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Cost recovery dynamics of water pricing for irrigation in India: Issues and future implications

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Abstract
Water as a common resource is expected to satisfy the basic human needs. However, the dimension of the scarcity of water has changed the perspective to view the resource as a free venture. The situation is even critical in agriculture which is one of the largest consumers of water. Traditional solutions are becoming obsolete to deal with this problem. To facilitate better water allocation and encourage conservation of the resource, pricing irrigation water appears to be the necessary solution. India among other developing countries uses the maximum water resources in agriculture. The situation is likely to get worse in future where the population growth will overtake the per capita water resources. Surface water resources in the country are charged at prices which are not sufficient to cover the maintenance expenses. Groundwater is outside the ambit of government legislation. Thus, adopting the right pricing strategy with effective institutional framework is the need of the water sector in India. The paper looks into the existing mechanism of levying prices for surface water in terms of cost recovery. The unnoticed usage of groundwater has been discussed. And the prospects of the water sector in India are suggested.

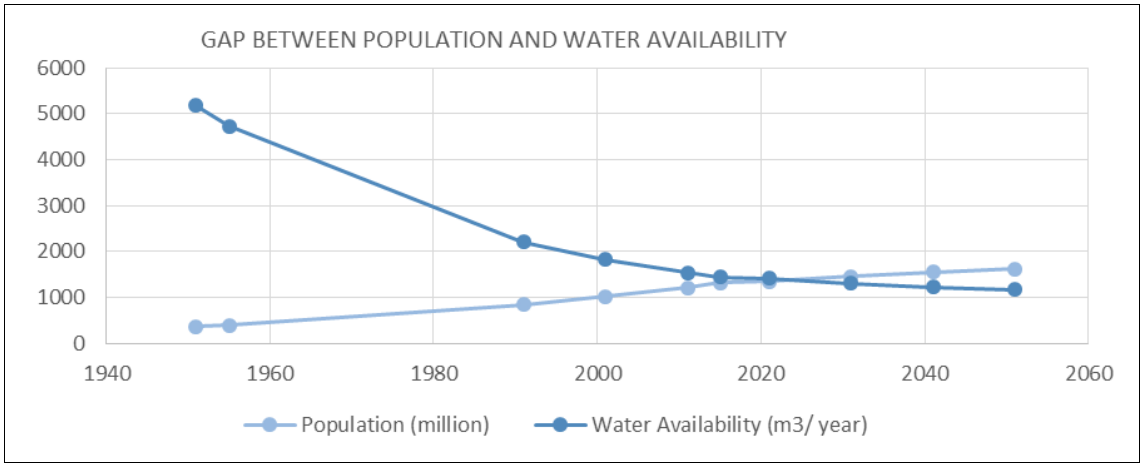
Keywords: Cost recovery, irrigation pricing, groundwater irrigation, surface water irrigation, water pricing

1. Introduction
Adam Smith in his famous "Water-Diamond Paradox" has stated that water being a common resource has no value in exchange despite the high intrinsic value. However, the theory has unravelled with the emergence of the dimension of water scarcity (Zetland, 2011) [36]. The growing water scarcity both physical and economic, calls for augmentation of supply as well the demand-side alternatives to meet the needs of competing ends (Ghosh & Rachuri, 2011) [14]. However, traditional solutions to facilitate supply provides an inefficient solution to water scarcity (Grafton, 2017) [17]. So, the policymakers are constantly looking for the tools to facilitate better allocation and encourage water conservation at the user end. Studies suggest that water pricing is the most suitable management instrument to target the two objectives (Rogers *et al.*, 2002) [28]. Prices which reflect the scarcity value enables the user to make efficient choices. Pricing of water gained popularity internationally in 1992 when Dublin principles acknowledged water as an economic good commanding a price (Dinar, 2000) [8]. Following the timeline, there was a wide consensus among several governments to initiate charges for the water. A wide range of methods to price the water were developed, suiting the administrative and institutional capacities of the governments. Several studies have been conducted to review the pricing mechanism in the global setting. However, no best practice can be recommended to a country or a particular sector (Dinar & Subramanian, 1997) [7] (Tsur et.al, 2004) [35]. Climate change is affecting the scarcity levels of water, demanding a dynamism in the pricing approach towards water conservation.
Agriculture is the single largest consumer of water (Lewandowski, 2013) [21]. A marginal saving in irrigation water can create a substantial expansion in agriculture. However, irrigation water is ill-managed making it scarce for other competing uses. Literature has extensively discussed the role of economics in managing irrigation water (Perry et.al, 1997; Tardieu & Pre´fol, 2002) [25, 34]. Economists want to treat the water as any other private good such that prices are determined by the market. However, the social dimension expects to keep water as a basic human need in consideration. Providing irrigation water requires a significant amount of capital investment and human labour. A proportion of cost must be recovered which requires pricing of water. Pricing and cost recovery have been a contentious issue among countries.

Several studies have carried to estimate the value of water that ensures cost recovery and encourage the conservation of the resource. Volumetric charging of water and indirectly levying taxes were introduced to optimize extractions. But the heavy need for inputs has made it unfeasible for developing countries (Sampath, 1992; Hellegers & Perry, 2001) [30]. Due to the rotational nature of irrigation area based as well as flat-rate systems according to the crop grown have come into the scenario. Due to the increasing scarcity value of water, recovery rates are undermined (Fredrick, 1992) [13]. Thus, the pricing of water needs structural reform as per the nation's suitability.

2. Details of the Study Area

Water resource management is the most emerging issue in developing countries like India. The per capita availability of water has declined from 1816 cubic meters to 1544 cubic meters. Projected per capita availability of water for the years 2025 and 2050 presents a declining trend as presented in Figure 1. While the population exhibits an increasing pattern. The increasing gap depicts the bleak future of water resources in India. Past 2010, country has entered the stage of water stress as defined by Falkenmark's Indicator and will soon enter into the of count of water-scarce nations (Falkenmark *et al.*, 1989) [12]. The sectoral consumption of water as displayed in Figure 2 reveal that Agriculture is the top most consumer of water. To ensure food security, water demand in agriculture is expected to continue in future as per the figure 2. The expanding demand and supply gap of water needs to be shortened. Large scale investments in major and minor irrigation projects are a common feature which fail to ensure proper cost recovery. Further, groundwater is outside the ambit of the government's legislation (Singh, 1995) [33]. Due to this. Its usage largely goes unnoticed. This calls for radical changes in institutional framework governing water development, distribution and use. Pricing of water with an effective institutional framework seems to be the most effective way in this direction.



Source: MOSPI, 2018

Fig 1: Gap between Population and Water Availability

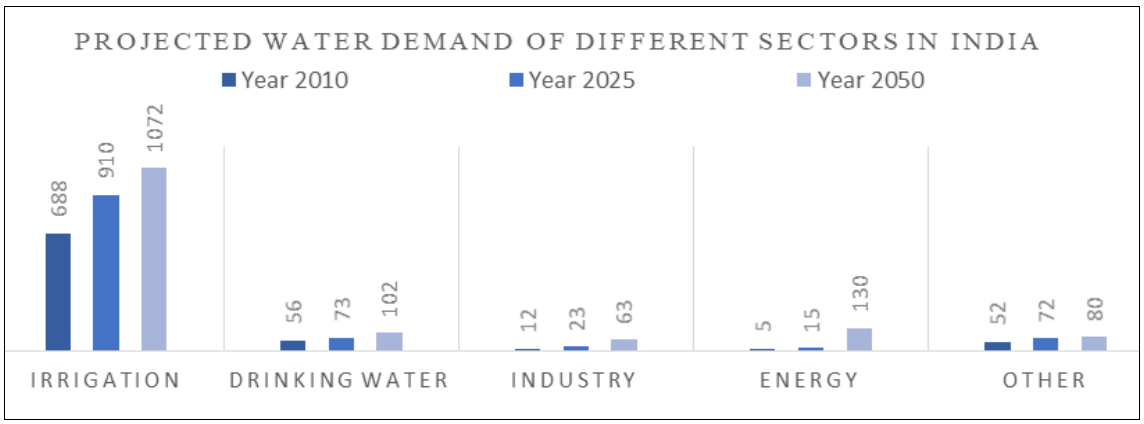


Fig 2: Projected water demand of different sectors in India

3. Irrigation water pricing Experience in India

The tradition of collecting water charges was prevalent in the British era. The origin of the prevalent water charging system is attributed to the British administration. Irrigation projects were treated as commercial undertakings and charges were set to recover the costs. The rates were set following the area-based method due to the impracticality of volumetric based charging (Palanisami *et al.*, 2015) [24]. After independence, there was a change in perspective for water charging. Policymakers viewed irrigation projects as an important component in augmenting income. Thus, huge assistance had been provided to farmers. Green revolution ignited the process in the form of subsidized inputs available to farmers. The country shifted to food adequacy, putting water resources at stake (Briscoe & Malik, 2006) [2]. Being placed in the concurrent list, states have continued using area or the crop-based methods of charging water prices. The priority in setting criteria was laid on the capability of

farmers to pay, Quantity of water put into the system and the system costs (Dinar *et al*., 2015). Despite efforts, Volumetric pricing could not be adopted. The intention of the central government to reflect the scarcity value of the resource, as well as foster intentions regarding its wise use, were reflected in National Water Policy, 1987 and 2002 (GOI, 2002). The National water policy, 2012 has been a significant step in providing an overarching legal framework regarding the general principles of water. The policy clearly states the need for legislation in every state along with the essentialness of devolving power to the lower tiers of government through Water user associations (GOI, 2012). Concerning pricing, the policy considers water as an economic good and acknowledges that the economic principles must be adopted in its valuation. The policy has also suggested its strong commitment to adopting volumetric pricing. Presently, there is a high disparity in the rates charged by states. The differences may either be because of different sources or the type of irrigation practiced. However, the fundamental logic is to charge the rates sufficient to cover the cost of irrigation (Central Water Commission, 2017) [4].

3.1 Surface Irrigation in India

Table 1: State-wise water rates for Flow and Lift Irrigation and the water pricing method adopted

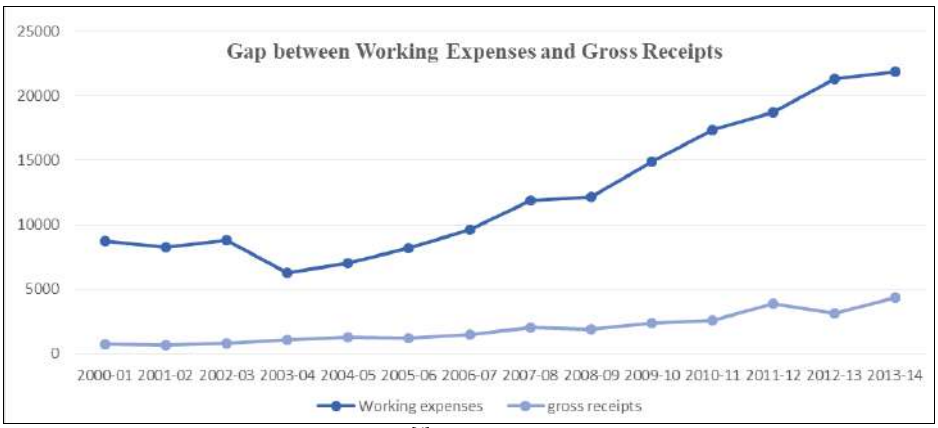
States	Flow Irrigation Range		Lift Irrigation Range		Date since applicable	Water Pricing Method
	Min	Max	Min	Max		
Andhra Pradesh	148.2	864.5	NA		01-07-96	Crop- Specific water pricing
Arunachal Pradesh	No water Rates				29-12-08	No Charges
Assam	150	751	150	751	30-03-00	Crop Specific Water pricing (Based on seasons)
Bihar	74.1	370.5	NA		Nov-11	Crop-Specific Water rates through perennial and non- perennial canal (Based on seasons)
Chhattisgarh	123.5	741	123.5	741	15-06-99	Crop-Specific Water pricing (Based on seasons)
Delhi	34.03	148.2	33.35	148.2	2009	Crop-Specific water rates (Based on seasons)
Goa	72	360	144	720	01-04-13	Crop- Specific water rates (Based on the type of source for water)
Gujarat	160	300	53.33	100	01-01-07	Season-wise, Region-wise and crop-wise water pricing methods (Fixed charges for single and two season crops, higher charges for perennial crops)
Haryana	24.7	197.6	12.35	98.8	27-07-00	Crop- specific (Crops are categorized as 'A' to 'F' based on water requirement. Incentives for water-saving devices)
Himachal Pradesh	49.92	49.92	99.81	99.81	01-04-15	Fixed Water charges
Jammu & Kashmir	121.03	298.87	298.87	2998.58	01-04-15	Crop Specific water charges
Jharkhand	74.1	370.5	74.1	370.5	26-11-01	Crop Specific water rates (Based on the source of irrigation)
Karnataka	37	988.4	74	1976.8	13-07-00	Crop- specific water rates
Kerala	37	99	93	148.5	18-09-74	
Madhya Pradesh	50	960	50	960	31-12-05	Crop- specific water rates (Based on the seasons)
Maharashtra	119	6297	20	5405	01-07-03	Crop- specific water rates (Based on the seasons, Rates of non-cash and cash crops fixed as a percentage of Income)
Manipur	184	602	184	602	24-08-13	Crop specific (uniform rates for flow and lift irrigation)
Meghalaya	No water Rates					No water charges
Mizoram	No water Rates					No water charges
Nagaland	No water Rates					No water charges
Orissa	60	930	NA		05-04-02	Crop-specific Fixed rates
Punjab	123.5	123.5	123.5	123.5	12-11-14	Fixed water rates for all the crops
Rajasthan	29.64	286.52	14.82	573.04	24-05-99	Crop specific (Different rates for Flow and lift irrigation from the central as well as state government)
Sikkim	10	250	NA		2002	Land-Based water pricing
Tamil Nadu	2.77	61.78	NA		06-11-87	Rates are fixed based on wet assessment and dry assessment (further classified as special rates of water cess and standard scales of water cess)
Tripura	312.5	312.5	312.5	312.5	01-10-03	Fixed water charges (For all the crops)
Uttarakhand	30	474	15	237	18-09-95	Crop-Specific water charges (Based on the source- canal for irrigation)
Uttar Pradesh	30	474	15	237	18-09-95	Crop- specific rates (Based on the source- canal for irrigation)
West Bengal	37.06	123.5	251.94	2015.52	01-07-03	Crop- specific water charges
A & N Islands	No water Rates					No water charges
Chandigarh *	NA					Fixed water charges (hourly charges)
Dadra & Nagar	110	830	75	275	29-01-96	Crop- specific water charges (Based on seasons)
Daman & Diu	286	286	286	286	2007	Fixed Charges
Lakshadweep	No water Rates					No water charges
Puducherry				NA		

Source: Central Water Commission, 2017 [4]

Table 1 presents the range of the water rates for flow irrigation and lift irrigation charged by the states of India along with their date of applicability. The states of Arunachal Pradesh, Meghalaya, Mizoram, Nagaland Andaman & Nicobar Islands and Puducherry have no water charges till date. Except for them, all the states have water

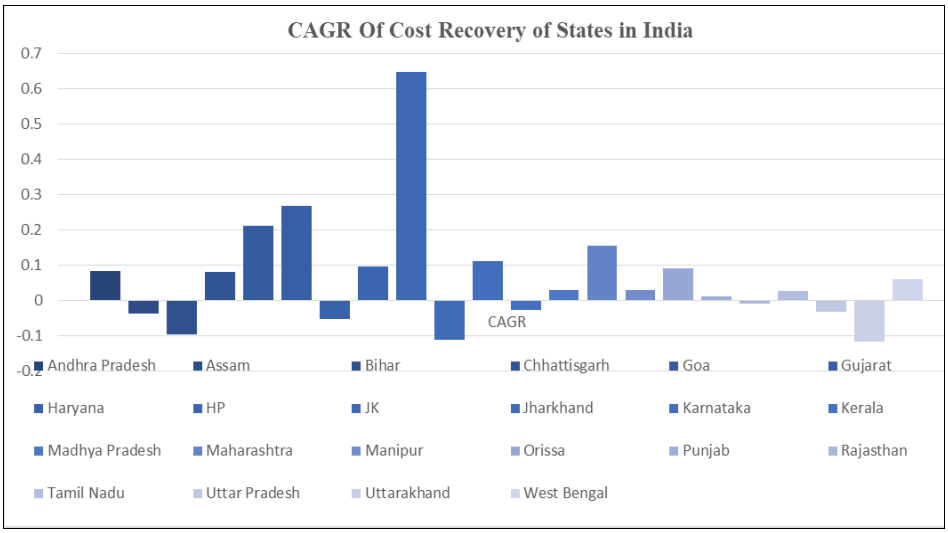
charges either directly or indirectly. The rates levied and the method adopted for charging price vary from fixed charges to the Crop specific charges based on the seasons or type of source. While most of the states have revised water rates in the last 10-15 years, states like Kerala (1974) and Tamil Nadu (1987) have it pending for three decades. Crop specific water rates based on the season -Kharif/ Rabi was a prevalent method adopted by Assam, Chhattisgarh, Orissa, Bihar, Madhya Pradesh and Delhi. In fixation of rates, Madhya Pradesh, Gujarat and Chhattisgarh considers Agreement rates, confessional water rates, geographical unit, system and type of irrigation apart from the season and the crops grown. These states have uniform rates for lift and flow irrigation. Most of the states have higher charges for lift irrigation due to higher rates of lifting. States of Goa, Jammu & Kashmir, Himachal Pradesh and West Bengal have more than double rates for lift irrigation. Gujarat classifies the crop rates on basis of seasons such that same rates are charged for the single seasonal or two seasonal crops and higher rates are charges for perennial crops. Another prevalent practice of water pricing is charging water services based on the source of irrigation. The variation based on irrigation projects reflects the continuity and dependability of irrigation services. Andhra Pradesh has classified rates in two categories while Uttar Pradesh and Uttarakhand have four classifications. Jharkhand has two categories with higher rates for perennial flow and lower for the non-perennial flows. Kerala bifurcates the rates in three classifications based on the area irrigated by flow or lift irrigation. Tamil Nadu has five classifications as per the capacity to irrigate lands. The charges are based upon the valuation of land revenues, which are higher for irrigated land than the dry lands which don't have assured supply of water. Few states like Punjab, Himachal Pradesh and Tripura follow the practice of charging uniform rates for all the crops. While in some states, variation in the crop rates appear to be marginal. The water rates in Haryana have undergone reforms. Crops are categorized from 'A' to 'F', where category 'A' covers green manure crops which have no water charges ranging to 'F'. Incentives are provided to the farmers incorporating water-saving devices in irrigation practices. The pricing policy in Maharashtra is governed by the Maharashtra State Irrigation Commission. The prices are fixed nearly around 6% of gross income for non-cash crops and 12% for cash crops.

Despite the reforms, the economic performance of the water sector has not delivered the desired results. Financial performance of India in terms of cost recovery has been very poor. The gap between working expenses and gross receipts has widened over 14 years as shown in Figure 3. None of the states has been able to cover operation and maintenance costs which are efficiency indicator for developing countries (Saleth & Dinar, 2005) [29]. The price gap has widened over time in all the states.



Source: Central Water Commission, 2017 [4]

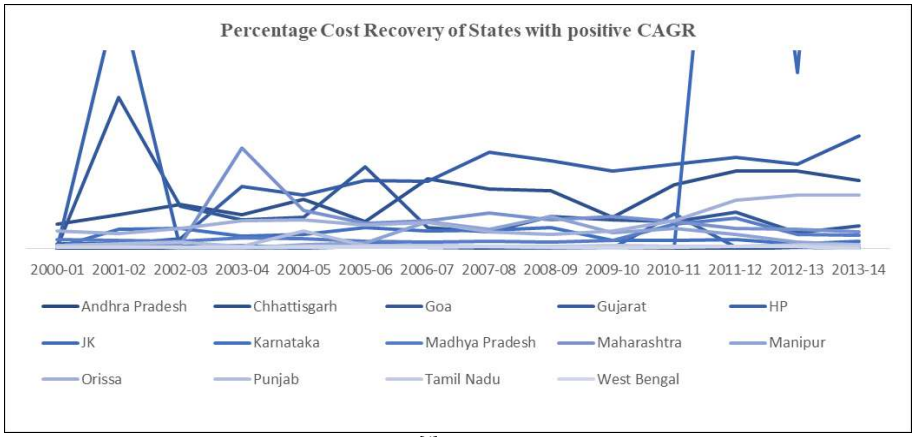
Fig 3: Gap between Working Expenses and Gross Receipts of All India



Source: Author's Calculation

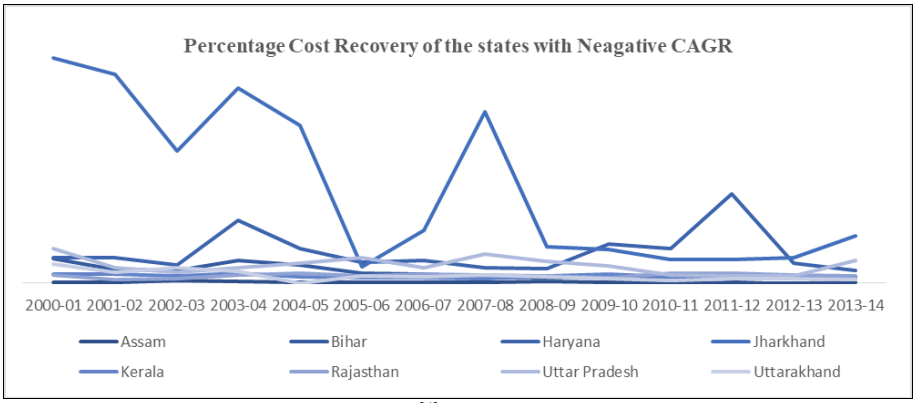
Fig 4: CAGR of Cost Recovery of States in India

Success stories of nations with better water performance reveal that their cost recovery percentage is high (Easter & Liu, 2005) [10]. India's poor performance can be attributed to the low rate of cost recovery of its states. Cost recovery is defined as the ratio of gross receipts to working expenses multiplied by 100. The computation of CAGR of percentage cost recovery of several states as presented in Figure 4 reveal that none of the states have recorded a CAGR higher than 0.6%. Majority of the states have consistently recorded low gross receipts throughout 14 years. 8 out of 22 states have recorded negative CAGR revealing the worse state of cost recovery among these states.



Source: Central Water Commission, 2017 [4]

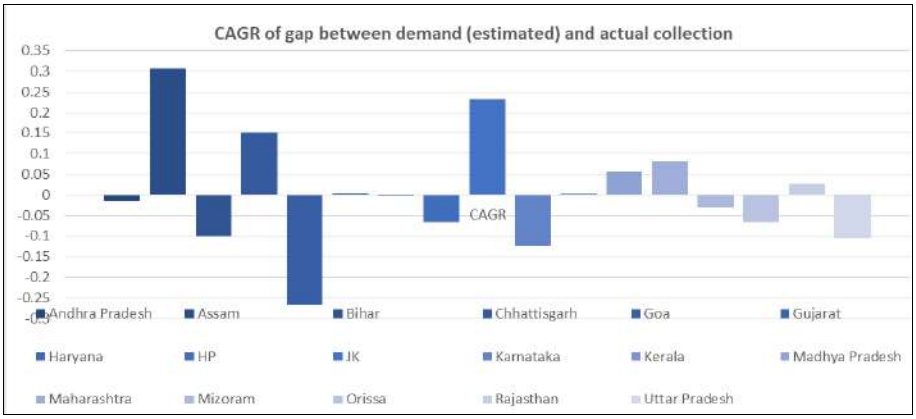
Fig 5: Percentage Cost Recovery of States with positive CAGR



Source: Central Water Commission, 2017 [4]

Fig 6: Percentage Cost Recovery of the states with Negative CAGR

A trend analysis for 14 years from 2001-2014 of the states recording negative CAGR has been presented in Figure 6. Jharkhand has been one of the most underachieving states displaying a steep decline in 14 years. Rest of the 7 states have shown consistency in their performance of low-cost recovery. The trend line of 14 states with positive CAGR has been shown in Figure 5. Jammu and Kashmir has recorded the highest CAGR of 0.64% with gross receipts exceeding expenses since 2011. Gujarat is the second-best performer recording a CAGR of 0.266%. Beyond 2006-07, gross receipts have overtaken working expenses. The success can be credited to the reforms in the pricing mechanism since 2007. Chhattisgarh and Orissa have presented an upward surge in CAGR since 2009-10 with gross receipts moving in an upward direction. Andhra Pradesh has recorded a positive CAGR, yet the gap between the working expenses and gross receipts has increased by large figures. Pricing reforms have led to an increase in water rates, yet they are unable to cover the operating expenses. Water users often report less irrigated area for collection of charges. The discrepancies persist on the collecters end as well pointing at the low score for cost recovery (Shen & Reddy, 2016). Rajasthan has recorded negative CAGR and gap between receipts and expenditure seems to be widening. Despite the presence of 800 water user associations, devolution of power has not taken place (Reddy, 2005). Haryana has incorporated price reforms. Collections rates in the state are around 90 per cent. However, the low CAGR and expanding gap in recovery is due to the low prices charged. The charges constitute a very low share of the farmer's profitability, hence there is no reason to reject payments (Hellegers & Perry, 2006) [19]. CAGR of the gap between demand (estimated) and the actual realization of receipts are shown in Figure 7. An analysis of CAGR reveals that only 6 states out of 17 states have shown positive grown in realizing the collections. The gap is substantial for the rest of the states.



Source: Author's calculation

Fig 7: CAGR of gap between demand (estimated) and actual collection

3.2 Groundwater Irrigation in India

Groundwater has emerged as a dominant source of irrigation and ensuring food security over time. It accounts for 89 per cent of the total irrigation potential utilized by the country (Envistats, 2018). Around 70 per cent of the food grain production is driven from irrigated agriculture where groundwater is the leading source. The legal framework bestows rights regarding groundwater to the owner of the property, hence falling under the private regime (Jeet, 2005) [20]. This makes a landowner draw any amount of groundwater unless limited by technology or hydrology. Further, there is no legal binding in the selling of the water (Singh, 1991) [32]. As the growth of groundwater irrigation is not policy-driven, this source of irrigation is heading for a crisis. The overall development of groundwater resource is 63 per cent, which does not raise concern. However, the geographical variation in these figures has a different story to tell.

Table 2: Share of Groundwater in total Irrigation potential utilized, Stage of groundwater extraction and number of Taluka/Blocks/ Mandals of all the states which are safe or overexploited

States	Share of Groundwater in total Irrigation potential	Stage of groundwater extraction	No. of Blocks/Mandals/Talukas			
			Safe (2013)	Over exploited (2013)	Safe (2017)	Over Exploited (2017)
Andhra Pradesh	69.27	44.15	74	9	75	7
Arunachal Pradesh	0.19	0.28	100	0	100	0
Assam	65.22	11.25	100	0	100	0
Bihar	96.22	45.76	97	0	81	2
Chhattisgarh	84.08	44.43	86	1	84	0
Delhi	NA	119.61	NA		9	65
Goa	42.08	33.5	100	0	100	0
Gujarat	94.73	63.89	78	10	78	10
Haryana	99.90	136.91	25	54	20	61
Himachal Pradesh	25.19	86.37	75	13	38	50
Jammu & Kashmir	7.65	29.47	100	0	100	0
Jharkhand	56.15	27.73	94	2	94	1
Karnataka	81.87	69.87	56	24	55	26
Kerala	19.67	51.27	86	1	78	1
Madhya Pradesh	83.24	54.76	73	8	77	7
Maharashtra	79.62	54.62	92	3	77	3
Manipur	0.00	1.44	100	0	100	0
Meghalaya	11.39	2.28	100	0	100	0
Mizoram	0.00	3.82	100	0	100	0
Nagaland	0.20	0.99	100	0	100	0
Odisha	34.73	42.18	98	0	5	0
Punjab	99.63	165.77	19	76	5	79
Rajasthan	97.14	139.88	18	66	15	63
Sikkim	0.00	0.06	0	0	0	0
Tamil Nadu	87.69	80.94	38	31	37	40
Telangana	80.99	65.45	70	10	48	12
Tripura	12.91	7.88	100	0	100	0
Uttar Pradesh	99.46	70.18	74	14	65	11
Uttarakhand	54.68	56.83	89	0	72	0
West Bengal	75.16	44.6	71	0	71	0

Source: Central Ground Water Board (2017), MOSPI (2018)

Table 2 shows the share of Groundwater in total Irrigation potential utilized, Stage of groundwater extraction and number of Taluka/Blocks/ Mandals of all the states which are safe or overexploited. There is substantial variation in

the share of groundwater in total irrigation potential utilized by each state. The per cent is above 90 in Bihar, Gujarat, Haryana, Punjab, Rajasthan and Uttar Pradesh depicting the crucial role of groundwater in irrigation. Whereas the share is less than one third (33 per cent) in Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Kerala and Northeastern states. There is a difference in the groundwater development among the states as well. The level of groundwater extraction has already crossed 100 per cent mark in Punjab, Haryana, Rajasthan and Delhi. The skewness in groundwater endowment is reflected in the variation of groundwater extraction among states. The high rate of groundwater exploitation can be traced back to the emergence of the green revolution. There was a surge in the nation to become food secure. As a result, inputs were provided at highly subsidized rates. Cheap and unmetered electricity accompanied with new pumping technologies became widely available. Moreover, the salinity and waterlogging problems observed in surface irrigated areas became another reason for the farmers to move a step towards groundwater irrigation. The practice of replacing groundwater sources over surface water for irrigation became widely prevalent as there we no institutional complexities involved. Subsequently, tube well irrigation became widely adopted method among states. (Briscoe & Malik, 2006) [2]. Punjab and Haryana were the major gainers of the green revolution. Since the 1970s, North-western states have experienced a steady increase in groundwater usage such that extraction exceeds the rate of recharge (Prasad & Rao, 1991) [26]. Regulation of groundwater is mainly done through electricity pricing which does not reflect the scarcity value. On the contrary, the subsidization of electricity along with the absence of metering and widespread commercialization has depleted the groundwater table in most parts of the country (Moench & Kumar, 1995) [22].

The stage of high groundwater extraction has led to high overexploited blocks in the state. The states have a high level of groundwater extraction have a high number of overexploited areas pointing at lack of initiatives for conserving water. The overexploitation raises another concern about the depleting quality of water. This has an impact on the health of users as well. The overexploitation has caused fluoride contamination in groundwater in Gujarat and Rajasthan. The table displays that Haryana, Himachal Pradesh and Punjab have displayed a considerable increase in per cent of overexploited areas. The scenario fosters questions regarding the sustainability of resources.

4. Conclusion and Future Prospects

Pricing of water has captured the interest of policymakers from a very long time. Yet the results have not been concrete. Prices reforms have time and again aimed at recovering the operation and maintenance cost, and eventually upgrading to a two-part tariff comprising of flat rate along with volumetric pricing. Despite the efforts to reshape the pricing structure, India's water sector has failed badly in financial terms. Water prices have not evolved enough to cover the scarcity value of water. The season based crop pricing followed in most of the states is appropriate, as irrigation requirements are lower in Kharif season. Despite that, low rates of recovery are still prominent. The reasons attributed to the low status of cost recovery is the poor linkage between the prices charged and funds allocated for the project. This has been the case with most of the states. Sustainability of irrigation system is one of the major reason that can increase the willingness to pay among farmers. Several political-economic factors block the pavement of efficient delivery of services. The case of Andhra Pradesh brings out discrepancies at the user end. Lack of transparency and communication can accentuate the financial troubles.

Evidences at global level indicate the adoption of volumetric based pricing as the most appropriate method of pricing. This can be an aid in achieving another objective of pricing- to enhance water use efficiency. To enhance efficiency, prices must be equated with the marginal cost.The policy may not be economically and politically feasible in many states of the country where the majority of farmers belong to marginal sections. However, there is a duality in resource endowment within the country. States like Punjab and Haryana bear a low or negative CAGR in cost recovery primarily due to the low charges of water compared to farmers profits. Volumetric based pricing can be an apt step in these states. This calls for a revision of pricing appropriate to the economic factors of the state. A success story of a volumetric based price mechanism is presented by Katepurna in Eastern Maharashtra. Shifting from area-based pricing to volumetric method promoted incentives to conserve water and promote efficiency (Balesare, 2001) [1].

Development of groundwater resources has led it to occupy a significant position in India's agriculture and ensuring food security. The groundwater resources of India are treated as common pool resources, thus outside the ambit of water pricing. Water can be treated as a social as well as economic good, depending upon the usage of the resource. The existing rate of depletion of groundwater demands for valuation of the resource as an economic good. The state-wise scenario of the groundwater extraction and the persistent overexploitation point out at unwelcoming future for the resource. The scarcity value of water must be reflected in its pricing to inculcate the efficient and sustainable usage. Pricing needs to be done as per the crop grown so that water-intensive crops are charged highly. Due to high water footprint of these crops, their production must be viewed by looking at economic as well as environmental considerations. As the usage of groundwater is regulated by levying charges for electricity, revision of electricity rates must be considered. Installation of meters can prove to be another significant step in promoting its efficient use. The biggest barrier in putting value to the groundwater as an economic resource is the legal arrangement. Due to its private ownership, landowners have exploited the resource to their convenience. The fundamental step in curbing the inefficient resource utilization would be to separate the land and water rights.

Managing water resources becomes essentially difficult at the suppliers end. Inappropriate pricing, high investment costs and inadequacy of recovery become barriers in managing the surface water resources. And the inability to fetch a market price for groundwater resources make its management difficult. The present institutions- central, state or local are unable to provide appropriate allocation and management. A major institutional reform can be in the form of building up of water user associations (WUAs). Involvement of farmers in decision making can reap benefits for surface as well as groundwater management.

Gujarat provides one such example where private ownership of tube well irrigation by the farmers has enhanced cost recovery (Cornish & Perry, 2003). There is an increase in incentive to pay, as the defaulter's land can be confiscated. The inclusion of water users in decision making has led to an increased willingness to pay for better services (Naik & Kalro, 2000) [23]. Therefore, pricing framework in its existing structure cannot enhance better water allocation. The price reforms coupled with appropriate institutional arrangements can address the crisis in the water sector sufficiently.

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