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# Micro irrigation of Millets – A Review

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**Abstract**

Micro irrigation related research in millets is very mearge. There is ample experimental evidence to establish the yield augmentation and water saving potential of micro irrigation in many crops. Drip irrigation is the best alternative system for special situations like sandy soils, low rainfall areas and sloppy lands where surface irrigation practice is not feasible.

**Keywords:** Micro irrigation, millets.

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**Introduction**

Micro irrigation can be defined as a low volume, low pressure and low flow rate method of applying water to a limited area of soil under a cultivated crop.

Micro irrigation system is characterized by water application at lower rate, water application over a long period of time, water application at frequent intervals and water application directly to plant root zone. It is said that the concept of micro irrigation owes its initialization to a random observation by Simca Blass, an Israeli engineer in 1959 that a banana tree near a leaking pipeline in the kitchen garden showed more vigorous growth than trees far away from the line. Besides the advantages of reduced water usage by 25 to 50 % and increased yields, popularization of micro irrigation system became possible with the technological advances in plastic industry especially the manufacturing of tough but flexible polythene pipes, highly suitable for micro irrigation system. Today micro irrigation system is extensively followed in Israel, New Zealand, USA, Australia, South Africa and it is gaining popularity in the third world and developing countries.

**Advantages of micro irrigation**

Micro irrigation in the form of drip irrigation and micro sprinkler irrigation offers many benefits-uniform application of water at low application rate, judicious use and saving of water, enhanced plant growth and yield, reduced salinity hazards, improved application method for fertilizer and other chemicals[1], reduced weed growth, reduced cost of operation and labour, uninterrupted cultural operations, controlled root zone environment, suitable for difficult terrains and problem soils, energy conservation, improved quality of produce, runoff loss is avoided, soil erosion prevention, less cost for land shaping, saving in land area and frost protection

**Benefits of micro irrigation in various aspects of crop production [2]**

| | |
|---|---|
| **Water use** | Distribution uniformity |
| | High application efficiency |
| | Water saving through lesser losses in air, canopy and deep percolation |
| **Output/ produce size** | Increased crop yield |
| **Economic returns** | Profit enhancement |
| | Saving in input cost |
| **Quality of produce** | Improvement in quality parameters |
| **Resource use** | High water use efficiency |
| | Increase in irrigated area |
| | Increase in irrigation intensity |
| | High nutrient use efficiency |
| | Labour saving |
| | Environmental safety |
| **Physiology** | Reduction in crop production |
| | Better plant water status |
| | Modified microclimate |

There is ample experimental evidence to establish the yield augmentation and water saving potential of micro irrigation in many crops. Drip irrigation is the best alternative system for special situations like sandy soils, low rainfall areas and sloppy lands where surface irrigation practice is not

feasible. Earlier drip irrigation was considered as an emerging new technology with its application limited to some special crops. Nevertheless, today it is used on a variety of crops which where initially considered unprofitable for management under drip irrigation. Drip irrigation is successfully practiced in fruit trees like coconut, mango, grapes and in many wide spaced crops like banana, sugarcane, turmeric, tapioca, cotton and vegetables.

Drip irrigation minimizes the loss of water through evaporation, seepage, deep percolation and leaching, thus saving water required to be applied through irrigation and improving the water use efficiency (WUE).

The results of recent research conducted by the All India Coordinated Research Project (AICRP) on water management, Madurai and other centres also confirm the water saving potential and yield advantage of micro irrigation over surface irrigation in many crops (Table-1).

**Table-1: Results from micro irrigation experiments at Tamil Nadu Agricultural University [3]**

| Crop | Yield with micro irrigation system (MIS) | Yield with surface irrigation | Yield increase (%) due to MIS | Water saving (%) due to MIS |
|---|---|---|---|---|
| Groundnut (kg/ha) | 1333-2292 | 1019-1257 | 24-88 | 9-32 |
| Typhonium tuber (t/ha) | 38-40 | 23-27 | 46-65 | 11-45 |
| Chillies (kg/ha) | 1890-2364 | 1140-1270 | 66-83 | 14-41 |
| Sugarcane (t/ha) | 143-148 | 128 | 12-16 | 10-21 |
| Maize (kg/ha) | 7951 | 6013 | 32 | 10 |
| Cotton (q/ha) | 24.3 | 19.6 | 24 | 12 |
| Cotton (q/ha) | 21-26 | 17-19 | 9-36 | 16-43 |
| Tapioca (t/ha) | 50-67 | 46-60 | 6-18 | 21-31 |
| Coconut (nuts/ tree/ year) | 118-134 | 97 | 20-38 | 40 |
| Coconut (nuts/ tree/year) | 133 | 112 | 19 | 59 |

**Mechanism of the advantages of micro irrigation [4,5]**

Enhanced plant growth, higher yield and improvement in quality of produce with micro irrigation (compared with surface irrigation) are made possible because soil water content in the root zone remains fairly constant at an optimal level (higher level of available soil moisture). This is achieved because irrigation water is supplied slowly and frequently at a controlled rate. The soil water potential is fairly high to enable easy absorption so as to maintain high leaf water status. Early maturity and lesser incidence of weeds, pest and diseases also enhance plant growth. Water is saved in micro irrigation system due to high irrigation application efficiency caused by closed conveyance of water in the distribution network, irrigation to a smaller portion of soil volume (30-70 per cent of surface irrigated area), decreased surface evaporation, reduced irrigation runoff from field, control of deep percolation beyond root zone, water application exactly with reference to quantity, time and place and less loss through transpiration by weeds. High

nutrient use efficiency through fertigation improves crop response to applied nutrients. Reduced weed growth under micro irrigation is due to limited area of wetting. Entry of weed seed through irrigation water is also prevented through filtration.

Even though system cost and installation costs are higher, micro irrigation ensures higher returns due to increase in yield and quality of crop and lesser expenditure on labour and operating costs. Salinity hazard is reduced even when water of high salinity is used for irrigation through micro irrigation system without affecting crop growth. Possible reasons are the dilution of salt concentration in the root zone by high frequency of irrigation, lesser addition of salt load due to reduced water application rates, movement of salts beyond active plant root zone by frequent irrigation, and no contact of salt water with leaves (in drip irrigation) thus avoiding any scorching effect. Use of waste water such as sewage water and effluent from factories through drip and sprinkler irrigation has been demonstrated successfully. The scope arises due to minimum quantity used which reduces pollutant load, avoidance of salt injury and oxidation of the wastewater during aerial spray as in sprinklers. Better control of many diseases causing pathogens reported from drip irrigated plots is mainly due to modified microclimate

**Constraints in micro irrigation**

Despite the many benefits of micro irrigation, there are many constraints too like high initial investment, unfit for gravity irrigation system (canals), requirement of operation and maintenance skills, need for external technical assistance for design, installation, operation and maintenance, persistent maintenance requirements, kigh energy consumption, rodent damage to lines and drippers, requires clear water free of debris and solid impurities, clogging of system, restricted soil water distribution zone affects root development in deep rooted crops causing lodging, rolling and relaying cost in short duration crops and in crop sequences, interferences with intercultural operations like weeding, earthing up and mechanical interculture when laid on surface and poor quality of system components affecting longevity of system and prolonging payback period

**Scope for micro irrigation in millets**

**Area irrigated in millets**

The share of irrigated area in Tamil Nadu for Finger millet, Sorghum, Pearl millet and Maize are 25.4, 11.8, 10.0 and 20.0 per cent respectively (Table-2). This indicates that still much of the millets area is only rainfed.

**Table-2:Area and Productivity of irrigated millets in Tamil Nadu**

| Crop | Area (Hectares) | | Percent of irrigated area | Productivity of irrigated crop * (Y) (kg/ha) |
|---|---|---|---|---|
| | Total area cultivated | Area irrigated (A) | | |
| Sorghum | 3,17,233 | 31,874 | 10.0 | 2251 |
| Pearl millet | 1,25,093 | 14,768 | 11.8 | 2552 |
| Finger millet | 1,24,958 | 31,696 | 25.4 | 2800 |
| Minor millets | 1,38,600 | 0.0 | 0.0 | - |

**Increasing the productivity of irrigated millets through micro irrigation**

The productivity of irrigated millets in Tamil Nadu is relatively low compared with the potential yield possible with the currently available high yielding varieties and hybrids. Micro irrigation combined with fertigation is one of the best management options available for

increasing the productivity of almost all irrigated crops including millets. Though evidence in favour of micro irrigation in millets is relatively less, this fact has been amply illustrated through many studies and on – farm demonstrations in other field crops like cotton, groundnut, chillies, onion and other vegetables. Production increase in millets through micro irrigation is made possible through two mechanisms. In the first instance more production is possible by bringing more area under cultivation with water saved through micro irrigation. Secondly fertigation adopted along with micro irrigation further augments the productivity of irrigated millets.

**Production increase through additional area with same water use**

Introduction of micro irrigation can help to save nearly 20 to 40 per cent of irrigation water currently used for irrigation to millets. Water thus saved can be utilized for spatial or horizontal (additional area under irrigation) and temporal or vertical (increasing cropping intensity by extending cropping season) expansion of irrigated area in millet growing regions. Assuming 20 per cent of water saving through micro irrigation to irrigated millets, additionally an area of 20,105 ha can be brought under irrigation (Table-3)

**Table-3: Additional area possible through adoption of micro irrigation in millets**

| Crop | Existing area (ha) under surface irrigation (A) | Additional area (ha) that could be brought under irrigation through introduction of micro irrigation (A x 0.2) | Total irrigated area (ha) possible with same water consumption (AA = 1.2 A) |
|---|---|---|---|
| Sorghum | 31,874 | 6,375 | 38,249 |
| Pearl millet | 14,768 | 2,954 | 17,722 |
| Finger millet | 31,696 | 6,339 | 38,035 |

**Production increase in millets through productivity augmentation by fertigation**

The potential of micro irrigation to improve the productivity of crop is further augmented by fertigation instead of soil application of fertilizers. Fertigation through micro irrigation system enables precision in application of fertilizers in terms of quantity to suit crop requirement, timing to match crop demand and reduction in loss of applied fertilizer. Through these mechanisms fertigation through micro irrigation improves nutrient availability, uptake and use efficiency leading to substantial yield benefits. Research conducted in India has demonstrated that the use of fertigation enhanced the yield of crops by 15-50 per cent, the response depending on the crop species and the level of management.

**Table-4: Estimated additional productivity of millets through fertigation**

| Crop | Area under possible (ha) through micro irrigation (AA) | Estimated production with existing productivity level (Y) under surface irrigation – AA x Y (tonnes) | Estimated production with 25 % enhanced yield (1.25 Y) due to micro irrigation – fertigation – AA x 1.25 Y (tonnes) |
|---|---|---|---|
| Sorghum | 38,249 | 86,099 | 1,03,318 |
| Pearl millet | 17,722 | 45,226 | 54,272 |
| Finger millet | 38,035 | 1,06,498 | 1,27,797 |

For the entire irrigated area (existing plus additional area made possible through microirrigation) the estimated yield at normal productivity level (existing productivity) will be 319 thousand tonnes. If fertigation through micro irrigation is also adopted, there is a scope for 25 % additional yield. Under such condition the expected production at enhanced production level will be 383 thousand tonnes (Table-4)

**Millets in crop sequence with other micro irrigation supported crops**

Most often millets are grown in sequence with high value crops like cotton, groundnut, chillies, onion, vegetables, etc., which are widely grown under micro irrigation. In such situations there is no extra cost on microirrigaion system for millets. By selecting millet crop that suits the micro irrigation system laid for the preceding high value crop it is possible to provide irrigation to millets with microirrgation system. For instance if a micro sprinkler irrigation system has been laid for a groundnut or onion crop the same system can be used for the succeeding millet by selecting fingermilelt which is close planted and is short in stature. When crops like cotton, chillies are raised under drip irrigation, the succeeding millets can be sorghum, pearl millet or maize. In order not to disturb the layout of laterals laid for the previous high value crop it is possible to manipulate the planting geometry for millets (paired row planting). By increasing the cropping intensity through introduction of millets in sequence with high value crops it is possible to reduce the payback period for the microirrigation system.

**Micro irrigation induced changes in crop management**

Micro irrigation warrants changes in crop management practices adopted under surface irrigation. Some of the major changes required choice of crops-preference for high value commercial crops in crop sequence, land shaping-dispensing with bunds, channels, less or no need for leveling-planting geometry, widening / narrowing row spacing-paired row sowing/ planting, increased population-nutrient management, change in method of application – fertigation, increased inputs-dose reduction without yield loss, response to higher than recommended dose-late application.

**Strategies for promotion**

By 2020 agricultural production in the country will have to be doubled mostly through yield enhancement and increase in cropping intensity coupled with sustainability. In the quest for improving productivity, water would be the most critical input. In irrigation management, micro irrigation must become a pivotal element because it has many agro ecological, socio economic and environmental advantages. Micro irrigation technology is a holistic approach to address poverty alleviation, crop diversification, enhanced productivity, environmental security, promotion of equity and reduction of biotic and abiotic stresses. During the tenth plan it has been targeted to bring 2 million hectares under drip irrigation in the country. The ultimate potential for micro irrigation in the country is put at 69 million hectares in 2030.

**The main constraints for the wide adoption of micro irrigation seem to be -l**ack of financial resources with small and marginal farmers for the high initial investments, poor institutional support, requirement of intense management skills, limited demonstrations and trainings, dependence on manufactures for technical guidance, inadequate research information for many crops, apprehensions about longevity of system components due to poor quality materials, low key efforts for transfer

of technology and reluctance to use for low value crop such as food grains.

**Where Micro irrigation is suitable?**

**Micro irrigation is suitable w**here water availability is limited and costly as in groundwater supported farms, where topography is uneven and leveling or land shaping for surface irrigation is difficult as in hilly terrain, where irrigation water is of poor quality such saline water and waste water, where soil physical properties hinder effectiveness of surface irrigation as in coastal sandy areas with high infiltration rate and light clay soils with low infiltration rates, where crops in sequence are amenable for planting in such a way as not to disturb the system layout every season.

**What is needed for promotion?**

The Micro irrigation Task Force set up by Government of India to promote micro irrigation in India has identified the following approaches for the purpose-to devise strategies to increase area under drip irrigation, to suggest institutional mechanism needed to promote micro irrigation including assurance, regionally differentiated technology and interventions, to suggest technical support for regions and crop specific interventions in micro irrigation, and to suggest measures so that the intended benefits reach the target group

**Requirement for success**

Full realization of the benefits of micro irrigation depends on attention paid to the aspects like design and layout.

The other requirements for success in micro irrigation are- soil suitability, alue of crop produce and crop choice, water quality and filtration to minimize clogging, water treatment to remove clogging, periodic flushing of the system, regulation of pressure of water flow, and technical expert assistance availability.

For success in micro irrigation a good design and quality equipment are important. Proper management is needed to ensure timely and uniform application of water. After determining the amount of water required by the soil the system is operated for a specified time depending upon its water application rate or flow rate. Since flow rated area is smaller in micro irrigation they are operated at higher frequency than other methods, i.e. daily, on alternate days, once in three days, etc. The frequency also depends on soil type, evaporation rate and age and type of the crop. Operating time must be carefully determined so as to avoid over or under irrigation.

**SWOT analysis**

Promotion of micro irrigation in millets in Tamil Nadu has the following Strengths, Weaknesses, Opportunities and Threats.

**Strengths**

**1.**Micro irrigation saves water and offer many other benefits

2.Micro irrigation coupled with fertigation improves crop productivity

3.Millets when introduced into a cropping system under micro irrigation help to increase cropping intensity and reduce payback period on cost of micro irrigation system

4.Additional cost of adoption of micro irrigation in millets will be marginal in farms where the system is already in operation for other high value crops

5.Increase in awareness and adoption of micro irrigation and its many benefits

6.Adequate research input in favour of micro irrigation and its many benefits

**Weakness**

1.A large share of area under millets is rainfed limiting the scope for micro irrigation

2.High cost of micro irrigation system dampens the motivation for option of the system in low value millet crops especially by resource poor small and marginal farmers

3.Infrastructure and incentives for promotion of micro irrigation in

general are not adequate in most regions of the state

4.Institutional assistance and technological guidance are inadequate

**Opportunities**

1.Demand for value added products from millets is increasing

2.Increasing preference of millet based products as supplementary food

3.Good scope for millet as alternative crops in view of increasing demand for maize as cattle feed and finger millet for food processing industry

4.Improved access to institutional assistance for finance, installation and maintenance

5.Continuing research initiatives for improving performance of micro irrigation and cost reduction

**Threats**

1.Poor quality of irrigation water may affect system performance through clogging unless adequate care is bestowed in maintenance

2.Poor quality of system components affect the longevity of the system with consequent adverse effect on payback period

**Research needs in micro irrigation to millets**

Micro irrigation related research in millets is very mearge. Input information on optimal schedules for micro irrigation and fertigation to various millets and planting geometry for micro irrigation will have to be generated. At current price levels, by itself millet may be non – remunerative for opting for micro irrigation. But when grown in sequence with other high value crops, millets will help to reduce the payback period on the system. Quality improvement in millets due to micro irrigation-fertigation is another field of study. In the backdrop of more value – added products from millets coming in to the market the profitability of millets might increase from the current levels thus enabling the option micro irrigation for the millet crops.

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