

Water conservation in India: An Institutional perspective

K.B. Ramappa¹, B.S. Reddy² and Savita K. Patil³

¹*Institute for Social and Economic Change (ISEC), Bangalore 72, India*

²*Department of Agricultural Economics, College of Agriculture, Bheemaranagudi 287, Karnataka, India*

³*Department of Agricultural Economics, UAS, Raichur, Karnataka, India*

ABSTRACT

The demand for water among various sectors is increasing due to population growth and economic development, in turn creating competition within sectors. The severity of this issue will have direct impact on water and food security of the country in future. Due to over exploitation of water resources, it has become scarce in many parts of the country. The concerted efforts of the government are trying to prolog this situation. Both the Central and State governments have undertaken various programs in water conservation and management successfully from the inception of FYPs in the country. In the course of all these programmes, the country could able to become the largest producer of several millets and second largest producer of rice and wheat in the world. Among the number of programmes, CADWM, NWDA and WDP were the major programmes for land development and water (resources) conservation and management in the country. Further, among externally assisted water sector projects, World Bank is the primary source followed by ADC, JBIC and Kfw, Germany. Many projects under the external assistance from these sources were completed and few are on-going in many states. All these programmes under water conservation created huge infrastructure and irrigation potential for agriculture and are trying to improve the water and food security situations in the country. In addition, they not only protect and conserve environment but also contribute to livelihood security of rural poor. Therefore, the country still requires continued efforts of the government along with external aids especially in the issues of global climate change and promotion of consumer awareness on water conservation. Government should come up with a new water policy prescribing the role and involvement of individuals, community and government for conservation of water.

Key words : Irrigation, Growth, World Bank, Watershed, Programs, Water demand, Water conservation

Introduction

Water is one of the precious natural resources; each and every living thing needs water to survive. Even though, 97 per cent of the earth is surrounded by water, only three per cent is fresh and two thirds of this is frozen, the remaining unfrozen was found mainly as groundwater, and a small fraction present above the ground or in the air. The usage of water across various sectors in India is on the rise. There-

fore, its sustainable management is essential to protect the water environment and to meet the increasing water demand in the future. Irrigation perhaps the most important input in the agriculture production compared to all other key inputs namely, seed and fertiliser. In fact, these inputs cease to realise their full benefit unless combined with irrigation. However, the past few decades has seen an increase in demand amongst various water using sectors putting enormous stress on the natural resource.

1. Associate Professor, 2. Assistant Professor, 3. Research Scholar

*Corresponding author's email: bsreddyagecon@gmail.com

It is pertinent to note that there exists a considerable temporal and spatial variation within the country with respect to water availability. For instance, the Ganga-Meghna-Brahmaputra basin covers a land area of 33 per cent and accounts for 60 per cent of India's water resources, while the catchment of rivers flowing west is 3 per cent and they account for 11 per cent of the country's water resources. Therefore, 71 per cent of India's water resources are available to only 36 per cent of the area while the remaining 64 per cent has 29 per cent available (Verma and Phansalkar, 2007). Various estimates point to a widening gap between water demand and supply in the future.

Since ancient, Indians have adopted traditional methods of water harvesting and they believed that protecting forest is protecting water catchments. The country has been making significant progress in developing water resources and creating infrastructure from the inception of FYP. Creation of large storage structures and minor storage structures through national level watershed programs and the external assistances (World Bank and other multilateral and bilateral agencies) have contributed considerably in conservation and management of water as a natural resource. These efforts could able to increase overall agricultural productivity without making additional demands on fresh water resources. In this paper, authors have made an attempt to understand the developmental activities undertaken by the concerted efforts of government and external support agencies for the efficient conservation and management of water for the future in the country.

Methodology

The research study is exploratory in nature. As the topic is a need of the hour, the initiatives taken up by different institutions and their new methods and programmes on water conservation and management were observed and revealed through this research. The necessary data were collected from the available secondary sources such as the annual reports, journals and the websites of different governmental portals. The tabular analysis was used to prepare necessary tables and graphs presented in this paper. The objectives of the study is to understand the present status and future demand for water in the country for various sectors, as well as the role of government and external agencies in conservation of water to meet this requirement.

With the limited availability of literatures on the topic discussed in this article, authors have tried to collect few reviews on methods and benefits obtained under water conservation in this section as follows;

The study conducted by Fuglie *et. al* (2007) on 'Productivity Growth in US Agriculture' from 1948 to 2004 averaged 1.8% annually due to the adoption of biotechnology- drought tolerant varieties that increased production per unit of water. Given this scenario, the biotechnology adoption assumes all crop yield increases at the rate of 0.5% per year. In addition, water use is assumed to be reduced at the rate of 1% per year.

The Economics Section of the Ogallala Aquifer Project conducted water conservation policy survey shown that the biotechnology and water use restriction policies resulted in the greatest increase in saturated thickness over the base line. The adoption of a water conservation policy, similar to the technology adoption process, may reduce groundwater consumption in the short-run but will not reduce groundwater consumption over an infinite horizon. The reported water savings are potential water savings. The selection of a water conservation policy by policymakers greatly depends on their goals for particular counties and/or regions. If the goal of the policymakers is to implement a policy that will result in the greatest amount of water savings, the water use restriction policy, biotechnology policy (if the technological advances are available), or permanent conversion to dry land policies would be the choice (Steve Amosson *et. al*, 2009).

Pande *et al.* (2011) conducted a study on the issue of incentives for the adoption of soil and water conservation in the ravines of Gujarat in the context of holistic development of small and marginal farms and their profitability. The study was based on two groups of farms- with and without conservation history. The results of the study verified with the argument that under the present price scenario, farm profitability makes the marginal farms susceptible to a vicious poverty circle. The input and output prices prevailing in the region do not favor the farming enterprise. Thus, authors suggested that this policy variable would have little impact on farm profitability and the incentive to adopt conservation on farm.

Smith (1998) discussed in his paper about the use of subsidies for soil and water conservation (SWC) in the KRIBHCO Indo-British Rainfed Farming

Project being implemented in degraded areas of western India. The author of this paper suggested that for private farmland, farm households are subsidized with fixed land improvement grants (rather than paying those who participate in the SWC work), the farmers and their hamlet members should discuss how the money would best be used otherwise they can propose a fixed subsidy per unit area for communal land improvement and when watershed management is conducted on a village basis.

Results and Discussions

Present Status and Demand for Water

The official estimates of the Ministry of Water Resources (MoWR) have put total utilisable water at 1,123 billion cubic metres (BCM) as against the current use of 634 BCM, reflecting a surplus scenario (Planning Commission, 2010) based on the Central Water Commission's (CWC) estimation of India's water resource potential as 1869 BCM. But there is a considerable temporal and spatial variation within the country with respect to water availability. Various estimates point to a widening gap between water demand and supply in the future.

The government has taken up various irrigation projects both in micro and macro irrigation schemes. The major sources of irrigation in the country are canals, tanks, wells (including tube wells) etc., which all together irrigated net area of 63601 thousand ha as on 2010-11 (Table 1). Among different sources of irrigation, canals were the principal sources which contributed about 60 percent of the net irrigated area till 1970s but their place was replaced by wells (including tube wells) thereafter. As noticed from the table that in recent years, even though groundwater has gone down, there has been phenomenal growth of minor irrigation and many farmers are going for individual pump sets to ensure better and reliable supply of irrigation water to their field. Tank irrigation constitute about 4 percent of the net irrigated area, most of these sources found in east and north eastern part of the country except few southern states wherein they have some traditional area for tank irrigation.

The increased area under irrigation has been directly contributing towards ensuring food security in the country even though economic growth contribution of agriculture to India's GDP declining. With the increased irrigation potential created, the country could able to become the largest producer of several staples such as millets and the second largest

Table 1. All India net area irrigated by source over the years (000's Hectare)

Year	Net Area Irrigated From						Other Source	Total
	Canals		Total	Tanks	Wells			
	Govt.	Pvt.			Tube wells	Other Wells		
1995-96	16561	559	17120	3118	17910	11787	3467	53402
1996-97	16889	220	17109	2821	19338	12457	3388	55112
1997-98	17186	211	17397	2597	19680	12431	3106	55210
1998-99	17099	212	17311	2795	21394	12606	3329	57436
1999-00	17247	194	17440	2539	22042	12597	2912	57531
2000-01	15809	203	16012	2466	22566	11252	2909	55205
2001-02	14992	209	15200	2186	23239	11944	4350	56920
2002-03	13865	206	14071	1803	25624	8724	3662	53884
2003-04	14248	206	14455	1916	26690	9693	4292	57046
2004-05	14550	214	14763	1734	25233	9956	7531	59218
2005-06	16489	227	16716	2083	26025	10045	5962	60831
2006-07	16802	224	17026	2078	26942	10699	5998	62744
2007-08	16595	217	16812	1978	28499	9901	6103	63291
2008-09	16750	195	16945	1985	28369	10426	6015	63740
2009-10	16508	188	16697	1638	28948	10094	5880	63256
2010-11	15496	171	15667	2004	28550	10510	6871	63601
Average % Contribution	27.4	0.39	27.78	3.81	41.67	18.66	8.07	100

Source: Ministry of Agriculture, Govt. of India. (ON348)

producer of wheat and rice. Few recent studies claim that India can easily feed its growing population. Maize has taking third place among food crops after rice and wheat in terms of area and production in recent years.

Note : Irrigated area : The figures related to irrigated area are either estimated based on the data for the latest available year received from the State/UTs or are estimated/taken from agriculture census.

It is only after the introduction of Five Year Plans by the Government of India in 1951, attempts were made for rapid harnessing of water resources and much emphasis was laid to accelerate the irrigation potential creation. Many major, medium and minor irrigation projects have been constructed in the country during the last two decades. Table 2 reveals that the irrigation potential created from 2005-06 to 2011-12. It is noticed from the table that on an average more than 1.50 million hectare irrigation potential was created per year during the period as reported in the annual report of Ministry of Water Resources. Many reports claims that there is a huge gap between potential created and utilised due to many factors such as defunct of Lift Irrigation Points (LIPs), Minor Irrigation Projects (MIPs), deterioration of distribution systems of irrigation projects etc.

Inadequate access to water is the biggest problem

Table 2. Targets of irrigation potential and its creation during 2005-06 to 2011-12 (Million hectare)

Year	Target	Irrigation potential created
2005-06	1.90	1.69
2006-07	2.40	1.96
2007-08	2.85	1.73
2008-09	2.85	1.93
2009-10	1.75	1.85
2010-11	1.75	1.22
2011-12	-	0.079*

Source: Annual Report 2011-12, MoWR

Note: * - up to September, 2011

limiting development in India. The main users of water are the agricultural, domestic and industrial sectors. Figure 2a and 2b displays the water demand estimate of diverse sectors by two different agencies, the Standing Sub-Committee of the Ministry of Water Resources (MoWR) and the National Commission on Integrated Water Resources Development (NCIWRD). Looking into the increasing population of the country and rising demand for water by the

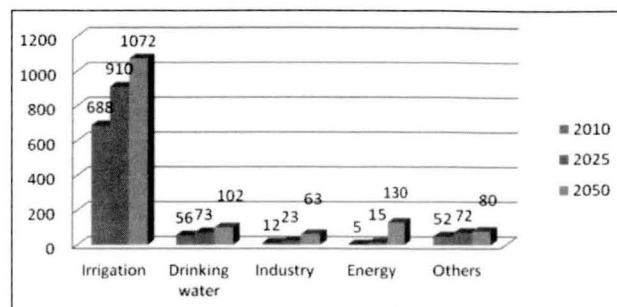
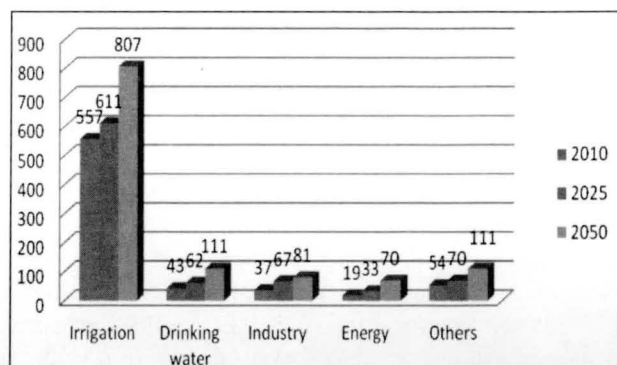


Fig. 2a. Projected water demand (in BCM) for various sectors as per MoWR



Source: GoI (2006) as cited in ADB (2009:3)

Fig. 2b. Projected water demand (in BCM) for various sectors as per NCIWRD

primary and secondary sectors, it reveals that India is reaching to the 'water stressed' situation. It is also observed that from amongst the various sectors, Irrigation alone contributing more than 70 per cent of the water demand followed by drinking water, industry and energy sectors. This signals that there will be severe problems in food security if we are unable to manage and conserve water for the future. In this regard, the government has been making sincere efforts to improve the situation in the recent years.

Role of Government in Water Conservation and Management

In partnership with Central and State Governments, the country could able to launch various schemes/programmes across the regions for conservation and management of water resources in a transparent, equitable and sustainable manner. Few important programmes and their achievements in the country are discussed in this section.

Command Area Development and Water Manage-

ment (CADWM) Programme

With the intention of increasing agricultural productivity and production and to bring sustainability in the integrated agriculture in a participatory environment, the Command Area Development Programme (CAD) was implemented in a holistic manner by Government of India in 1974-75. The program was restructured and renamed as Command Area Development and Water Management (CADWM) since April First 2004. The main objective of the programme was to improve the utilization of created irrigation potential and optimising foodgrains production to meet the increasing need of food for growing population with the improved water use efficiency. The scheme is now being

implemented as a State Sector Scheme the XI Five Year Plan (2008-09 to 2011-12) onwards. Since 1974-75 till now 314 projects with a Cultivable Command Area (CCA) of 28.95 million ha have been included under this programme. Table 3 depicts the State-wise funds released under CADWMP in India during 2007-08 to 2012-13. During this period (XI plan), few broad provisions were made in the programme and thrust insisted on Participatory Irrigation Management (PIM). Because of change in provisions in the new programme, many states were not eligible to get the assistance during the period. In case of States such as Andhra Pradesh, Himachal Pradesh, Jharkhand, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Uttarakhand and West Bengal had most on-going projects and hence are not included

Table 3. State-wise funds released under command area development (CAD) and water management programme (WMP) in India
(Rs. in Lakh)

States	2007-08*	2008-09	2009-10	2010-11	2011-12	2012-13
Andhra Pradesh	-	-	-	-	-	-
Arunachal Pradesh	238.59	250	0	41	56.39	168.84
Assam	-	595	0	226	0	269.48
Bihar	-	-	6095	2669	2943.86	3000
Chhattisgarh	-	-	-	8285	1392.17	2000
Goa	-	-	-	81	6.42	178.85
Gujarat	3057.66	0	0	494	682	1791.5
Haryana	2332.22	4411	5451	4767	5800.62	5515.26
Himachal Pradesh	-	-	-	-	-	-
J & K	777.61	1293	1432	2250	2005.52	3156.69
Jharkhand	-	-	-	-	-	-
Karnataka	5771.29	1500	3170	5342	5308	3952.52
Kerala	-	-	-	106	418.08	28
Madhya Pradesh	490.07	0	590	1000	5510.11	2557.71
Maharashtra	622.27	2624	3405	0	2148.27	409.25
Manipur	184.07	554	939	1200	927.02	775.42
Meghalaya	-	-	4	26	-	-
Mizoram	6.43	-	-	-	13	-
Nagaland	19.43	-	-	-	15	-
Odisha	1101.91	2976	1578	3563	3102.85	2341.79
Punjab	3589.24	6091	0	6000	3000	0
Rajasthan	1804.38	4630	2981	-	2244.07	1744.41
Sikkim	-	-	-	-	-	-
Tamil Nadu	1740.48	0	4650	1500	2999.82	1030.82
Tripura	-	-	-	-	-	-
Uttar Pradesh	0	7095	9476	7000	10000	7597.79
Uttarakhand	5746.3	410	-	-	-	-
West Bengal	231.58	-	1600	690	-	-
India	27713.52	32429	41370	45640	48573.2	36518.73

Note : * : Including reclamation of water logged areas. Source : 1. Lok Sabha Unstarred Question No. 2212, 4198, 4512 and 4932 dated on 02.12.2009, 20.12.2011, 20.12.2012 and 25.04.2013 respectively. 2. Information extracted from www.indiastat.com

under this new provisions. From among the states, Uttar Pradesh followed by Haryana, Karnataka, Punjab and Bihar States utilized maximum assistance under CADWM. However, the Central assistance to this programme has been increased substantially in the XI Plan period and the States having irrigation development below national average, PM's package for agrarian distress districts and the projects located in Special Category States/areas were given preference.

Central Assistance of about Rs. 4722.49 crore has been released to States under this programme since its inception in 1974-75 up to March, 2011. The continuation of CADWM scheme has been approved as State Sector Scheme since the year 2008-09. The details of financial achievement in terms of central assistance released in the XI Plan are shown in Table 4.

Watershed Development Programmes

Watershed Development projects have been taken up under different programmes launched by the Government of India. These programmes undertaken by two ministries such as Ministry of Agriculture (MoA) and Ministry of Rural Development (MoRD) for land development in the country are shown in Table 5. The table reveals that Ministry of Rural Development has started the Drought Prone Area Development Programme (DPAP) and the Desert Development Programme (DDP) in 1970s but adopted the watershed approach in 1987. The Integrated Wasteland Development Project Scheme (IWDP) taken up by the National Watershed Development Board in 1989 also aimed at developing wastelands on a watershed basis. In addition to these programmes, few Externally Aided Projects (EAPs) have also been implemented in the country. All these programmes could able to develop 320.56 Lakh ha of land under watershed with an expenditure of Rs. 9523.2 crore through the Ministry since

their inception up to end of X Plan. On the other side, Ministry of Agriculture adopted watershed concept in the National Watershed Development Programme in Rainfed Areas (NWDPR) as a fourth major programme in watershed development. In addition, the Centrally Sponsored Schemes (CCS) like River Valley Project (RVP) (scheme initiated during III Five Year Plan) and Flood Prone River (FPR) for soil conservation & watershed management implemented through Macro Management of Agriculture (MMA) (since IX Plan) were joined hands in watershed development. In case of hilly areas, Watershed Development Project for Shifting Cultivation Area (WDPSCA) was initiated by MoA as watershed development programme. Reclamation of Alkali Soil (RAS) was launched in the VII Plan for reclamation of Alkali soil which contains Exchangeable

Sodium Percentage (ESP) and the programme was subsumed under MMA and in the X Plan, the programme of development of Acid soils was also initiated by different states under MMA. Since XI Five Year Plan, these programmes have been expanded for reclamation and development of both alkali and acid soils and renamed as "Reclamation and Development of Alkali and Acid Soil (RADAS)".

The union government has established a Watershed Development Fund (WDF) during 2000 with a total cost of Rs. 200 crore which includes Rs. 100 crore each by MoA and National Bank for Rural and Agricultural Development (NABARD). From, all these programmes together with EAPs, MoA have achieved land development of 187.73 Lakhs ha with a total expenditure of Rs. 9680.49 crores till the end of X Plan. In total, through watershed development programmes, the country could able to develop 508.29 lakh ha of land with an expenditure of Rs.19203.69 crore. These programmes not only pro-

Table 4. Central assistance released during 2008-09 to 2011-12 (Rs. Crore)

Period	Outlay in Planning Commission	BE Allocation	Release	% Releases w.r.t. BE Allocation
2008-09	350	350	324.29	92.7
2009-10	400	400	413.70	103.4
2010-11	499	499	456.40	91.5
2011-12	584	584	247.05*	-
Total	1833	1833	1441.44	

Source: Annual Report 2011-12, MoWR

Note: * 29th Feb 2012

tect and conserve environment but also contribute to livelihood security of rural poor.

Role of Externally Assisted Water Sector Projects: The Ministry of Water Resources assists the State Governments in availing external assistance from different funding agencies to fill up the resource gap and state of the art technology for water resources and development and management of the country. Through external assistance many projects were completed in different states and few are still on-going. But in this section, few major ongoing projects were considered for the discussion. Table 6 represents the major sources of external assistances and their ongoing projects in different States as on June 2012. Among different sources, World Bank (WB) is the primary source of external assistance in the water sector followed by Asian Development Bank (ADB), Japan Bank for International Cooperation (JBIC), Kreditanstalt fur Wiederaufbau (Kfw) Germany etc. Few major on-going projects are listed in the Table 6. In addition, the Government of India has also approved bilateral cooperation with African Countries recently for preparation of strategy paper, conducting training courses etc. Out of 9 ongoing externally aided projects, 6 projects are assisted by World Bank, two projects by JBIC, and one by ADB in which many projects relates to water sector restructuring and Irrigation. Among States,

Andhra Pradesh tops the list in terms getting more funds from the external sources and few States are lagging behind. In many circumstances of external aids, up to 80 percent assistance will be received from the external sources and the remaining has to be contributed by the respective State Governments and Government of India.

Future line of work for water conservation

- Need for efficient management practices such as adoption of improved technologies such as drought tolerant varieties, use of drip/sprinkler irrigation systems and mulching techniques in agriculture, preserving water quality, protecting water catchment areas etc.
- Continued efforts of government and other external agencies in water conservation and management.
- Artificial recharge to ground water both in rural and urban areas.
- Evaluation of all watershed projects/programs for understanding possible positive and negative impacts to make necessary corrections.
- Incentivise farmers for up taking of conservation practices and discouraging water waste in their fields.
- Encouragement of R&D on global climate change.

Table 5. Lands developed under various watershed development programmes in India
(Area in Lakh ha, Expenditure in Rs. Crore)

Ministry/Scheme and Year of Start	Progress Since Inception up to IX Plan		Progress During X Plan* (2002-07)		Progress Since Inception upto end of X Plan*	
	Area	Expr.	Area	Expr.	Area	Expr.
Ministry of Agriculture, (Department of Agriculture & Cooperation)						
NWDPRA (1990-91)	69.79	1877.74	23.3	1147.82	93.09	3025.56
RVP & FPR (1962 & 81)	54.88	1516.26	9.98	727.98	64.86	2244.24
WDPSA (1974-75)	2.58	166.27	1.35	129.31	3.93	295.58
RAS (1985-86)	5.81	76.39	1.3	45.35	7.11	121.74
WDF (1999-00)	0	0	0.59	26.02	0.59	26.02
EAPs	13.35	2039.81	4.8	1927.54	18.15	3967.35
Total	146.41	5676.47	41.32	4004.02	187.73	9680.49
Ministry of Rural Development (Department of Land Resources)						
DPAP (1973-74)	68.95	3284.74	68.32	1557.76	137.27	4842.5
DDP (1977-78)	33.56	797.38	45.17	1152.5	78.73	1949.88
IWDP(1988-89)	37.34	616.51	62.22	1821.64	99.56	2438.15
EAPs	1.4	18.39	3.6	274.28	5	292.67
Total	141.25	4717.02	179.31	4806.18	320.56	9523.2
Total (A+B)	287.66	10393.49	220.63	8810.2	508.29	19203.69

Note: * Includes Tentative Achievement of 2006-07.

Compiled the statistics released by Lok Sabha Starred Question No. 442, dated 07.05.2007.

Table 6. Status of ongoing externally assisted water sector projects in India
(As on June, 2012)

Projects	Agencies/ Banks	River/Basin	Benefits (' 000 Ha.)	Assistance Amount in Million Donar Currency	Reimbursement in Million Donor Currency
Madhya Pradesh Water Sector Restructuring Project (MPWSRP)		World Bank Chambal, Betwa, Shindh, Ken and Tons	495	US\$ 387.40	US\$193.82
Maharashtra Water Sector Improvement Project (MWSIP)		Godavari, Krishna, Tapi and . Narmada	668.85	US\$ 325.00	US\$ 242.74
(a) Rajasthan Water Sector Restructuring Project (RWSRP)		-	400.43	XDR 93.45	XDR 77.04
(b) Additional financing to RWSRP.	World Bank			XDR 12.40	XDR 2.75
Uttar Pradesh Water Sector Restructuring Project (UPWSRP)		Ganga	295	XDR 87.27	Closed
Andhra Pradesh Water Sector Improvement Project (Nagarjuna Sagar)		Krishna	895	US\$ 450.60	US\$ 61.63
Andhra Pradesh Irrigation and Livelihood Improvement Project	Japan International Cooperation Agency	Krishna, Godavari, Sagileru, Pillaperu, etc.	114.88	JPY 23974.00	JPY 5618.98
Rengali Irrigation sub project LBC-II (Revised estimate)	Japan International Cooperation Agency	Brahmani, Baitarni.	93.5	JPY 3052	JPY 2492.59
Odisha Integrated Irrigation, Agriculture and Water Management Investment Project (OIIAWMIP) (Tranche-II)	Asian Development Bank	Subarnarekha, Burha Balanga, Baitarni, Brahmani.	115.26	US\$ 16.50	US\$ 6.43

Source : Lok Sabha Unstarred Question No. 947, dated on 16.08.2012.

- Increase public awareness on water conservation (educate the people, seek suggestions, assign responsibility in case of employees etc)
- Reduce domestic water use,
- Promotion of wastewater reuse & recycling through modern techniques.

Conclusion

Due to over exploitation of water resources, it has become scarce in many parts of the country. In this regard, government has undertaken various programs in water conservation and management successfully from the inception of FYPs in the country. Among the number of programmes, CADWM, NWDA and WDP were the major programmes for land development and water (resources) conservation and management in the country. Further, among externally assisted water sector projects, World Bank is the primary source followed by ADC, JBIC and Kfw, Germany. Many projects under the external assistance of these sources were completed and few on-going in many States. All these programmes under water conservation created huge infrastructure and irrigation potential for agriculture and are trying to improve the water and food security situations in the country. In addition, they not only protect and conserve environment but also contribute to livelihood security of rural poor. Therefore, the country still requires continued efforts of the government along with external aids especially in the issues of global climate change and consumer awareness on water conservation. Government should come up with a new water policy prescribing the role and involvement of individuals, community and government for conservation of water.

References

- Anonymous, 2001. Census of India Reports. *Census of India 2001*. Government of India
- Amosson, S., L. Almas, B. Golden., B. Guerrero., J. Johnson., R. Taylor. and E. 2003. *Wheeler-Cook. Economic Impacts of Selected Water Conservation Policies in the Ogallala Aquifer*. Kansas State university Agricultural Experimental Station and Cooperative Extension Service. Staff Paper No. 09-04.
- Annual Report 2011-12. Ministry of Water Resources. Govt of India, New Delhi. <http://www.performance.gov.in/sites/default/files/departments/water-res/AR-2011-12.pdf>
- Asian Development Bank (ADB). 2009. *Water Resources Development in India: Critical Issues and Strategic Options*. Asian Development Bank, New Delhi. Available at <http://www.adb.org/Documents/Assessments/Water/IND/Water-Assessment.pdf> [Accessed on 6 February 2014].
- Central Water Commission (CWC). 2009. Central Water Commission – Annual Report 2008-2009. India: Ministry of Water Resources (MoWR), Government of India.
- Fuglie, Keith O., MacDonald, James M. and Ball, Eldon. 2007. Productivity Growth in U.S. Agriculture. Economic Brief No. 9. Washington, D.C.: Economic Research Service, U.S. Department of Agriculture. September, 2007.
- McKenry, M. The Transition to Hi-Tech Agriculture. Paper Presented at Conference on the Future of Central Valley Agriculture, Parlier, CA, June 21, 1996.
- Narasimhan, T.N. 2008. A note on India's water budget and evapotranspiration. *Journal of Earth System Science*. 117(3) : 237-240.
- Pande, V.C., Kurothe, R.S., Singh, H.B. and Tiwari, S.P. 2011. Incentives for Soil and Water Conservation on Farm in Ravines of Gujarat: Policy Implications for Future Adoption, *Agricultural Economics Research Review*, 24 : 109-118.
- Smith, P. 1998. The Use of Subsidies for Soil and Water Conservation: A Case Study from Western India, *Agricultural Research & Extension Network*, Network Paper No. 87
- Verma, S. and S. Phansalkar, S. 2007. 'India's Water Future 2050', *International Journal of Rural Management*, vol. 3, no. 1, pp. 149-79.
- http://eands.dacnet.nic.in/Land_Use_Statistics-2010/s5.pdf