

MORE CROP PER DROP THROUGH KEN BETWA RIVER LINK SYSTEM

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ABSTRACT

The interdependence of the water with food and energy is well reiterated worldwide and the present challenge is on how to produce more crop per drop per kwatt energy per unit area of land. From this point of view the micro irrigation in general and drip irrigation in particular has received considerable attention to increase water use efficiency, agricultural productivity, economic growth, and environmental sustainability. The analysis of economics of crop cultivation under drip irrigation has revealed that the drip method of irrigation has a significant impact on resources saving, cost of cultivation, yield of crops and farm profitability in long run.

With this objective, National Water Development Agency (NWDA) Ministry of Jal Shakti, Department of WR,RD&GR Government of India identified 30 Inter Basin Water Transfer(IBWT) links for detailed studies; 14 under Himalayan Component and 16 under Peninsular Component. Four priority links for the preparation of Detailed Project Reports(DPRs) under Peninsular Rivers Component have been identified viz; Ken-Betwa Link Project(KBLP)(Phase-I & II), Damanganga-Pinjal Link Project,(DP) Par-Tapi-Narmada Link Project(PTN) and Godavari-Cauvary Link Project.

Out of these, DPRs of KBLP, DPLP and PTNLP links have been completed. The project has been declared as the first national project under ILR Programme of the Government of India.

The Ken-Betwa Link Project (KBLP) a multipurpose project will provide an annual irrigation of 904 thousand ha. The water utilisation from the project is about 4843.26 MCM including for irrigation and domestic water supply. The project will generate 103 MW of hydropower at 27 MW solar power through the panels proposed to install on the proposed canal tops. The main project components planned under the KBLP project are Daudhan Dam, Lower Orr Dam, Bina Complex Multipurpose Project, Kotha Barrage, repairing/strengthening of Bariyarpur Pickup Weir, Paricha Weir and Barwa Sagar Dam. To maximize the irrigation and water use efficiency, micro irrigation system has been proposed to be introduced in the entire command areas of the project coming under the concerned State Governments of Madhya Pradesh and Uttar Pradesh. This will save 395 MCM of water and provide additional irrigation to the tune of 90000 ha. Culturable command area equivalent to 520536 MT of food production. Through this paper an attempt is made to highlight the importance of adopting drip irrigation, cost benefit, enhancement of irrigated area, employment generation and overall economic development of the specific regions.

Keywords: water-energy-food-nexus, water use efficiency, environmental sustainability, crop cultivation and yield of crops

1. INTRODUCTION

The water, energy and food security nexus according to the Food and Agriculture Organization of the United Nations (FAO), means that water security, energy security and food security are very much linked to one another, meaning that the

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actions in any one particular area often can have effects in one or both of the other areas. As the world population is nearing 8 billion, The demand for all three resources continues to grow for various reasons: a growing population, ongoing population movements from farms to cities, rising incomes, increased desire to spend those incomes on energy and water intensive goods/varying diets, international trade, urbanization and climate change. Water being a finite resource, but also the most abundant resource of the three sectors is the most exploited. Water is primarily used in forestry and fishery, agricultural production (in its entire agri-food supply chain) and is used to create and/or transfer energy in varying forms. In fact, agriculture is the largest user of freshwater, making it responsible for 70% of total global withdrawal, while more than one fourth of energy used worldwide is an input for food production, distribution, and use. In addition, food production and supply chain simultaneously utilize approximately 30% of the total energy that is used globally. The greater the capacity to pay for improved water, the more it will enable alternative water sources, such as desalination to bring water into urban areas from greater distances, such as desalinated seawater often requiring energy-intensive production and transport methods. The unbroken links between these sectors continues to demand well-integrated plans to protect food and water and food security. increasing demands for basic services also rise, such as the growing desires for higher living standards and the need for more conscious stewardship of the vital resources required to achieve those services and these desires have become both more obvious and urgent.

The interactions among water, energy and food are numerous and substantial. Food production is by far the largest consumer of global fresh water supplies. Globally, agriculture is responsible for an average of 70% of fresh water consumption by humans; in some countries that figure jumps to 80%-90%. Agriculture is therefore also responsible for much of fresh water over-exploitation. Food production further impacts the water sector through land degradation, changes in runoff, disruption of groundwater discharge, water quality and availability of water and land for other purposes such as natural habitat. The increased yields that have resulted from mechanization and other modern measures have come at a high energy price, as the full food and supply chain claims approximately 30% of total global energy demand. Energy fuels land preparation, fertilizer production, irrigation and the sowing, harvesting and transportation of crops. The links between food and energy have become quite apparent in recent years as increases in the price of oil lead very quickly to increases in the price of food. The energy sector can have other negative impacts on the food sector when mining for fossil fuels and deforestation for biofuels reduce land for agriculture, ecosystems and other uses.

Improved water, energy, and food security on a global level can be achieved through a nexus approach—an approach that integrates management and governance across sectors and scales. While the opportunities provided by the nexus perspective and the consequent social, environmental and economic benefits are real, implementation requires the right policies, incentives and encouragement, and institutions and leaders that are up to the task, as well as frameworks that encourage empowerment, research, information and education. Accelerating the involvement of the private sector through establishing and promoting the business case for both sustainability and the nexus is essential to driving change and getting to scale.

Govt of India has taken up the Interlinking of Rivers Project on high priority in a consultative manner to check the regional imbalances in availability of water, increase in agricultural production, mitigation measures for floods/droughts, etc.. Out of 14 identified links under Himalayan Component, NWDA has completed feasibility studies of 2 links i.e. Sarda-Yamuna & Ghaghara-Yamuna (Indian portion) but not circulated as the work in Nepal area is not completed. Besides above, survey & investigation (S & I)

and preparation of draft feasibility report works in Indian portion, pertaining to the 7 links namely (i) Yamuna - Rajasthan link (ii) Chunar -Sone barrage link (iii) Subernarekha - Mahanadi link (iv) Ganga - Damodar - Subernarekha link (v) Farakka - Sunderbans link (vi) Rajasthan - Sabarmati link (vii) Gandak - Ganga link have been completed. Preparation of Feasibility Reports(FR) of Sone Dam-Southern Tributaries of Ganga(STG) link, Manas-Sankosh-Teesta-Ganga and Kosi-Ghagra link projects are under progress. The Kosi-Mechi link which entirely lies in Nepal territory and Jogighopa-Teesta-Farakka being an alternate of MSTG, are presently not targeted for preparation of FR.

Out of 16 links identified under Peninsular Component, FRs of all links except 2 minor links viz. Bedti-Varda and Netravati –Hemavati links pertaining to Karnataka have been completed. Preparation of Detailed Project Report of Bedti-Varada link project will be taken up shortly. The consent of Govt of Karnataka for preparation of DPR of Netravati-Hemavati link project is awaited. The Government of Andhra Prdaesh has implemented the Polavaram-Vijayawada link project according to their own planning.

The DPRs of 3 link Projects viz. Ken-Betwa link project (Phase-I, Phase-II and Comprehensive report of Phase-I&II), Damanganga-Pinjal link and Par-Tapi-Narmada link have been completed. The draft DPR of Godavari(Inchamppalli/Janampet)-Cauvery(Grand Anicut) link project has also been completed.

1.1 How Improved Water Use Efficiency and Productivity Impact the Nexus

Ken-Betwa Link(KBLP)is one of the 16 links under Peninsular Component of National Perspective Plan (NPP) of Government of India for Water Resources Development under Interlinking of Rivers (ILR) Programme. The index map of KBLP is given at Plate-I.

The KBLP is a multi-purpose project with irrigation, hydropower and water supply benefits. The project envisages to provide enormous benefits to the water starved Bundelkhand region of Madhya Pradesh and Uttar Pradesh as well as to the Vidisha, Sagar, Shivpuri, Datia and Raisen districts of Madhya Pradesh. Thus, the project will provide an annual irrigation of 904 thousand ha utilizing about 4843.26 MCM of water including drinking water supply and also generate 103 MW of hydropower and 27 MW solar power. The annual irrigation include 698 Th.ha from Daudhan Dam, 90 Th. ha from Lower Orr Project, 20 Th. ha from Kotha Barrage and 96 Th. ha from Bina complex. A part of the power generation will be utilized for micro irrigation in the project.

1.2 Aim & Objective of the Project and Description of Works

KBLP mainly envisages to provide irrigation and domestic water supply facilities to drought prone areas namely Chhatarpur, Tikamgarh, Panna, Damoh, Vidisha, Sagar, Shivpuri, Datia & Raisen districts of Madhya Pradesh and Mahoba, Banda, Jhansi & Lalitpur districts of Uttar Pradesh. The component Command area of its viz. Daudhan Dam 698 thousand ha utilising 4049.95 MCM, lower Orr 90 thousand ha utilising 329.67 MCM, Kotha barrage 20 thousand ha utilising 80.69 MCM and Bina Complex Project 96 thousand ha utilising 448.5 MCM. In addition, it is proposed to provide 204 MCM towards drinking water needs of 6.3 million people. The Project will also provide 494 MCM of water downstream of Dams for environmental needs. It will also have Hydro Power generation of 103 MW and Solar Power generation of 27 MW. The total estimated cost of the Ken-Betwa Link Project has been worked out as ₹. 351112.4 million (\$4994.48 million) at 2017-18 price level (Table 1).

Table 1. Brief of total benefits from various components under KBLP is tabularized below:

S. No	Component	Command Area in thousand ha	Water Utilisation (MCM)	Cost (Rs. million)	Cost (in million Dollars)
1.	Daudhan Dam and its Components	698	4049.95 (including domestic water requirement)	270184.90	3843.31
2.	Lower Orr Project	90	329.67	30651.40	436.01
3.	Kotha Barrage	20	80.69	7087.30	100.82
4.	Bina Complex Project	96	448.5	43188.80	614.35
	Sub-total	904	4908.81	351112.40	4994.49
5.	Domestic Water Requirement		204		
6.	Environmental Flow		494		
	Total	904	5479 MCM		
7.	Power Generation		103 MW		
8.	Solar Power Generation		27 MW		

1.3 Micro Irrigation Proposed Under Ken Betwa Link

1.3.1 Introduction of Pressurized Pipe Micro Irrigation System in the Command Area

A pressurized pipe micro irrigation system is a system that relies on water pressure for the system to work. In pressurized irrigation system, water is pressurized and precisely applied to the plants under pressure through a system of pipes. Pressurized systems as opposed to surface irrigation system are more effective in application of water to the crops there are many variations of pressurized irrigation systems but the two major ones are drip irrigation system and sprinkler system. They consist of the control station where the pressure is applied; the mains and the sub mains, which are pipes of different dimensions, irrigation system or other fixtures delivering water to plants or spray booms for forage and entire pivot system (in sprinkler system). Pressurized pipe micro irrigation systems have the potential to avail the water loss related to surface irrigation system increasing the open irrigation application efficient from 45%-60% to pressurized pipe micro irrigation system with efficiency of 75% to 90%. Therefore, Government of India is promoting pressurized irrigation system in the command of major and medium irrigation projects.

2. PLANNING AND LAYOUT OF VARIOUS COMPONENTS OF KEN BETWA LINK PROJECT

2.1 Daudhan Dam

Daudhan Dam proposed across Ken river is 2031 m long, out of which 1233 m length of dam will be earthen and rest 798 m length of dam will be of concrete. The concrete portion of dam alongwith spillway has been proposed on the left flank of the dam. A penstock is proposed in left concrete portion of dam for taking water to Power House-I (PH-I) located at the toe of the dam. Tail race channel off-taking from PH-I will join Ken river again in d/s of the dam on left bank.

For providing irrigation water to enroute command of link canal, an Upper Level Tunnel (1.929 km long) with invert level and crown level of 256.0 m and 262.0 m respectively at the mouth of Daudhan Dam has been proposed. Diameter of the proposed tunnel is 6.0 m (need to be revised at the time of construction as the design discharge is increased from 76.226 cumec to 115.51 cumec) whereas slope of the tunnel is 1:800. However, cost of the tunnel taken for increased discharge is on proportionate basis. This tunnel takes off from the left bank of Ken river in upstream of Daudhan Dam. Invert level of Upper Level Tunnel at the exit point is 253.5 m. After provision of energy dissipation device at the exit of tunnel, the link canal will take off with FSL of 257.0m and full supply depth of 4.3 m.

From the left bank of Ken river in upstream of Daudhan Dam but in the downstream of Upper Level Tunnel, another tunnel i.e. Lower Level Tunnel of 5.5 m dia. takes off. Invert level and crown level of Lower Level Tunnel at its inlet are 244.6 m and 250.1 m respectively. Power House-II (PH-II) having installed capacity of 18 MW is proposed at its outlet. After generation of power, water will be taken through canal to provide irrigation water for Ken command in Madhya Pradesh as proposed in Ken Multi-purpose Project(KMPP). The rest of Ken command area will be provided irrigation through canal taking off from Bariyarpur headworks. Provision of bye pass channel has also been made for supplying water to the canal directly from tunnel in case Powerhouse-II does not run. However, to take care of similar situation in Power house-I, sluices have been provided in the dam.

The Ken-Betwa Link canal which takes off from the de-silting basin located after the exit portal of the Upper Level tunnel, traverses a total length of 176 km and will out falls into Barwa Sagar reservoir. The canal will start with FSL of 256.931 m (at RD 500 m) from Daudhan Dam and will outfall in Barwa Sagar at FSL of 221.000 m., 133.797 thousand ha command area will be irrigated by direct pumping from Daudhan reservoir, 637 MCM water will be used by pressurized irrigation while the water use is 669 MCM without pressurized irrigation. The details of area proposed for pressurised irrigation under direct pumping from Daudhan reservoir is given in Table-2.

Table 2. Area proposed for pressurised irrigation under Direct pumping from Daudhan reservoir

S.No.	Location	Pumping Station No.	Details of area covered	Command area in thousand ha
1.	Daudhan dam reservoir	1	Chhattarpur	43.678
2.	Panna & Hatta LIS	5	Panna	90.111
Total				133.789

2.2 Reachwise Design of Pumping System of Ken-Betwa Link Main Canal for Enroute Irrigation Through Micro Irrigation System.

Details design of pumping station for serving the enroute and high elevated command through main canal has been done. The KB Link canal uses 978 MCM and 970 MCM without pressurized irrigation and with pressurized irrigation respectively for 193.899 thousand ha of command area. Details of design locations of pumping system of Ken-Betwa Link Main Canal are given below (Table 3).

Table 3. Upper Level tunnel- KBL – Details of Pressurized micro irrigation

S. No	Location	RD of KBL	Details of Area covered	Command area in thousand ha
1.	Pumping Station 2	70 Km.	High Level Command	130.949
2.	Pumping Station 3	117 Km.	KBLP Command	28.830
3.	Pumping Station 4	156 Km.	KBLP Command	34.120
Total				193.899

2.3 Reachwise Details of Pumping System of KLBC for Enroute Irrigation Through Micro Irrigation

Summing Up:The culturable Command area for Daudhan Dam as per earlier proposal without pressurized irrigation was 287 thousand hectare utilising 4049.95 MCM of water which is with pressurised irrigation has been increased to 447 thousand hectare utilising same water thus increasing efficiency. The culturable Command area for lower Orr Dam without pressurized irrigation as per earlier proposal was 45000 ha which has been increased to 90000 ha with pressurized irrigation. The culturable Command area for Bina Complex has been kept 96000 ha with pressurized irrigation which would be 48000 ha in conventional method. In nutshell, the proposed CCA of KBLP through pressurized irrigation shall be 904 thousand ha against 635 thousand ha.

3. CONCLUSIONS

The use of micro irrigation technologies will result in a significant productivity improvement (economic gain) over the traditional methods of irrigation. The micro irrigation system will conserve the resources such as water, fertiliser, power, labour, etc., as compared to conventional irrigation practices. The economic analysis can be found to be profitable, cost effective with positive NPV and higher IRR than the traditional method. The maintenance of soil health with the reduction in leaching losses can be proved to be environmental friendly technology. The favourable soil water balance in the crop root zone depth will result in optimal soil water plant relations, nutrient availability, improved weed control, etc., and in turn contribute to higher yield of crops. Reduction of water losses by seepage, runoff and deep percolation will result in water savings. Significant saving in application of water to crops will result in reduction of working hours of pump set leading to less electricity consumption. Application of fertilisers through drip irrigation ensures higher fertiliser use efficiency resulting in savings of fertilisers. Eventhough high in initial investment for Micro/Sprinkler irrigation, the same can be recovered by increased yield, lesser cost of cultivation, etc. Adoption of micro/sprinkler irrigation will result in increased water use efficiency. This will enhance the agricultural production resulting in improvement in financial status of farming community, overall growth in Agriculture and its allied fields, etc. References: Detailed Project Report of Ken-Betwa Link Phase I & II NWDA Website www.nwda.gov.in, Comprehensive Report of Ken-Betwa Link.