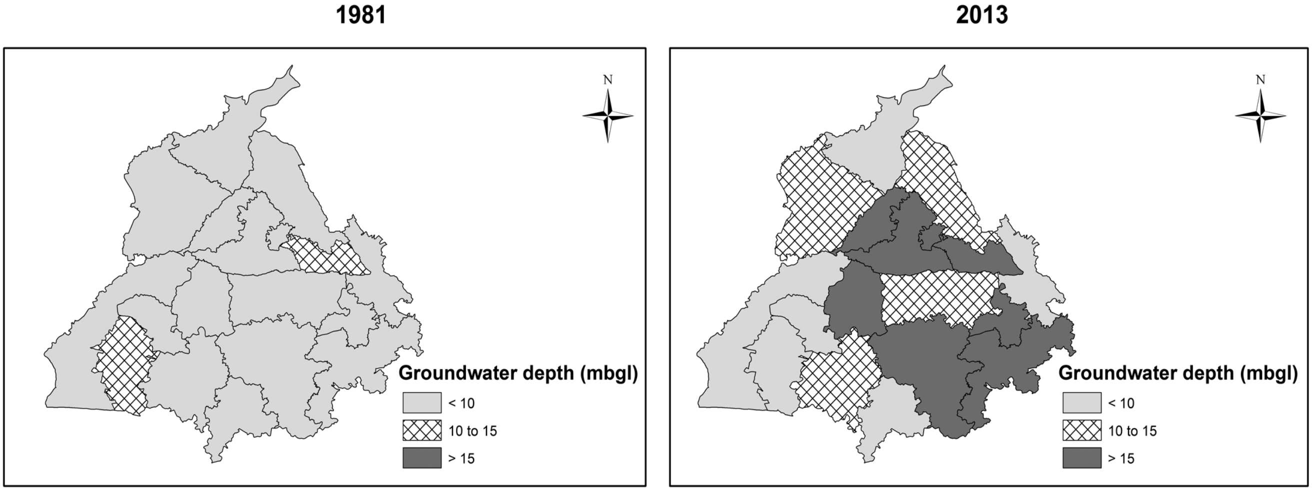

Figure 2. District-wise average groundwater level between 1980 and 2013 in Punjab.

Table 1. Factors influencing changes in groundwater level in Punjab: 1980–2011

Variables	Coefficients
Dependent variable: Groundwater depth (m bgl)	
Explanatory variables	
Intercept	7.969*** (0.793)
Rainfall (mm)	–0.0012** (0.00059)
Canal share (%)	–0.0418*** (0.0080)
Paddy share (%)	0.0587 *** (0.0172)
Free power dummy	2.456*** (0.368)
R^2	0.3498
F-statistics	46.67***
No. of observations	352 (11 districts * 32 years)

***, **Significant at 1% and 5% level of significance respectively. Figures within parentheses are standard errors of the respective variables.

between groundwater and surface water has not been emphasized in the state. Due to higher efficiency and reliability of groundwater irrigation, and poor operational management of canal irrigation system, the share of canal in gross irrigated area (GIA) declined from 42.28% during 1980–81 to 27.35% during 2012–13. The dependency on groundwater irrigation has further increased due to weakening volume and fluctuating pattern of rainfall over time. Consequently, the share of groundwater in GIA has increased from 57.33% during 1980–81 to 72.58% during 2012–13, making it a predominant source of irrigation in the state. Thus, over-dependence on groundwater without proper realization about integrated water resource management is a major supply-side reason of depleting groundwater resources in Punjab. The slow speed of natural replenishment as compared to the continued exploitation necessitates construction of artificial recharge structures for speedy augmentation of groundwater. CGWB has estimated that 43,340 sq. km area (86% of total geographical area) of the state is suitable for artificial recharge[19]. However, the quantity of non-committed surplus surface water in the state has been estimated to be only 1201 million cubic metre (MCM) against the requirement of 70,071 MCM. Therefore, ongoing efforts to augment groundwater supply through artificial recharge structures must be supplemented with measures of reducing demand of groundwater.

Over-dependence on groundwater was accompanied by increasing dominance of water-guzzling paddy crop in cropping pattern. The assured groundwater irrigation along with comparative advantages such as higher and stable yield, support prices, assured market, subsidized farm inputs and free electricity prompted Punjab farmers to cultivate non-traditional paddy crop. Consequently, the share of paddy in gross cropped area increased significantly from 18% during 1980–81 to 36% during 2012–13. It must, however, be noted that paddy consumes 45% (than sugarcane) to 88% (than maize) higher groundwater, and exhibits the lowest groundwater productivity (Rs/m^3) and large-scale inefficiencies in groundwater use than other crops in Punjab[5]. Thus though remunerative, paddy is ecologically a misfit crop in Punjab. The regression analysis also captured adverse effect of paddy cultivation on groundwater depth (Table 1). In order to reduce groundwater use in paddy, the Government of Punjab has enacted The Punjab Preservation of Subsoil Water Act, 2009, which prohibits farmers from sowing nursery of paddy before 10 May and transplanting paddy before 10 June. It is estimated that effective implementation of the Act can check the fall in water table by about 30 cm (ref. 20). On the contrary, a recent study indicated that groundwater level has declined in paddy growing areas after the policy change[10]. Further, in March 2013, the Punjab Government initiated a crop diversification programme for diverting at least 5% of paddy area to alternate crops (maize, *kharif* pulses, oilseeds). However, under the prevailing conditions of electricity pricing and minimum support price, paddy will remain the most remunerative crop[11] and farmers may not move towards diversification until incentivized by economically attractive alternatives. Some of the other initiatives to save groundwater and increase water-use efficiency are the development of short-duration paddy varieties and promotion of resource conservation techniques such as zero tillage, laser levelling, direct seeded rice, etc.

One of the major reasons for inefficient use of groundwater for crop production is the provision of free electricity for energization of pumps, which gives no incentive to farmers to optimize groundwater use. The estimated dummy coefficient for free power for agriculture revealed a significant negative impact of provision of free electricity on groundwater depth (Table 1). Therefore, power reforms and electricity pricing for irrigation play a key role in averting the groundwater crisis in Punjab.

Cost of groundwater extraction for irrigation in Punjab

The economic analysis of groundwater use in Punjab is primarily based on plot-level data collected under 'comprehensive scheme for cost of cultivation of principal crops (CCS)' of the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. In CCS, each household is surveyed consecutively for three years and the latest available data pertain to the period 2008–09 to 2010–11. For Punjab, 300 representative farmers belonging to 30 tehsils were surveyed consecutively for three years by Punjab Agricultural University, Ludhiana, which is the nodal agency for this state. Further, selected households in each tehsil were equally distributed among five land-holding size groups. For estimation of groundwater cost paddy, wheat, cotton, sugarcane and maize, which constituted 87.68% of the gross cropped area of sample households were taken into consideration.

The cost of groundwater extraction depends mainly on the type of tubewells (shallow/deep), pumpsets (centrifugal/submersible) and energy sources (diesel/electricity). The groundwater irrigation cost also depends on whether farmers own groundwater extraction devices (GEDs) or purchase groundwater from fellow farmers. In the present study, groundwater extraction cost for the farmers having their own GEDs has been estimated as the sum of depreciation of tubewells and pumpsets, interest (10%) on investment on tubewells and pumpsets, and operating expenses involved in running and maintaining GEDs. As different crops vary in terms of irrigation requirement, the above expenses were distributed among them based on irrigation hours in each crop. For the farmers purchasing groundwater, cost is equal to the payment made to groundwater sellers. The groundwater cost has been expressed per unit volume of groundwater use and per hectare land under crop cultivation. Following the detailed methodology given in ref. 5, volume of groundwater use in paddy, wheat, cotton, sugarcane and maize was estimated as 12151, 2520, 3920, 6735 and 1485 m^3/ha respectively.

Average cost of extracting 1 m^3 groundwater for irrigation in Punjab was estimated as Rs 0.46 for triennium ending (TE) 2010–11 (Table 2). Among different types of tubewells, groundwater cost was highest (1.04 Rs/m^3) for diesel-operated centrifugal pumps, followed by electricity-operated submersible pumps (0.55 Rs/m^3) and electricity-operated centrifugal pumps (0.23 Rs/m^3) (Table 3). Interestingly, groundwater cost witnessed an inverse relationship with land-holding size. Small and marginal farmers incurred 2–3 times groundwater cost than large farmers during TE 2010–11. While exploring the reasons behind such phenomenon, it was found that about 96% of small and marginal farmers had their own GEDs. The major factors behind the decision to have their own GEDs even by resource-poor small and marginal farmers are almost zero operating cost due to free electricity, unreliable water supply from canals[21], lack of community tubewells[12] and weak groundwater market[22]. According to latest available Fourth Census of Minor Irrigation Schemes, only 0.31% of the total GEDs in Punjab are owned by government or community[16], which indicates a complete absence of community-based approach to manage groundwater resources.

According to CCS data, average present value per GED owned by marginal farmers was Rs 34,963 with average command area of 0.93 ha during 2010–11. On the other hand, for large farmers average present value of groundwater irrigation investment was Rs 50,704 with average command area of 4.33 ha. Thus, large farmers incurred less than one third of the fixed cost to irrigated 1 ha land as compared to marginal farmers. From the preceding discussion, it can be concluded that over-capitalization of GEDs on smaller land holdings and presence of economy of scale in larger farms resulted into inverse relationship between irrigation cost and land-holding size. The analysis further revealed that for marginal farmers groundwater extraction cost from family-owned GEDs (0.98 Rs/m^3) was higher than the cost incurred in purchasing groundwater (0.70 Rs/m^3), though very few farmers purchased groundwater from other farmers. The purchase of groundwater from other farmers is not only unreliable, but also illegal to sell water from the tubewell using free power supply. Thus unavailability of alternative reliable sources of irrigation forces resource-poor smaller farmers to invest in installing GEDs, which in-turn translates into higher unit cost of extracting groundwater than large farmers.

Depleting groundwater level puts further financial burden on the farmers in terms of rising cost of installing new wells, deepening of existing wells, shifting from centrifugal to expensive submersible pumps and other

Table 2. Groundwater extraction cost under different water levels in TE 2010–11 (Rs/m^3)

Groundwater level (m bgl)	Marginal (0.01–0.99 ha)	Small (1–1.99 ha)	Semi-medium (2–3.99 ha)	Medium (4–5.99 ha)	Large (≥6 ha)	Overall
<10	0.48	0.28	0.23	0.17	0.25	0.26
10–15	0.94	0.61	0.46	0.30	0.25	0.44
>15	1.21	0.86	0.47	0.49	0.35	0.57
Overall	0.94	0.65	0.41	0.36	0.30	0.46

Source: Authors' estimate.

Table 3. Effect of de-subsidization of energy on groundwater extraction cost in Punjab during TE 2010–11

Groundwater extraction device	Groundwater cost (Rs/m^3) With subsidy	Without subsidy	Estimated subsidy	Share of subsidy in total groundwater extraction cost (%)
Oil-engine	1.04	1.32	0.28	21
Electric pumps	0.23	0.52	0.29	56
Submersible pumps	0.55	1.18	0.63	53
Overall	0.46	0.91	0.45	49

Source: Authors' estimate.

maintenance activities[10,23]. A perusal of Table 2 shows a sharp increase in groundwater cost with decline in groundwater level, and impacts of such cost escalation are borne more adversely by small and marginal farmers. In many cases, expenses become so large that farmers fail to invest on irrigation and lose access over groundwater resources. Thus, groundwater depletion adversely affects economic access to groundwater resources and farmers with smaller land holdings are worst affected. Installation of community-based GEDs and promotion of groundwater market would go a long way in improving economic access to groundwater, particularly by the farmers with smaller land-holdings in the state. Such a move will result in increase in command area per GEDs as well as reduce groundwater irrigation cost incurred by the farmers.

Effect of de-subsidization of energy on groundwater cost and crop profitability

Among several direct and indirect demand-side management and supply-augmentation approaches[24–26], regulation of energy supply and pricing is often suggested as an effective indirect approach for sustainable groundwater development[12]. During TE 2010–11, Punjab Government incurred Rs 3.20/kWh for supplying free electricity to farmers. The electricity charges for irrigating crops were estimated by multiplying per unit electricity subsidy with energy used (horse power × 0.746 × irrigation hours) in groundwater extraction. Similarly, using unit-level CCS data, diesel subsidy for groundwater irrigation during TE 2010–11 was estimated by multiplying diesel use (litre/m^3) with subsidy rate of Rs 12.95/litre. The estimated subsidy for groundwater extraction varied from 0.28 Rs/m^3 for diesel-operated pumps to 0.63 Rs/m^3 for electrically-operated submersible pumps with average value of 0.45 Rs/m^3 (Table 3). In a scenario of no energy subsidy, average groundwater cost increased from 0.46 to 0.91 Rs/m^3. The results revealed that subsidy accounted for 49% of the total groundwater extraction cost. Thus, financial expenses in extracting groundwater in Punjab are borne equally by the society and the farmers. Among different types of wells, the share of energy subsidy varies from 21% in diesel-operated centrifugal pumps to more than 50% in electric-operated centrifugal and submersible pumps.

The per hectare groundwater subsidy varies across different crops depending on the amount of groundwater used in crop production. In Punjab, estimated per hectare groundwater subsidy varied from Rs 843 in maize cultivation to Rs 5087 in paddy cultivation during TE 2010–11 (Table 4). Similarly, effect of de-subsidization of energy on profitability would also not be uniform across different crops. The results show that increase in variable cost (cost A_1 + imputed value of family labour) due to de-subsidization would reduce net returns by 12.94%, 9.89%, 4.37%, 2.84% and 2.64% in paddy, maize, wheat, sugarcane and cotton respectively. However, more than one value of output–cost ratio across all the crops taken into consideration indicated that farmers would still cover variable cost of production. Thus, empirical evidences indicate that energy pricing would reduce net returns, but crop cultivation will still be profitable in Punjab.

Table 4. Effect of de-subsidization of energy on crop profitability in Punjab during TE 2010–11

Particulars		Paddy	Sugarcane	Wheat	Cotton	Maize
Groundwater irrigation subsidy (Rs/ha)		5087	2552	1125	995	843
$CostA_1$ + family labour (Rs/ha)	With subsidy	29,482	58,680	21,474	30,599	21,955
	Without subsidy	34,569	61,232	22,599	31,594	22,798
Gross return (Rs/ha)		68,788	148,539	47,237	68,326	30,477
Net return (Rs/ha)	With subsidy	39,306	89,860	25,763	37,727	8522
	Without subsidy	34,219	87,307	24,637	36,732	7680
	Change (%)	–12.94	–2.84	–4.37	–2.64	–9.89
Output–cost ratio	With subsidy	2.33	2.53	2.20	2.23	1.39
	Without subsidy	1.99	2.43	2.09	2.16	1.34

Source: Authors' estimate.

Table 5. Effect of withdrawal of energy subsidy on groundwater use for irrigation in Punjab

Particulars	Paddy	Wheat	Sugarcane	Maize	Cotton
Cost elasticity of irrigation	–0.23	–0.37	–0.30	–0.43	–0.60
Irrigation hours (h/ha)	285	60	170	53	46
Discharge (cum/h)	55	55	55	55	55
Increase in groundwater cost due to subsidy withdrawal (%)	98	98	98	98	98
Effect on groundwater use (cum/ha)	–3533	–1200	–2749	–1217	–1478
Present level of groundwater use (cum/ha)	12,151	2520	6735	1485	3920
Per cent change in groundwater use	–29	–48	–41	–82	–38

Source: Authors' estimate.

Effect of energy de-subsidization on groundwater use

The increased marginal cost of groundwater extraction due to withdrawal of energy subsidy would prompt farmers to reduce wasteful utilization of groundwater resources in crop production. The positive effect of energy de-subsidization on groundwater use can be quantified in terms of savings in groundwater use due to increase in extraction cost. The extent of groundwater saving in different crops was estimated using following formula:

$$\mathrm{GWS} = \frac{E_{\mathrm{Ir}} \times \mathrm{IrriHrs} \times \mathrm{Discharge} \times \mathrm{IncreIrriCost}}{100},$$

where GWS is the groundwater saving (m^3/ha), E_{Ir} is the cost elasticity of irrigation, IrriHrs is the number of hours for irrigating crops (hrs/ha), Discharge is the discharge rate of GEDs (m^3/hrs) and IncreIrriCost is the increase in irrigation cost due to subsidy withdrawal (%).

The cost elasticity of irrigation (E_{Ir}) measures per cent change in irrigation hours due to 1% change in groundwater extraction cost. These elasticities were estimated for different crops by fitting translog cost function using seemingly unrelated regression equations (SURE) technique. The detailed procedure for estimation of elasticities has not be given here due to paucity of space and can be obtained from the corresponding author. The estimated E_{Ir} came out to be negative across all crops, implying inverse relationship between groundwater extraction cost and irrigation hours (Table 5). Further, E_{Ir} varied across different crops, which shows varying effect of change in groundwater cost on irrigation. The multiplication of E_{Ir} with irrigation hours, discharge and per cent increase in irrigation cost due to subsidy withdrawal gives the extent of groundwater saving (m^3/ha) in the respective crop.

The results showed that 98% increase in average groundwater cost due to withdrawal of energy subsidy (Table 3) would result in reduction in existing groundwater use by 3533 m^3/ha in paddy, 2749 m^3/ha in sugarcane, 1478 m^3/ha in cotton, 1217 cum/ha in maize, and 1200 m^3/ha in wheat in Punjab (Table 5). In relative terms, the extent of groundwater saving is 29% in paddy, 38% in cotton, 41% in sugarcane, 48% in wheat and 82% in maize. Based on these evidences, it can be concluded that withdrawal of energy subsidy will bring substantial reduction in groundwater extraction and improve groundwater use efficiency for crop production in Punjab.

Conclusion and policy implications

With 172% level of groundwater development, Punjab has emerged as an extreme case of groundwater overexploitation. The empirical evidences clearly show a significant declining trend in groundwater level over time due to injudicious and unrestricted withdrawal of groundwater over its replenishment level. There exists wide heterogeneity in groundwater development across different regions of the state. The extreme overexploitation in the north-central region is accompanied by rising water level in south-west part of Punjab. This calls for a region-specific approach to avert groundwater crisis in the state.

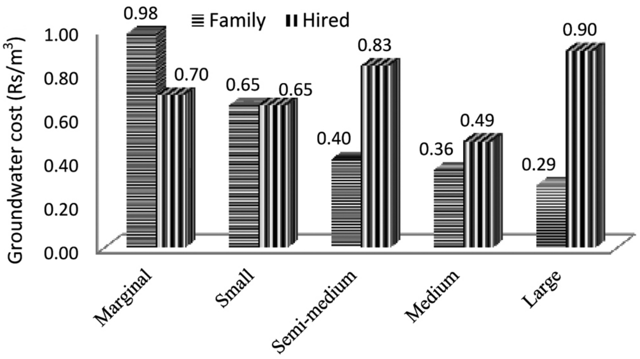

Figure 3. Farm size category-wise groundwater extraction cost from family and hired groundwater extraction devices.

The present study estimated the effects of different demand- and supply-side factors on groundwater level. Among supply-side factors, rainfall and canal irrigation were positively associated with groundwater level by augmenting groundwater supply. The effect of rainfall on groundwater recharge was found to be weaker than recharge potential of canal irrigation. This is expected as rainfall contributes only 32% of total groundwater recharge due to low annual precipitation and surface water is the predominant source of groundwater recharge in Punjab. Therefore, integrated water resources management plays a crucial role in augmenting groundwater resources of the state. However, the synergy between surface and groundwater has not been emphasized in Punjab. On the other hand, higher irrigation efficiency and reliability of groundwater and poor operational management of canal irrigation have made groundwater a predominant source of irrigation. Thus, over-dependence on groundwater without integrated water resources management is a major supply-side reason of depleting groundwater resources in the state. In addition, dominance of paddy in the cropping pattern and free electricity supply for irrigation have emerged as major demand-side drivers of groundwater depletion.

On an average, Punjab farmers incur Rs 0.46 for extracting 1 m^3 groundwater for irrigation, while small and marginal farmers incur 2–3 times groundwater extraction cost compared to large farmers. The inverse relationship between groundwater extraction cost and farm size is due to over-capitalization of GEDs on smaller land holdings and the presence of economy of scale in larger farms. The falling groundwater level further increases the groundwater cost and such cost escalation affects small and marginal farmers more adversely. Therefore, for smaller land holdings, installation of community-based GEDs and promotion of groundwater market will be an economically viable alternative.

The energy pricing is an important tool for sustainable management of groundwater resources. Presently, electricity supply for irrigation in Punjab is free, and financial expenses in extracting groundwater are borne equally by the society and the farmers. In a scenario of withdrawal of subsidy, groundwater extraction cost will double, which will adversely affect net returns from crop production. However, reduction in net returns would vary across crops depending on the extent of groundwater use. The return will still be covering at least variable cost of cultivation. On the positive side, de-subsidization of energy will prompt farmers to improve groundwater use efficiency, which will result in 29–82% savings in existing groundwater use in different crops in Punjab.

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