WATER USE EFFICIENCY IN AGRICULTURE IN NORTH BIHAR

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Abstract

Water and agriculture has developed symbiotic relationship especially in monsoonal world. Efficiency of water use in Bihar most vital because of fickleness of monsoon and almost complete dependency of its economy on agriculture. Hence each drop of water needs scientific utilization so that maximum return from each unit area may be obtained.

In case of water resources being defined, the objective should be to obtain maximum production per unit of water. What are called intensive and protective irrigations explain the above so-called economic and social aspects of irrigation.

WATER & CROPS:

In heavy soils, depletion of available moisture is at a slower rate and in a lighter soil, at a faster rate. For paddy, it is enough to impound 5 cm of water the field comes to saturation point but before the formation of hairline cracks, whichever is earlier. For maize at 25 per cent depletion, irrigation frequency should be one; in four days in red and six days in clay soils. The chart shows that crops like ragi, sorghum and cotton can withstand a longer frequency gap. Thus, cotton and groundnut require irrigation once in ten days in red and 15 days in clay soils when the depletion of available soil moisture is 75 perr cent; Other soils, that may fall in between red and clay loams, may have to be irrigated once in the to 15 days at the level of depletion.

Irrigation Requirement of Major Crops:

Several experiments on various crops and irrigation requirements have highlighted the following (Hukkri and Panday).

Paddy is a semi-aquatic plant and covers about 35 per cent of irrigated area in the country, Different Varieties have been evolved to suit different regions, seasons and water availablelity. cultural practices liked paddling and transplanting reduce percolation loses, and weed growth, increase the availability of plant nutrient's, regulate soil and water temperatures, and improve photosynthesis in the lower leaves due to reflected light from the water surface. These operations may require about 300-300 mm of water per hectare. submergence below 50 mm for low and rice has been found to yield low efficiency. Recent researches have shown that continuous submergence throughout the growth period may not maximize the yield. Also that, selective submergence during critical stages (initial tailoring, panicle initiator to flowering) would be sufficient to maximize yield and to save water during the monsoon period. However, during summer, continuous submergence has to be followed for maximum yields. Proper drainage helps to remove the toxic substances and regulate oxygen supply to the roots. About 15 to 20 days prior to harvest, irrigations are stopped and water drained to facilitate harvesting operations. A major problem in paddy irrigation is deep percolation loses which consume 50 to 75 per cent of water applied.

Wheat occupies about 29.5 per cent of the irrigated area and is best produced in the Indo-Gangetic plain where humid and dry climate prevails during the growing season (rabi) . The recently introduced dwarf varieties are highly responsive to irrigation and fertilization. The critical staged for irrigation are crown root initiation, flowering and jointing and milking. Four to six irrigations were found to yield in maximum productivity at about to 50 per cent of depletion of available soil moisture. Because of favorable cultural practices involved, wheat is the most mechanized of all cereals.

Maize, an all-region/season crop hs early vegetative and tassel ling and sulking stages as critical and after dough, there is no need for irrigation. The permissible depiction of soil moisture may be 25 per cent in lighter soils and 50 per cent in sandy loam to loam soils.

Sorghum, bajra and ragi, drough-reasistant and mostly rain fed, can withstand soil moisture deplection up to 75 per cent . Some varieties are of very short duration, adding to the adaptability, varied soil and water conditions. Scedling and flowering are the critical periods for irrigation scheduling, in case these are raised as irrigated crops.

Pulses or grain legumes by virtue of their root system utilize soil moisture very efficiently and require very less number of irrigations (that too during summer). Because of their atmospheric nitrogen fixation capacity and nutritional value, their development has bright prospects.

Of the oilseeds, groundnut occupies a very important place. In kharif, the crop is raised as rain fed and if grown during rabbi or summer, requires two to four irrigations and 50 per cent of soil moisture.

Cotton, a sub-tropical crop, tolerates high temperatures up to 45 to 50^{0}C , but temperature below 21^{0}C is not conducive to good growth . In drier and ill-distributed rainfall conditions, the crop needs six to eight irrigations with 50-75 per cent of soil moisture depletion.

Sugarcane, raised best under tropical conditions, is a long duration crop and occupies about 5 per cent of the irrigated areas in the country. The optimum soil moisture range has been reported as 50 per cent depletion of available water from 30 to 60 cm depth of soil layer. The crop entirely depends on irrigation except in parts of Bengal, Assam, North Bihar and East U.P. Irrigation requirements are low in rainy season, higher in winter and highest in summer.

Ther are also different vegetables and fodder crops suited better to kharif or rabi season, but these require frequent supply of water for good growth, the soil moisture being maintained above 75 per cent of availability in the rool zone . Water requirement depends upon the soil and the season in which crops are grown, ranging from three to four irrigations during summer and two irrigations in rabi per month. If the kharif dry spell exceeds 12 to 15 days, irrigation in that season becomes necessary.

Irrigation requirements of the principal crops are outlined in Table No. 1 and 2 . It is seen that variation in IR of paddy is more pronounced than that of WR, owing to the influence of effective rainfall. The rainfall. The average WR seems to be centered around 1,500 to 1,600 and that of IR, 1,000 to 1,200 mm. The number of irrigation frequency repotted varies from 12 to 20. In comparison, the WR and IR of other cereals are quite low, especially in the kharif season. As shown in Fig. 1 , millets can withstand a larger proportion of soil moisture edepletion, thereby reducing the number of irritation frequencies. The case is brighter for crops like cotton and groundnut, Sugarcane is not that efficient, but certainly superior to paddy. On the whole, 50 per cent of available soil moisture and .75 to 9 IW/CPE (irrigation water belong about 6 cm in depth, whereas the cumulative pan evaporation measuring the ET shows 6 to 7 on) seem to be optimal irrigation regime for most of the crops.

Table No. 1

Water and Irrigation requirements of rice at different locations

Place	WR (mm)	IR (mm)	Season
Araria	1890 2150	1440 N.A.	July /Aug-Nov/Dec. Dec/Jan-Mar/April
Saharsa	1300 1199	790 980	June-September January-April
Madhubani	1440 1650	780 1630	June-September September-Decement
Muzaffarpur	1620	750	June-october
Sitamarhi	1630	910	June-October
Motihari	1520	1170	June-October
Siwan	N.A.	280	March-June
Vaishali	1680	N.A.	July/Aug-Dec/Jan
Khagaria	N.A.	1620	February –May
Samastipur	2400	1600	June-October
Gopalganj	N.A.	1240	June-October

Table No. 2

Irrigation requirement of wheat, maize, sorghhni and bajra

Crop	Place	Soil type	Season	Ir	
				No	Amount (mm)
Wheat	Madhubani	Heavy black day	Rabi	7	375
	Saran	Loamy sand	Rabi	9	405
	Samastipur	Sandry loam	Rabi	7	420
	Siwan	Sandry loam	Rabi	3	220
Maize	Gopalganj	Sandy loam	Kharif	2.3	100-150
	Sheohar	Clay loam	Kharif	3	150
	W.Champaran	Black clay	Summer	10	510
	Vaishali	Loamy sand	Summer	25	1250
Sorghum	Supaul	Loam to clay	Kharif	5	360
	Sitamarhi	Clay loam	Summer	4	300
	Khagaria	sandy loam	Khariff	4	250
Bajra	Begusarai	Sandy loam	Kharif	3	200
	Muzaffarpur	Sandy loam	Kharif	2	150
	E.Champaran	Sandy loam	summer	10	500

Note: For crops other than wheat, IR excludes pre-towing irrigation.
Source: Pai and Hukkeri, pp. 16-18.

Engineering concepts centre around efficiency expressed in terms of net amount of water added to the root zone or used in ET by a crop, as a fraction of the water diverted from some source (Singh and Sinha). this would include different forms of water losses in covariance and application.

$$\text{WUE or CUE} = 100 \times \frac{\text{Normal Cu}}{\text{Net amount of water depleted from root zone soil}}$$

This is nothing but the proportion between water delivered and that beneficially used. Since losses could be during conveyance, application, storage and distribution, efficiency stages (Michael, Chapter 7),

i) Water conveyance efficiency = $100 \times \frac{\text{Water delivered to the Irrigated plot}}{\text{Water diverted from the source}}$

ii) Water application efficiency = $100 \times \frac{\text{Water stored in the}}{\text{Water delivered to the field.}}$

iii) Water storage efficiency= $100 \times \frac{\text{Water stored in the root}}{\text{Water needed in the roll zone prior to irrigation}}$

(iv) Water distribution efficiency = $100 \times (1 - Y/d)$

Where d = average depth of water stored along the run and

Y= average numerical deviation from d.

The aim of economic irrigation is to maximize the financial retun per unit of water applied or amount of money invested in the irrigation project.

$$\text{WUE} = \frac{\text{Crop Yield}}{\text{FT}}$$

WUE is the ratio of crop yield to the amount of water depleted through ET, Water utilization by the crop is generally described in terms of kg of yield per ha-mm . In the field, WUE would be the ratio of crop yield to total amount of water used. WUE could be increased either by increasing the crop yield or decreasing ET. Increasing crop production is achieved through an integrated use of the productive inputs. Decreasing ET requires adaptation of the plant varieties to the micro-environment and such other genetic and climatic improvement . Not only optimal irrigation, but production efficiency also should be aimed in the economic evaluation of water use by crops.

The genetic variation in plans influences WUE by the crops. Those plants with higher rate of photosynthesis, usually have higher WUE-maize, sorglhum, bajra, ragi and sugarcane. Most of the pulses, oilseeds and cereals like wheat barley and oats have lower rates of photosynthesis as well as WUE. It is also found that the new hybrids and modern varieties have higher rate of WUE, both from agronomic and climatologically considerations.

Social considerations of efficiency would differ from both engineering and economic concepts of WUE, Here, intensive vs, extensive irrigation criteria assume importance. Intensive irrigation especially in regions of insured irrigation as well as rainfall, would try to maximize crop productivity. But in a country like India, social justice demands extending the irrigation benefits to a larger extent. The extensive aspect of irrigation, therefore, may aim at what may be called a 'protective' system wherein the crops are assured just a protective dose (in the absence of rainfall for example), thereby extending the crop distribution as far as possible. That is, whether one wants I' ha of paddy under irrigation or 3 ha under millets, and so a\on.

This is explained by evaluating a component of efficiency criteria, of comparison among the different crops.

Table No. 3

Productivity of cereals per unit of water

Crop (New strains)	WR in a typical tract (mm)	Yield kg/ha	WUE per mm water
Rice	1200	4500	2.7
Sorghum	500	4500	9.0
Bajra	500	4000	8.0
Maize	625	5000	8.0
Wheat	400	5000	12.5

Source: Distance, p. 122.

Wheat has the highest productivity, followed by the millets; and rice has the lowers WUE. This may suggest adoption of a non-paddy system, where all these crops are really competitive. But different regions have different cropping patterns and even similar cropping patterns may have different legless of productivity and water duty. Paddy is no doubt a less productive user of water and any strict economic consideration may thwart its growth. The regional distribution may be such that paddy cultivation is specifically supported by climatic factors also.

To evaluate the crop mix and irrigation pattern at the state, project and field levels.

Analysis would start by assessing the water resource availability in the different states with reference to the cropping and irrigation pattern for a particular or different time periods, Rainfall distribution, adequacy in rainfall and irrigation, utilization of surface and ground water resources, nature of rainfall and irrigation use would have to be considered also . At the intermediate stage, a profile of the project and the commanded area would be necessary. Lastly at the micro level, the characteristics of the location and water using households would be given due consideration to view WUE in all these different contexts.

References:

1. Biswas, A.K. "Water : A Perspective on Global Issues and Politics" in Biswas, A.K., ed. Water Management for Arid Lands in Developing Countries, Paranon Press, 1980.
2. Caturvedi, M.C. Second India Studies: Water, MacMillan, New Delhi 1976.
3. Dastane, NG. "New Concepts, Practices and Techniques in the field of Water Use and Management". Paper presented to the Symposium on Soil and Water Management. ICAR New Delhi. 1969.
4. Hakkeri, S.B. and Pandey, S.I., "Swatter Requirement and Irrigation of Crops", in Water Requirement and Irrigation Management of Crops in India. WTC, IA , New Delhi, 1977.
5. Kaliappa, R. and In lvaraj, K.V. " The Gap between Irrigation Practices and Technology in Lower Bhavani Project Command Area". Paper presented to the Workshop on Management of Water Resources for Agriculture in Bhawaai river Basin, Tamil Nadu, College of Agricultural engineering. TMAU, April 1979.
6. KANWAR, J.S. "New Dimensions in Water Management Technology for Agriculture in India". Paper presented to the symposium on Soil and Water Management, ICAR , New Delhi, 1969.
7. Michael. A.M. Irrigation Theory and Practice, Vikas Publication House,new Delhi, 1978.
8. Morachan, Y.B., "Efficient Utilization of Water for Crop Management". Pap[er Prezented to the Workshop' on Management of Water Resources for Agriculture Bhavani River Basin, Tamil nadu. CAE, TNAU, Ap;rial 1979.
9. Pai P.P. and M\Hakked, S.B. (eds) Manual an Irrigation and Water Management. Department of Agriculture, GOI, New Delhi, 1979
10. Singh, N.P. and Slaha, S.K. "Water Use Efficiency in Crop Production" in Water Requirement and Irrigation Management of Crops in India WTC, IAPI, New Delhi. 1977.