NEW TECHNOLOGIES IN IRRIGATION SECTOR

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New initiatives in the irrigation need to be comprehensive so as to cover the modern technologies, practices and policies for all the water resources of surface water and ground water, and rainfall for about 51% of the rainfed farmers; reduce the non-beneficial uses of water and deterioration of water quality and synergise all these benefits to improve the crop yields and economic value and livelihoods based on the water resources.

Irrigation has always been central to life and society in India. With a net irrigated area of 68.1 Mha (2013-14) by canals, tubewells and wells and other sources; and a gross irrigated area of 95.77 Mha, India has the largest irrigated area in the world. Still only about 49 per cent of the gross cropped area is under some degree of assured irrigation and rest of the 51 per cent cropped area is dependent upon the seasonal rainfall. Largest share of irrigated area is concentrated in the north-west India (Punjab, Haryana, and western Uttar Pradesh) and presently, Punjab is the only one state in India which has almost 100 per cent irrigated agriculture. Irrigation coverage in rest of the 28 states varies from a low of 5 per cent to above 90 per cent. Thus, it is not surprising that Punjab also has the highest yield levels of rice and wheat in India. Several studies have shown that irrigation coverage is positively correlated to productivity and prosperity and negatively to rural poverty.

Irrigation Development in India:

Starting with a net irrigated area of about 22.5 Mha in India during 1950-51, the country witnessed a strong emphasis on the development of large multi-purpose surface irrigation projects and a good network of canals, distributaries, minors and field channels along with a number of Canal Area Development Authorities were established (Fig. 1). Massive investments in public major and medium irrigation systems and to a smaller extent in minor irrigation were made through loans and assistance from World Bank and other donor and development agencies (Fig. 2). But there irrigation infrastructure and investments were not sufficient to achieve the much-desired food self-sufficiency in the country. With the advent of Green Revolution in the seventies, there was an urgent demand to provide timely irrigation to moisture-sensitive improved dwarf varieties of rice and wheat which could not be fulfilled only with the slow pace of development of canal irrigation. This additional demand was fulfilled with the rapid development of shallow groundwater tubewells which provided the irrigation on demand and in areas outside the canal command.

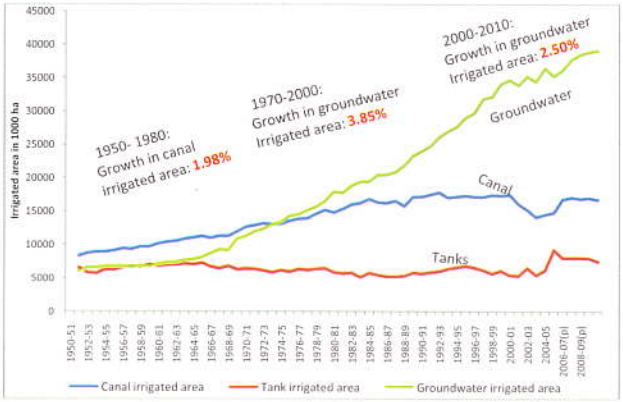

Fig. 1. Source-wise irrigation infrastructure development in India during 1950-2008(CWC)

Groundwater:

India is also now the largest user of groundwater in the world. About 71 % of the tubewells are energised by electricity, and the rest mostly in the eastern region of the country, have to depend upon costly diesel-based irrigation. Further, the distribution of the wells and tubewells is also sparse in the eastern region and intensively concentrated in the north-west and southern regions. Though on one hand the large expansion of groundwater resources has provided stability to irrigation and sustained and expanded the green revolution to other regions, on the other hand, this has caused massive over-exploitation of the groundwater resources and rapid decline of groundwater levels and a rise in 'critical' and 'semi-critical' groundwater blocks in the country (Fig. 3). During the last decade, there has been a

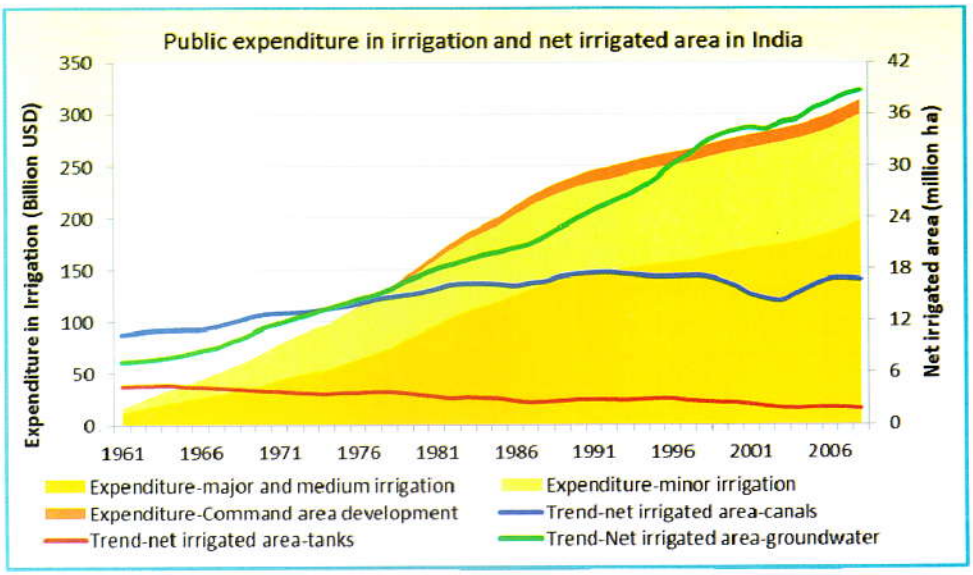

Fig. 2. Public expenditure in irrigation and net irrigated area during 1961-2008 in India (CWC)

drastic increase in the number of deep tubewells from 14.4 lakh to 26.1 lakh. Eleven states of Uttar Pradesh, Maharashtra, Madhya Pradesh, Tamil Nadu, Telangana, Rajasthan, Karnataka, Gujarat, Punjab, Andhra Pradesh and Bihar have almost 90% of the total minor irrigation structures in the country.

The above analysis shows that both surface and groundwater irrigation in India, inspite of being the largest in the world, is under great stress and needs a paradigm shift in the technical designs; efficient conveyance, distribution and application systems; innovative operation & maintenance and pricing, sustainability both in terms of quantity and water quality; inclusive and balanced regional development through policy changes in energisation and resource development and use of modern technology and ICT to reach the millions of irrigators so as to achieve the laudable objectives of *"Har Khet ko Pani- Irrigation to Every Farm" and "More Crop per Drop- Higher productivity and value from each unit of water."*

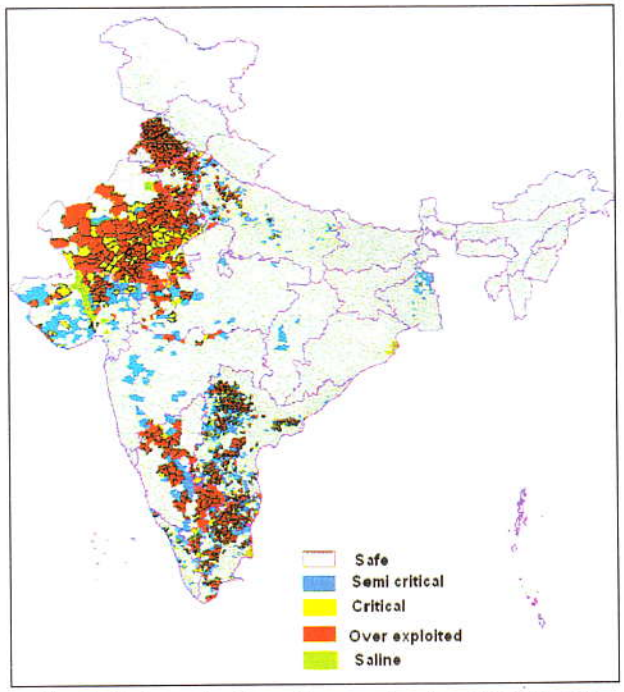

Fig. 3. Categorisation of groundwater structures in the country- groundwater use is highly exploitative in the north-western region and some southern states. (CGWB, Faridabad)

New Initiatives in the Irrigation Sector:

New initiatives in the irrigation need to be comprehensive so as to cover the modern technologies, practices and policies for all the water resources of surface water and ground water, and rainfall for about 51% of the rainfed farmers; reduce the non-beneficial uses of water and deterioration of water quality and synergise all these benefits to improve the crop yields and economic value and livelihoods based on the water resources. The following matrix approach in Fig. 4 is suggested:

Fig. 4. Comprehensive Matrix Approach for New Initives in the Irrigation Sector in India

A brief description of some of the important initiatives is given below:

i. Improving Conveyance Efficiency of Surface Irrigation:

Freshwater resources are finite and even by allocation of large funds for ambitious programs, the development of new public water resources is happening at a very slow pace. Farmers dependent on rainfall or private sources cannot wait any further. In cases where the development of water resources is not happening any time soon, the states and the centre can at least take steps/ interventions to cover larger areas with the already created irrigation potential. This is possible through improved distribution and conveyance pipes, underground distribution systems, affordable and reliable energy to lift water from shallow depths and innovative and differentiated energy policies both for the 'north-west and south', and more importantly for 'east and the north-east'.

Setting up piped water facilities to connect dams/ canals and micro-irrigation system can reduce water loss and increase the overall water use efficiency up to 90 per cent. At present, considering the conveyance loss of surface irrigation and application loss due to flood irrigation, only about 40 per cent of irrigation water actually reached the farmer's field from the source dam. Thus the investments need to be made not only to increase creation of irrigation potential, but must be channelized to make them more efficient.

ii. Micro-irrigation for Improving Application Efficiency of Irrigation

Micro-irrigation (drips, sprinklers, micro-sprinklers, tapes, guns) is a suitable option to

Table 1:

Strategies	Technologies, Practices and Policies
Improved Usage of Surface and Groundwater	Laser land levelling of fields, optimum size of basins
	Furrows, raised beds, conveyance pipes, underground distribution system
	Proper canal schedules, irrigation schedules, well-maintained distribution networks
	Use of remote sensing, GIS, sensors, drones and ICT technologies for improved irrigation
	Water user associations, Smart card based community tubewells
	Pricing of water and power to recover their full costs,Solar pumps and allowing excess solar power to be fed back into the grid, focus for the east.
Improved Use of Rainfall	*In-situ*, on-farm and catchment water harvesting for supplemental irrigation
	Synchronising crop planting, transplanting with on-set of monsoons
	Improved water retention through mulches; drainage of excess water, use of rainfall for recharge through Underground Taming of Floods for Irrigation
	Agro-met advisory services, crop insurance; drought and flood management
Reducing non-beneficial Uses and Water Quality Deteriora-tion	Improved canopy architecture through agronomy and plant breeding
	Zero and minimum tillage to reduce evaporation
	Enhanced use of micro-irrigation- drips, micro-sprinklers, sprinklers
	Use of plastic and residue mulches; boundary plantations
	Peri-urban agriculture and safe use of waste water.
Improving Crop Yields and Water Productivity	Improve incentives structures for water efficient crops through price and procurement policies, Direct Input subsidies to all farmers and let farmers decide which crops they want to grow.
	Breeding of superior crop varieties with higher yield, stress and disease tolerance
	Precision irrigation: synchronising water application with crop water demand
	Soil fertility management-rotation, tillage, targeted application of nutrients
	Disease, pest and weed management

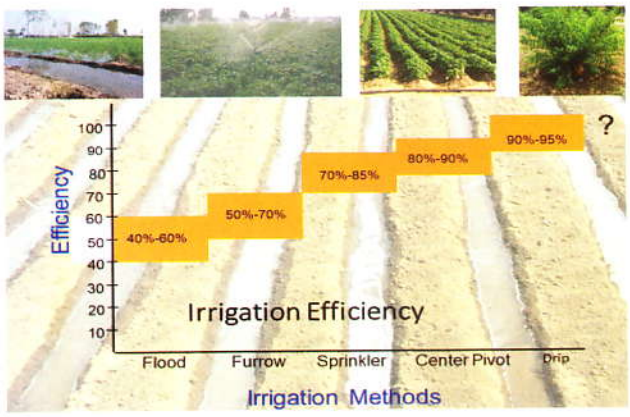

Fig. 5. Irrigation efficiency of different irrigation methods (Courtesy: Rajput, WTC)

enhance the coverage under irrigation, improve land and water productivity and quality of the produce. In case of commonly practiced flood irrigation method, the rate of water application loss is around 35 per cent, while in micro irrigation techniques, the application loss is only 10-15 per cent. Adoption of these techniques (Fig. 5) will help to save water and thereby increase the area under irrigation by diverting the saved water to other non-irrigated fields. Instead of promoting micro irrigation as just a water saving technique, it should be popularised among the farmers as an yield enhancing and input cost saving method, considering the incremental yield and electricity and fertiliser saving associated with the technique.

iii. Solar Irrigation:

Solar irrigation system needs to be further promoted to ensure assured and timely irrigation water availability in electricity deprived interior villages particularly in the eastern region. Solar pumps shall turn out to be a boon promising timely availability of power for lifting groundwater and water from ponds, lakes and depressions for irrigation, helping farmers to get rid of the costly diesel pumps. These can be further coupled with efficient application methods for higher water productivity. The ***Solar Pump Irrigators" Cooperative Enterprise*** (SPICE) in Gujarat is one of the worthwhile models that can be followed and scaled up. Assured grid connection must also be provided to the farmers to encourage them to divert the excess solar power generated in fields to the state grids, thereby ensuring the judicious use of solar power for groundwater extraction. Successful models such as *Solar Power as Second Remunerative Crop* (SPaRC)at Dhundi are working and can be scaled up by NABARD and other agencies. Such projects may be capital intensive at the initial stages and government will have to figure out smarter ways like feed-in-tariff (FIT) to mobilise the funds.

iv. Underground Taming of Floods for Irrigation (UTFI) :

Innovative and economically viable techniques have now been developed to utilise the excess flood water for ground recharge through construction of a battery of vertical shafts in the unused village ponds. Successful models have been developed and demonstrated by International Water Management Institute at Rampur district in Uttar Pradesh and elsewhere (Fig. 6) and successfully included in the District

Fig. 6. An unused village pond retrofitted with UTFI technology for flood water recharge in Rampur, Uttar Pradesh

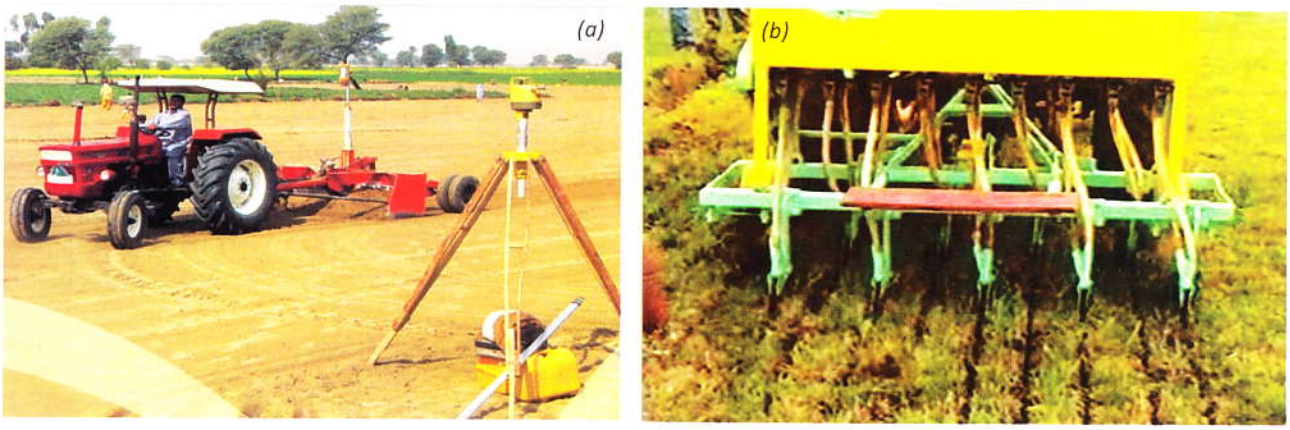

Fig 7. Use of Laser Land Levelling (a) and a Zero-Tillage Machine(b) for Conservation Agriculture

Irrigation Plans. This has sufficiently helped in improvement of water tables, some moderation of the floods and improvement in the local environment. These models need to scaled up under comparable agro-hydrologies in India.

v. Laser Land Levelling, Zero Tillage, Aerobic Rice and System of Rice Intensification for Saving Water and Energy and Improving Yields

These are some of the promising new initiatives adopted by progressive farmers which help in saving irrigation water upto 15-25 per cent, saving of farm energy by upto 20 % and improving the crop yields upto 20-25 per cent. Farmers need to be trained to use these new technologies with the help of improved machinery (Fig. 7) which can be made available through custom-hiring basis or the farm cooperatives.

Table 2. Important Programs and Policies in the Irrigation Sector

Major and Medium Irrigation Projects	Irrigation potential created increased from 9.72 M ha (1950-51) to 47.97 M ha (2011-12)
Accelerated Irrigation Benefits Programme (AIBP)	108.21 M ha irrigational potential created (about 77% of UIP)
Command Area Development and Water Management Programme	About 22 M ha covered since inception upto March, 2011
Repair, Renovation and Restoration (RRR) of Water Bodies	Restoration completed in 1054 water bodies in 15 States
Artificial Recharge to Ground Water through Dug wells	Implemented in 1180 over exploited, critical and semi-critical blocks in 7 States.
National Water Mission	Major goal to improve WUE at least by 20%
National Mission on Micro Irrigation	Promoting enhanced WUE
National Program on Aquifer Mapping & Management	Mapping & characterizing aquifer at 1:50000
Prime Minister Krishi Sinchayee Yojana	Provide water access to each farm field
Regulation for Delayed Transplanting of Paddy to Save Groundwater	Implemented in Punjab and Haryana with real savings in water and energy

vi. New Programs and Policy Initiatives in the Irrigation Sector:

A number of programs and policy initiatives have been developed to improve the irrigation sector in the country. Some of these programs have been on-going for some time and others have been launched recently and still are in nascent stage to show their full benefits (Table 2).

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