WATER MANAGEMENT FOR FIELD CROPS PRODUCTION

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Efficient water management requires multidisciplinary approach and calls for working together, by users, the farmers, agronomists and irrigation engineers. The water management technology is highly location specific and as such the management decision vary with quantity, quality and time of water availability, topography, soil characteristics, climatic conditions, crops to be grown, sowing time and other agronomic practices.

Exploitation of Water Resources

The annual precipitation, which is ultimate source of water, is estimated for the country at 400 mham. The average natural runoff as per estimate of CWC (1987) is 180 mha, while annual replenishable ground water is about 60 mha. At the end of 1996-97 the total irrigation potential created is 97.8 mha, which is 81 percent ultimate potential of 113 mham (Raddy, 1998). Irrigation at present accounts for nearly 84 per cent of water requirements (Hashim, 1998). As a result of ineffective water management, there is a gap of about 9.8 mha between the water resources created and utilized by 1996-97 (Reddy, 1998). Irrigation efficiency in India is estimated between 38 to 40 per cent for canal irrigation and about 61 per cent for ground water schemes (Hashim, 1998). Optimum efficiency is about 60 per cent for canal schemes and 75 per cent for ground water schemes. Low irrigation efficiency in the Canal Command Area (CCA) is an important source of water logging, land degradation and soil salinity (Yadav, 1998)

Problems of Water Management

I. Scarcity of good quality irrigation water.

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II. Poor quality of ground water.

III. Erratic, ill distributed and highly undependable rainfall pattern.

IV. Semi-arid to arid climate in most part of the state.

V. Inadequate natural drainage and lack of outlets for drainage.

VI. Rise of water table in canal irrigated areas at an alarming rate posing serious problem aggravating the situations in areas having brackish under ground water.

Dimensions of Water Management

a. Crop Planning in Relation to Water Availability

Select suitable crops / cropping patterns which could provide higher returns per unit of water application.

i. Crop Planning for Assured Water Supply

Out of the several rotations tried, *'Cowpea-Bajra-Wheat', 'Moongbean-Bajra-Wheat' and 'Cowpea-Toria-Berseem' (For seed)* was most remunerative under adequate good quality water (Singh et al. 1989). In recent years it has been observed that Bajra-Mustard and Bajra-Mustard/Toria-Sunflower could be more remunerative crop sequences.

ii. Crop Planning for Limited Water Supply

During Rabi when only one irrigation available profitable to grow 'Kabuli' gram. Tall wheat for 2 irrigation's is recommend. Following during Kharif is advisable to overcome the scarcity of nitrogen and water in comparison to 'Bajra-Wheat' rotation.

B. Increasing Irrigation Efficiency and Improving Drainage

(i) Irrigation guide for Important Field Crops (Singh, 1996)

Crops	Irrigation Schedule Criteria		Irrigation			Critical Stages
	ID / CPE	Others	Depth (cm)	Number	Requirement (cm)	
Rice	1.0-1.4(1.2)	1-5 DDPW (IDDPW)	5±2	8-26	49-128	Flowering, Panicle initiation CRI, Flowering
Wheat	0.8-1.05(0.9)	(for dwarf)	4-7	4-8	30-52	Flowering, Tillering
		(for tall)	7-8	3-4	25-30	
Cotton	0.7-0.9(0.75)		3-8	2-9	28-84	Flowering, Boll formation
Sugarcane	0.6-0.9(0.8)	50% DASM	6-10	5-20	60-200	Shoot elongation, Tillering
Sorghum	0.8-1.25(0.8)	45-55% DASM	6-8	1-8	8-48	Flowering, Premodia initiation
Maize	0.75-1.2(0.9)		5-8	3-6	24-48	Tasseling, Silking
Pearl millet	0.4-0.9(0.6)		6-8	1-5	8-30	Flowering, Silking
Barley	0.5-0.9(0.6)	50% DASM	3.5-8	2-6	15-24	Tillering, Heading
Rapeseed & mustard	0.6-1.05(0.7)	75% DASM	6-8	1-4	8-24	Flower initiation, Pod formation
Groundnut	0.4-0.9(0.6)	50-75% DASM	5-8	2-8	15-50	Peg formation, Pod filling
Sesamum	0.5-0.9(0.6)	60-75% DASM	5-8	1-5	8-30	Flowering, Seed setting
Gram	0.4-0.8(0.6)	50-70% DASM	6.8	1-4	8-24	Flower initiation, Pod formation
Pigeon pea	0.25-0.9(0.6)		6-8	1-4	8-30	Flower initiation
Potato	1.9-2.0(1.2)		3-6	6-9	30-45	Stolonization, Tuber formation
Tobacco		0.4-0.5 bar tension	4-6	1-10	6-45	Vegetative phase
Lentil	0.4-1.0(0.6)		6-8	1-3	8-20	Pre-flowering, Pod formation
Peas	0.6-0.8(0.6)		5-8	1-3	8-24	Flower initiation, Pod formation
Sunflower	0.8-1.05(0.9)	40-50%DASM	5-8	2-6	15-40	
Safflower	0.2-0.6(0.4)		6-8	1-5	8-30 setting	Flower bud initiation, Seed
Soybean	0.4-0.8(0.6)		5-6	3-7	18-35	Flower initiation, Pod filling
Berseem	0.9-1.2(1.0)	0.25 bar tension	4-5	13-16	80-110	Flowering, Seed setting (forseed purpose)
Green gram gram/cowpea	0.6-0.9(0.6) mm CPE*	80-300	5-8	2-4	15-30	Flowering

DDPW – Days after dis-appearance of ponded water, DASM = Depletion of available soil moisture;

Values of ID / CPE in parenthesis denotes 'most common index'.

* Cumulative Pan-evaporation.

ii. General Guidelines for Selection of Irrigation Methods (Singh, 1996)

Methods of Texture	Soil Rate (cm/hr)	Infiltration and Slope (%)	Land Topography (l/Sec)	Stream Size Crops	Irrigation
Check/basin	Light or heavy	0.5-10	Leveled, less than 0.1	Large, more than 15	All crops, except those on ridges and s usceptible to water logging
Border Strip	Medium	1-2	Uniformly graded 0.1-0.3	Any and more than 12-15	All crops
Furrow	Light to moderate	0.5 – 2.5	Moderate, 0.3-3.0	Small and more than 12	Row crops and vegetables
Sprinkler	Very light	2.5 – 20	Rolling and undulating (sand dunes)	Any or more than 5	All crops, except rice and jute
Drip	Light to heavy soils	0.5 or more	Level to undulating	Any or more than 5	Widely spaced and fruit crops.

iii. Improving Drainage

The drainage problem arises owing to an excess of water from rain, irrigation on inflows from adjoining areas either on the surface of the soil or in the root zone beneath the surface of the soil. When water stands on the surface, the problem is of surface drainage and can be remedied by providing an appropriate method of removing the surface water. However, when it is because of the high water table, it affects the crop growth by limiting the soil aeration and depth of the soil for root growth. Thus provision of sub-surface drainage by horizontal or vertical means is inevitable.

C. Increasing Water use Efficiency

Water use efficiency can be increased by genetic and environmental manipulations of the crops. In most of the irrigated areas of the country, the water supply is erratic

and limited and thus it warrants judicious use for increasing crop production. By and large, there is a tendency to take rice, sugarcane and wheat as soon as water is made available. But these crops are very high water consuming and therefore, the productivity per unit volume of water is low as compared to the light irrigated crops such as mustard, groundnut, barley and pulses. There is new adequate evidence that judicious use of water and fertilizers improves each other's efficiency in field crops. Select suitable crops/cropping patterns, which could provide higher returns per unit of water application.

B. Safe Use of Saline / Sodic Ground Water

In semi-arid regions of India, more than 60 per cent of the ground water is brackish and is considered unsuitable for raising crops.

i. Appropriate Selection of Crops / Varieties

Table – 1 : Relative Salt Tolerance of Crops (Abrol et al. 1994)

Sensitive	Semi-tolerant	Tolerant
Beans, groundnut, berseem, grain, rice mango and papaya.	Bajra, sorghum, maize, firldpea, bakla, tobacco, pomegranate and gua.	Barely, sugar beet, cotton,mustard, safflower, wheat,ber and phalsa.

ii. Guidelines for Using Poor Quality Saline Waters (Abrol et al., 194)

Soil Texture (% Clay)	Crop Tolerance	Upper Limits of Eciw dSm-1 in Rainfall Area(mm)		
		< 350	350 - 500	550 750
Fine (> 30)	S	1.0	1.0	1.5
	ST	1.5	2.0	3.0
	T	2.0	3.0	4.5
Moderately Fine (20 – 30)	S	1.5	2.0	2.5
	ST	2.0	3.0	4.5
	T	4.0	6.0	8.0
Moderately Coarse(10-20)	S	2.0	2.5	3.0
	ST	4.0	6.0	8.0
	T	6.0	8.0	10.0
Coarses(<10)	S	-	3.0	3.0
	ST	6.0	7.5	9.0
	T	8.0	10.0	12.5

S, ST and T denotes sensitive, semi-tolerant and tolerant crops, respectively Eciw denotes Electrical Conductivity of irrigation water.

ii. Guidelines for Using Poor Quality Alkali Waters (Abrol et al., 1994)

Soil Texture (% Clay)	Upper Limits		Remarks
	SAR	RSC	
Fine (> 30)	10	2.5 – 3.5	Limits pertains to kharif fallow/ rabi crop rotation when annual rainfall is 350-550 mm. When the water having Na<75% (Ca+Mg>25%) or rainfall is 550 mm the upper limits of RSC becomes safe. For double cropping RSC naturalization with gypsum is essential, based on quantity of water used during the rabi season. Grow low water requiring crops during kharif and avoid growing rice.
Moderately Fine (20-30)	10	3.5 – 5.0	
Moderately Coarse (10-20)	10	7.5 – 10.0	
Coarse (<10)	20	7.5 – 10.0	

E. Rain Water Management

In dry lands the rainfall is less than half the PET. In such areas the prime concern is moisture conservation. The core strategies of rainwater conservation under the AICRPDA were based on improving the water availability to the crops and increasing the ground water recharge. The approaches are:

i. Building in situ moisture reserves to tide over the recurring drought spells.
ii. Disallowing subsequent loss of soil stored moisture.
iii. Permitting safe runoff disposal, its collection above and below ground.
iv. Tactical recycling of harvested runoff.

Conclusion

With the adoption of intensive agriculture the problems like water logging, salinity, nutrient deficiency, soil sickness, etc., have developed which need attention for sustaining the productivity rate. Conservation farming with emphasis on efficient / safe use of water resources seems to be the desirable and feasible solution to these problems. The issues for attention are:

1. Identification of efficient crop zones and adoption of efficient cropping systems.
2. Efficient use of water with increased emphasis on rainwater harvesting and it's recycling; WUE in relation to cropping pattern.
3. Making provision of sufficient funds creating effective drainage system in all the irrigated areas.
4. Control of rise in water table in canal irrigated areas of arid and semiarid regions having brackish ground water.
5. Perfecting technology for safe use of brackish water and development of salt, drought and pest tolerant varieties of field crops.

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