

Potential of micro-irrigation

systems in sugarcane for achieving higher productivity, sugar recovery and water savings

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Sugarcane, one of the water-intensive crops, is cultivated in 13 states of the country but major areas (80-85%) fall in 5 states, viz. Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu and Andhra Pradesh. Despite being a water intensive crop its acreage increased by 13.48% from 2000-01 (4.32 million ha) to 2017-18 (4.97 m ha). Also, its cultivation is mainly practiced through surface method of irrigation. In such a scenario water use efficiency (WUE) is quite low (35-40%) on account of heavy distributional losses.

Key words: Micro irrigation, Productivity, Sugar recovery, Sugarcane, Water savings

IN India water requirement for irrigation purposes is 688-700 billion cubic meter (BCM) per year with a compounded annual growth rate (CAGR) of about 1.5%. The irrigation water required for sugarcane cultivation is 80-100 BCM/year (with a growth rate of about 1.2 % CAGR) and it is about 11-14% of total water requirement for the agriculture. As per Indian Sugar Mill Association (ISMA) about 88 kg of water is required for producing 1 kg cane and 884 kg water for producing 1 kg sugar through plant crops. This water requirement increases in case of ratoon crop to 118 kg and 1,157 kg, respectively.

One of the demand management strategies introduced recently (late 20th century) is to control water consumption in Indian agriculture by adoption of micro irrigation (MI). It includes mainly drip and sprinkler irrigation methods. Unlike the conventional flood method of irrigation (FMI) water (and may be nutrients also) is supplied at a required interval and quantity using pipe network, emitters and nozzles; thereby reducing conveyance and distribution losses almost completely.

In the drip method of irrigation (DMI) water is supplied directly to the root zone of crop/tree through a network of pipes/laterals with the help of emitters.

As Indian agriculture is heavily dependent on monsoon; its failure leads to farmers' distress, particularly in drought prone areas in Maharashtra, Karnataka, Andhra Pradesh, Odisha, Gujarat, Madhya Pradesh, Karnataka, Rajasthan etc. In such a situation micro irrigation management with proper planning and implementation is considered vital. However, the adoption rates are still limited that too for select field and vegetable crops and fruit trees. Also more adoption is in the regions that either face water scarcity or have the privilege of higher subsidies/

incentives offered by the respective state governments or both. Sugarcane is considered highly suitable for DMI interventions. In this paper various aspects related to this are presented from the angle of water/nutrient saving and achieving higher crop productivity and sugar recovery.

Merits of micro irrigation practice

The drip method of irrigation (DMI) holds promise as water and nutrients are supplied directly to the root zone of crops/trees through a network of pipes and distributional losses are avoided. The irrigation efficiency of well-designed and managed drip systems is as high as 90-95%. Besides, higher crop/tree productivity is achieved and cultivation costs are reduced. The

Table 1. Broad based gains in adoption of drip systems over the surface method of irrigation in some field and vegetable crops and trees

Attribute	Gains	Quantification
Water use efficiency	Increase	50-90%
Nutrient use efficiency	Increase	60-95%
Productivity of field crops	Increase	25-35%
Productivity of vegetable crops	Increase	35-55%
Productivity of fruit crops	Increase	35-45%
New crop introductions by farmers	Increase	15-30%
Costs of irrigation	Savings	27-32%
Costs of fertilizers/nutrients	Savings	20-28%
Costs on energy usage	Savings	20-30%
Farmers' income	Increase	35-45%



broad based gains in different attributes on adoption of DMI leads to significant improvement (Table 1).

The principal constraints identified include poor awareness, capital investments and pay-back period, availability of government schemes and levels of subsidies etc.

Sugarcane cultivation

The sugarcane cultivation area in the country now stands at 4.971 million ha – largest area in Uttar Pradesh (2.226 M ha) followed by Maharashtra (0.918 M ha). The all India crop area under micro-irrigation is very little (6.5%) of crops with its largest share in Maharashtra (24.5%). The coverage in Uttar Pradesh is very less (Table 2). Maharashtra and Karnataka together having 27% of the area under sugarcane have now enforced rules making drip method of irrigation mandatory for the cultivation of sugarcane in the states. Their estimates suggest water saving up to 60% from current levels. The feedbacks from farmers indicated that they are benefitted on account of higher production and less water requirements.

Sugarcane needs sufficient water for optimum productivity and sugar recovery. Excess (especially irrigation before harvesting) water may decrease the productivity and recovery. In this context, more adoption of micro

Table 2. Area (m ha) under sugarcane and MI penetration (%) in selected states

State	2000-01	2017-18	Present MI Area (%)
Uttar Pradesh	1.94	2.226	0.010
Haryana	0.14	0.111	0.360
Gujarat	0.18	0.186	0.211
Maharashtra	0.60	0.918	24.500
Andhra Pradesh	0.22	0.134	6.700
Karnataka	0.42	0.445	0.910
Tamil Nadu	0.32	0.254	0.140
All India	4.32	4.971	6.5

Source: Gol 2018; Press reports 2017-18.

irrigation technology is very important in this crop. A crop-specific focus in a given area is needed for quicker results so that large areas are brought under micro irrigation in shorter periods of time.

Water Consumption

In India, during the last 35 years irrigation coverage to sugarcane has increased from 83% to 94%. Main sources of irrigation include deep well pumping (> 60%) and canal water. The consolidated view about meeting water requirements for this crop through rainfall and irrigation is depicted in Table 3. The crop raised in *Adsali* season in Maharashtra that is planted in July/August and has duration of 16-18 months requires maximum water (3,500 mm/ha).

Cane cultivation requires high water availability. There are variations in irrigation water requirement for the sugarcane in different states on account of rainfall pattern and other agro-climatic considerations. According to one estimate average irrigation water requirement in Bihar, Uttar Pradesh, Maharashtra and Tamil Nadu are 750, 925, 2800, 1550 and 1400 mm/ ha, respectively.

About 250 tonnes of water is needed to produce 1 tonnes of sugarcane. The water requirements vary with respect to plants’ growth stage and geographical regions. Broadly, partitioning of water requirement during germination, tiller formation, grand growth and maturity periods are 12, 22, 40 and 26% in the tropics and 17, 24, 37, 22% in subtropics. Irrigation management is important otherwise crop faces drought like conditions in tiller formation stage and waterlogging in grand growth phases. In tropics, irrigations are required at 7 day interval during germination phase (1-35 days after planting), at 10 days during tiller formation stage (36-100 days after planting), at 7 days during grand growth phase (101-270 days after planting), at 15 days during maturing phase (271 days after planting till harvest). Adjustments are done according to rainfall scenario in the



Top left, Flood irrigation method in sugarcane cultivation; Top right, Scheme of drip irrigation system in sugarcane cultivation; Bottom left, Inside view of sugarcane field with drip pipes; Bottom middle, Surface drip irrigation for small holdings, Bottom right, Sub surface drip irrigation for large holdings.

Table 3. Water requirements for sugarcane crop in different states/regions

State/region	Crop duration (months)	Total water requirements mm/ha)	Source of water (%)	
			Rainfall	Irrigation
Northern region(includes UP)	9-10	1400-1600	55	45
Maharashtra	12-16	2500-3500	20	80
Tamil Nadu	10-12	1850-2150	30	70
Karnataka	12-14	2000-2200	30	70

Source: ISMA 2013.

Table 4. Comparison of different parameters under FMI and DMI (based on station trails) in cultivation of sugarcane in India

Parameters	FM I	DM I	Gains (%)
Water consumption (mm/ha)	2,150	940	56
Yield (t/ ha)	128	170	33
Water use efficiency (yield/water consumption)	0.060	0.181	200
Cost of cultivation (₹/ha)	42,540	37,500	13.5
Gross income (₹/ha)	92,000	112,000	17.9
Capital costs (₹/ha)			
without subsidy	-	165,000	-
with subsidy	-	47,500	-
Benefit cost ratio	2.16	3.45*	37.4

*In a pay-back period of 3.5-5 years (without subsidy)

area. Thus about 30-40 irrigations are needed. In subtropics, the requirement is for 7-10 irrigations. Methods like alternate furrow irrigation, trash mulching and drip irrigation have potential in economizing irrigation water during scarcity periods.

Micro irrigation and sugarcane cultivation

There are basically three components in a micro irrigation system – control unit, water carrier system and water distribution system. For small holdings, surface drip irrigation may be fine whereas for large holdings sub surface irrigation may be considered.

Fertilizer applications are installed after the backflow device. The design and selection of component will depend on holding size, plant spacing, water quality etc. Selection of appropriate dripper and dripper line, pipe diameter, wall thickness and dripper flow rates are the other considerations. Periodical maintenance and cleaning is required for trouble free operations. A comparison of various parameters under FMI and DMI in sugarcane cultivation revealed superiority of the latter (Table 4).

Parameters like germination of seed (cane), single cane weight, cane girth, cane length, number of internodes, leaf length and leaf breadth are

higher in DMI over FMI. The recovery rates also improved due to less moisture stress under DMI. The studies on heavy soils and sub humid climate of South Gujarat suggested that adoption of DMI can solve the issue of water logging and secondary salinization in the region.

Under the same set of situation, appropriately designed DIM exhibits distinct superiority in sucrose content on harvest. Cane yield along with quality of harvested cane has significant implication on profits by using less water. The efficiency gap in Uttar Pradesh was significant when compared to Maharashtra. The recent initiatives of the government of India and various state governments of the major sugar producing states to promote micro irrigation are likely to pay rich dividends in future. In water deficit areas or if water charges are levied in future, adoption of such technologies on large scale will become necessary in future in India.

The research results generated at stations on DMI technology in improving crop productivity, water saving etc. In other high value crops like banana, grapes and sugarcane it works well and the investments in the form of capital costs incurred are economically viable for farmers even at 15% discount rates, even without availing subsidy from government. Such costs are compensated to large

extent in sugarcane if more number of *ratoons* is planned. However, the maintenance part of drip irrigation system is very important for peak performance of such systems in sugarcane fields. Maintenance is required to ensure clogging of the drippers and can be achieved through flushing, chemical injections and irrigation scheduling. Constant monitoring of system flows and pressure and setting a time table in this matter is required.

The potential and prospects of widespread adoption of MI technology in context of sugarcane in the country are enormous on account of water saving, higher productivity and recovery and reduced costs of cultivation. Less weed population in field, electricity usage and ground water exploitation are the bonus. Only issue about the one time capital costs and management of the MI systems are to be given consideration on a long term basis. There is an urgent need about motivating the farmers through a quality extension and knowledge support networks and programmes to tackle the problems of water scarcity that is becoming more serious day by day. In such extension programmes the maintenance part and prescription about a regular schedule of monitoring should be highlighted for optimum results. As 2-3 ratoons are in the same set of planting may be taken, chances of success of MI in sugarcane become more evident.

SUMMARY

The limits on cultivated area expansion and water scarcity necessitate increased yield and higher sucrose content per unit area in case of sugarcane in coming years. Micro irrigation techniques, especially the drip method has emerged as the most precise, efficient and practical method of delivering water (and nutrients) to crops. More adoption of such technologies in sugarcane cultivation will overcome many of the concern related to productivity, sugar recovery, profitability, ratoon management, water scarcity (and droughts) and labour costs etc.

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