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Growing More with Less: Water Productivity in Agriculture

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India's agricultural sector, a cornerstone of its economy, heavily relies on water as a critical input. Agriculture in India consumes about 80-90% of the total water resources, making it the largest user of water. This intense dependency on water resources for agriculture is juxtaposed with a growing crisis of water scarcity.

A report by NITI Aayog (2018) highlighted those 21 major cities, including New Delhi, Bengaluru, and Chennai, are racing towards zero groundwater levels, affecting access for 100 million people. The situation is exacerbated by climate change, which is altering rainfall patterns and exacerbating water scarcity Sustainable water management in agriculture is crucial for India to achieve several United Nations Sustainable Development Goals (SDGs), especially SDG 2 (Zero Hunger), SDG 6 (Clean Water and Sanitation), and SDG 12 (Responsible Consumption and Production). the distribution of water resources on the planet Earth was accounts for 3 % of fresh water with 0.9 % of surface water, 30.1 % of ground water and 68.7 % of ice caps and glaciers and 97 % oceans. Surface water constitutes 2 %, 11 % and 87 % of rivers, swamps and lakes, respectively.

Central Water Commission (CWC) has assessed India's surface water potential at 1869 BCM, of which 690 BCM is considered utilizable. Central Ground Water Board (CGWB) has assessed additional replenishable groundwater resource as 433 BCM. The National Commission on Irrigation and Water Resources Development (NCIWRD) projected both low and high-water use requirements for three scenarios of 2010, 2025 and 2050 and concluded that India would fully utilize its water resources by 2050. India's water availability shows a critical trend: while total water availability increased from 1,869 BCM in 1993 to 1,999 BCM in 2019, per capita water availability plummeted due to population growth, from 5,178 cubic meters in 1951 to 1,486 cubic meters in 2021, with a projection of 1,228 cubic meters by 2051.

The Economic Survey 2018-19 suggests that "focus should shift from 'land productivity' to 'irrigation water productivity'

Water Resources in Telangana

Irrigation & CAD Department of Telangana State is making every effort to harness and utilize all the available water resources for the benefit of Agricultural sector, Industrial Sector and also providing drinking water for overall development.The main objective of Irrigation Department in Telangana is to create irrigation potential in the drought prone areas, upland areas and upkeep of the existing projects to enhance the agriculture productivity per unit of water with increased water use efficiency. Telangana has a heritage of cultivation and irrigation which dates back to several centuries. It is a riverine state with minor, medium and major rivers such as Godavari in the north, Krishna in the south and other rivers such as

Bhima, Manair, Penganga, Akeru, Dindi, Manjeera, Paleru, and Pedda Vagu. River Godavari is one of most important rivers of Telangana which covers Nizamabad, Adilabad, Karimnagar, Warangal and Khammam districts. Total water allocated to projects in Godavari basin is 954.23 TMC.

Projects are classified as under, based on the extent of irrigated Ayacut (commandable area) under them.

Sl. No	Type of projects	Ayacut (ha.)
1	**Major Project**	Ayacut above 25000 Acres (10,000 ha.)
2	**Medium Project**	Ayacut above 5000 Acres (2000 ha.) & upto 25000 Acres (10000 ha.)
3	**Minor Project**	Ayacut upto 5000 Acres (2000 ha.)

Major Projects (>10000 ha)

Number of projects	Status	Ayacut (acres)
9	Completed	21,32,724
14	Ongoing	42,55,936

Medium Projects (2000-10000 ha)

Number of projects	Status	Ayacut (acres)
32	Completed	3,18,112
10	Ongoing	1,00,624

Many major and minor projects are under Krishna basin. The major existing projects are Musi project, Nagarjuna Sagar project, Priyadarshini Jurala project, Rajoli Banda diversion scheme. The major projects which are under construction are AMRP including SLBC tunnel, Rajiv -Bhima LIS, Mahatma Gandhi-kalwakurthy LIS, Jawahar Nettempadu LIS, Koilsagar LIS, Dindi LIS, Palamuru Ranga Reddy LIS. The major projects which are under contemplation are Thumilla LIS, Gattu LIS. Kaleshwaram is the India's largest lift irrigation project with 141 TMC capacity, 19 reserviors and 1832 km length supplying route.

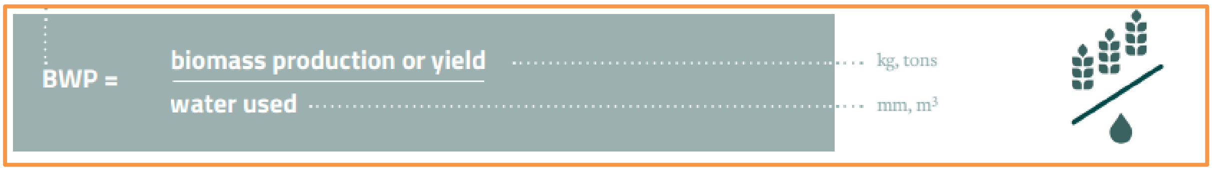
Water Productivity

As the world population increases, so does the demand for water in all domains of human life: food production, domestic use and industry. Of these three sectors, agriculture is the largest user as "irrigated agriculture accounts for more than 70 percent of global water withdrawals, and, globally, 41 percent of withdrawals are not compatible with sustaining ecosystem services". In a global context of water scarcity brought about by overexploitation, mismanagement and a changing climate. Productivity can be broadly defined as the ratio between a unit of output and a unit of input; therefore, water productivity iskilograms of dry matter produced per volume of water supplied or output per cubic meter of water consumption, including 'green' water for rain-fed areas and 'blue' water (diverted water from water systems) for irrigated areas.Water productivity becomes essential to ensure sustainable growth in agriculture.It is time to change the mind-set from raising agricultural productivity per unit of land to per unit of water.

TYPES OF WATER PRODUCTIVITY

Biophysical water productivity

It describes agricultural output (biomass production or yield) per unit of water used in a given area.



Optimizing this type of water productivity means producing more crop for every drop of water either by taking management measures to increase yield at the same water use level (such as with improved application of fertilizers, better choice of crop varieties and cropping calendars, or by mitigating on-field factors that reduce production such as salinity), decreasing water use at the same production level (with deficit irrigation practices in some instances, or by reducing non-productive water consumption such as evaporation, etc.) or doing both at the same time. Management measures to improve BWP can be taken at different scales *i.e.*, at the level of the crop, in the field, or at the level of the irrigation scheme.

Economic water productivity

This type of water productivity can be defined as the economic value of water used for production.

$$\text{EWP} = \frac{(\text{yield} \times \text{price received for crops}) - \text{production costs}}{\text{water used}}$$

in USD or local currency, as relevant

mm or m^3

Optimizing economic water productivity has to do with obtaining more "MONEY" per drop by attempting to influence elements of the equation:

- Yield: producing more
- Price: selling at a time when prices are higher if the prices are fluctuating (though that requires access to markets and storage)
- Costs: reducing when possible
- Water used: taking measures to reduce the water use

Alternatively, farmers may choose to switch to a crop or a different cropping system that will have a higher economic water productivity. At the farm level, EWP can help farmers make decisions that will help them increase their income. At the policy-level, this indicator can assist decisionmakers and water managers in allocating water in an economically optimal way.

Social water productivity

Although seeking to attain higher biophysical or economic water productivity can bring many societal benefits including poverty alleviation, or water savings that might free-up water for environmental flows, it is always important to remain critical of the tools we have and take into consideration the societal objectives that they may help us further.

$$\text{SWP} = \frac{\text{net social benefits}}{\text{water used}}$$

the numerator depends on the societal objectives in question

mm or m^3

This indicator permits us to look at and compare the net societal benefits per unit of water used and has a distinctively political nature in the sense that there isn't a single equation for it: the numerator is defined by the social priorities that animate the decision-making process that it can facilitate.

Nutritional water productivity

NWP is the nutritional content of a crop per volume of water used in its production. It can be helpful in guiding the choice of crops towards highvalue nutrient-dense ones whilst using resources sustainably.

$$\text{NWP} = \frac{\text{crop nutritional content}}{\text{water used}}$$

macro/micro-nutrient content measured in g, mg, µg, kcal per kg of crop

mm or m^3

Optimizing NWP has to do with obtaining more nutrition per drop. It could also serve as a farm or scheme-level tool for assessing the impact that different irrigation regimes and other field-management practices can have on the nutritional content of the food crops or as a tool to help ensure that nutrition is prioritized when deciding how to allocate water in agriculture.

FACTORS AFFECTING WATER PRODUCTIVITY

Crop selection: Different crops have varying water requirements and productivity levels

Irrigation management: Timing, frequency, and method of irrigation impact water productivity

Climate: Temperature, humidity, and precipitation patterns influence crop water requirements

Soil type: Water infiltration, retention, and availability

Crop density: Plant spacing affects water use and productivity.

Drainage: Poor drainage can lead to waterlogging, reducing water productivity

Technology adoption: Use of precision irrigation, drip irrigation, and other water-saving technologies.

Water harvesting: Collecting and storing rainwater for irrigation improves water productivity.

Farmers' knowledge and skills: Training and education

Conclusion

- The issues and challenges in adoption of irrigation technologies on wide scale could be technical, economic and social/ institutional.
- Farmers and field level staff are at the centre of any process of change and need to be encouraged and guided through appropriate technologies and practices towards water saving.
- The governments should act as a bridge (through extension services) to promote/ transfer the technologies to farmers and field staff on continuous basis.
- Better research–extension–farmer linkage and policies to stimulate adoption of technologies that improves system operation, efficiency, crop productivity and eventually farm income.
- Effective financing system for purchase of equipments and tools by small holder and resource poor farmers is required.
- Technologies alone will not achieve water savings unless supported through innovative management, policy and institutional reforms.

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