RESEARCHABLE AND PROMOTIONAL ISSUES IN MICROIRRIGATION

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ABSTRACT

Micro irrigation is an efficient method of water application, applicable mostly for fruits vegetables and field crops. It was introduced in India about 3 decades back which has expanded at a very fast rate. Its coverage has been higher than most of the countries. Although its application has progressed in most of the states in India, it has extended maximum in Maharashtra, Gujarat, Karnataka, Taminadu and Andhra. A number of system manufacturers have come up which not only to manufacture but also to design install and maintain the systems. The Government of India is also providing subsidy to encourage its application. However with fast expansion a number of concepts and issues have also evolved relating to Crops, Micro irrigation components, Standardization, and Implementation. The objective of this paper is to describe the concepts and analyze the problems.

INTRODUCTION

Micro irrigation was introduced in early 1980 on an experimental scale in many locations in India. Initially this irrigation method was adopted in the Maharastra State because of acute water scarcity conditions. Gradually the practice extended in the states of Karnataka and Tamil Nadu also. Major coverage of drip irrigation area lies in these states. Other states like Gujarat, Rajasthan, Andhra Pradesh and Madhya Pradesh are also slowly adopting this irrigation technology. Drip irrigation has been mostly adopted for commercial/horticultural crops such as grapes, banana, coconut etc. It has also been adopted for sugarcane, tea, coffee, cardamom and other plantation crops in different states.

There is an acute realization of importance of improving water management for sustainable development of agriculture which contributes about 20% to India's GDP.

It is realized that water is no longer unlimited and bountiful which can be used thoughtlessly, that would have adverse consequences to the posterity. The situation becomes more appalling with the increasing number of ground water overexploited areas. Presently ground water is over exploited in more than 440 blocks in the country and water tables are fast declining making further development of agriculture more difficult. In many parts of the country the situation is reaching alarmingly critical or permanently irreversible which if not

Controlled would slowly turn into social, economical and political crisis. Present irrigation system is operating at 35 –50 % efficiency against 60-65 % expected causing enormous wastage of precious resource besides ushering ecological degradation. Considering the

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cost of creating new sources, country can ill afford such a luxury of present irrigation practices that irrigate more of soil and les of crop.
Theoretical potential for micro irrigation according to Tankhiwale is estimated at 176.19 million hectare including 16.89 million hectare of fruits and vegetables and 159.5 million hectare of oilseeds and field crops. On a conservative assessment the area most suitable for MIS as estimated by the Horticulture Commissioner, MOA, is 27million hectare.
However, despite its established benefits the progress of the system has not been substantial. With government support and aggressive pioneering dedicated and concerted efforts by the manufacturers; MIS has spread well in a short span of time. But this speedy coverage has slowed down during past few years and unless hard decisions are taken the prospects of growth of MIS may become gloomy. In that event meeting food security could pose a challenge.
Micro irrigation has fairly extensively covered in a large area in India in the last two decades. A number of new concepts have developed internationally. Also during its extension several problems have been encountered. It is worth testing these concepts Proper solution of these problems would further expeditious promotion of this efficient method of water application. Some of the issues may be broadly divided as, criteria of Adoption, Crop related issues, components related problems, Special Applications, Issues of standardization and: Implementation problems These have been identified and discussed in the paper.

Researchable Issues

1. High density orchards

Such orchards need an intensive system of inputs and care and also in some case require growth regulators or dwarfing vireos. Normally micro sprinklers have proved better for citrus because of their spread roots.However in a Valencia orchard inoculated with dwarfing viroid yield per tree was found to be greater for drip and water used was 16 percent of that of micro sprinklers. Inoculation had no effect on growth. Thus response of viriod was better for drip than for micro sprinklers. It is therefore worth examining whether drip is better both for viriod and water economy.

2. Drip irrigation in Sloping Lands

Feasibility of drip for irrigation in a sloping land not only eliminates the need of constructing costly Bench terraces in sloping lands with shallow soils, has become a boon for irrigation of orchards. As experienced in Spain and may prove useful here also.

3. Shallow water tables

Drip irrigation in Shallow water tables partially contributes to meet the plant water requirement, more so in fruit trees, as they are relatively deep rooted than most other crops. Citrus and tomatoes grown under high water tables permitted a substantial cut back of water in Southern Florida without affecting yield thus providing water economy. This offers a possibility of cutting back irrigation through micro sprinklers, thereby saving water and operational energy cost.

4. Partial Wetting

The trees seem to adapt within one year to partial wetting. It seems that less water stress and yield damage occur in partially wetted trees where the amount of irrigation water is lowered. On the other hand, partially wetted trees seem to react more favourably to higher water application or fertilization. Most of the differences in fruit yield are caused by the number of fruits and not by the fruit weight. In studies of citrus trees it has been found that the yield increase ranged from 39 percent for the drip irrigation treatments which irrigated 5 to 10 percent of the area beneath the tree canopies to 64 percent for two spray jets per tree which irrigated 50.7 percent of the areas beneath the tree canopies.

5. Sprinkler versus Micro sprinkler

In citrus grown in areas affected by frosts, sprinkler irrigation seems to be better than drip surface or micro jets. Sprinkler irrigated treatment was found to be the best with less frost damage and higher juice acid content than the responses of other methods though rate of irrigation were less marked. This is a regional finding requiring further investigation as otherwise in many areas micro sprinklers have been replacing sprinklers because of their edge on water and energy economy as well as other advantages like feasibility of use of less cleaner water.

6. Minute Micro irrigation (MMI)

Such a system has showed to be a promising method for water economy as found for Citrus in Israel. Minute Micro irrigation applied intermittently in high frequency pulse Application (HFPA) eliminates runoff like surge method in surface irrigation and provides a scope of water economy. Experimented in Israel along with conventional drip to Avocado groves and citrus orchards and to carnation plants in greenhouse showed that no Runoff was created using HFPA saving 40% water in orchards. Yields for both the treatments were similar. The instrumentation need, operational convenience, cost and performance of HEPA need to be studied and adopted if found feasible.

7. Cropping in High Salinity

It is believed that because of maintenance of continuous moist regime drip irrigation can permit higher salinity in growing crops than surface method. A study of salinity under drip irrigation in clay soils for orange in India showed that it was low below the emitter and increased towards the periphery 30 cm away from emitters. Surface soil EC was higher but decreased with depth and was three times higher at the 30 cm periphery than below the emitter. There is a necessity as to what extent drip irrigation can facilitate fruit growing in salt affected clay and other soils.

8. Reclaimed Water Use in Scarcity areas.

In water scarcity regions, reclaimed water use has demonstrated to be a good source of irrigation water at lower cost. In experiments visual ratings of trees vigor and measured

tree height and trunk diameter were significantly lower for trees watered with the reclaimed water without fertilizer than for others in both the years. Thus its optimum use would need compensating fertilizers. Its feasibility of use needs to be explored in different areas along with the supplementary nutrient requirement based on soil analysis and knowledge of the plant response to nutrients.

9. Deficit Irrigation

Some experimental results suggest that fruit trees established with adequate irrigation can thrive well with deficit irrigation at a later stage. If this is corroborated by further field trials, then the area under remunerative orchard crops may be increased gradually with the same amount of available water. This requires conceiving a long term plan where surface irrigation development is a remote possibility. This possibility has to be weighed against another experimentally established fact that partially wetted trees react more favorably to higher water application or fertilization.

10. Crop water stress

This has a great role in reducing water use in water scarcity areas, but it also affects fruit dropping, out of season blossoming and fruit quality. In crop water stress management of Sirocco oranges it was found that a delay in the beginning of the irrigation season to the indicated limits will bring about a fruit drop which in each turn will reduce total yield by 11%but will increase fruit size by seven percent. Also an average increase of 20% in water use efficiency can be achieved. There is a need to study degree of stress which should be carefully checked to avoid the risk of out of season blossoming and fruit quality.

11. Daily night time spray irrigation

Was found in Italy to increase relative humidity and reduce maximum temperature of plots. Night time irrigation resulted in effective control of vapour pressure deficit during the day and significantly lowers evaporation than those during the day time application. Thus high frequency night time irrigation tends to provide more water saving than the weekly day time application. This needs regional study and confirmation.

Main criteria of Adoption Issues

They consist of ,cost of installation, water Saving:, Yield Increase, Quality of Produce, Study of Growth Components and Irrigation Scheduling and some current new concepts. Each of the issues have been discussed below

1. Cost of Installation

The cost of installation continues to be high even after a long time this technology has co existence it is worth checking whether industries can bring about some cost reduction from the available material alternatives and equipment combinations and needs of different farm sizes.

2. Water saving of crops not yet experimented

There is a need to determine water saving through micro irrigation in a given region for different fruits vegetables and field crops not yet experimented with keeping in view the impending serious shortage of water in the coming future.

3. Yield Increase and Quality of Produce

There is a necessity of studying yield increase and improvement in the quality of fruits and vegetables with micro irrigation as against conventional methods. Quality aspect is becoming more and more important from the point of marketability and export

4. Irrigation Scheduling

There is necessity of establishing and testing of more rational and sophisticated methods of scheduling of irrigation of different crops by micro irrigation and comparing them with conventional methods.

Important Crop related issues

They consist of Variation of Geometry of Cropping, Adoption Feasibility by old trees, Root restriction with computer controlled automated system, Root volume irrigated and yield increase, water application and yield

1) Variation of Geometry of Cropping

The drip system being costly for close growing crops like vegetables or other cash crops like sugarcane or bananas quite an economy can be ensured by adopting various geometries of installation of laterals and emitters, such as paired row laterals and other arrangements. It will be useful to work on feasible geometries according to a given crop and soil to economise installation.

2) Intercropping During Orchard Establishment

Irrigation of inter-crops by an economic system needs to be established. During the period the trees have been planted and are in growing stage, if drip system at a heavy cost is installed only for trees, how to irrigate field inter-crops during this period needs to be established. If during this period flood irrigation is provided to inter-crops, the investment on drip system becomes questionable.

3) Study of Growth Components

The study of various aspects also includes besides yield increase and water saving, the effect of micro irrigation on various growth components such as height of the tree, area of the leaves, diameter of stems etc. As a routine, there is no harm in studying all these

factors. However, unless these components can be related with either water economy or increase in yield, they generally seem to be of little use. It is quite possible that the plant height may increase substantially along with other growth components but the yield may not increase. Therefore, such studies may be more useful for crops like cabbage, asparagus or others where the vegetative growth itself constitutes the produce. However, it should be looked for in studies to correlate yield components with useful parameters like yield and water requirement.

4) Lysimetric Studies

It may be worthwhile studying water requirement of important tree crops by lysimetric studies unto certain growth stage for more precise determination,

Micro irrigation components related problems

They consist of Various Type Micro sprinklers and their Varied Applications, Study of Line Sources and Applicability to High Water Requiring Crops

1) Study of Various Type Micro sprinklers and Their Varied Applications

A variety of minisprinklers, and mini sprayers have come in the market which are useful for under tree irrigation orchard nurseries greenhouse. Criteria for their performance and efficiency needs to be established for standardizing their performance and quality control. This is needed for sprinklers also

Micro sprinklers have originally been used for under tree irrigation. But later-on it has found to be useful along with its number of variations useful for close growing crops, row crops, nurseries, green houses etc. also. In orchards in the form of micro sprayers it has been used for single trees. But for closely spaced crops like vegetables if used, it would reduce number of laterals as well as emission devices. The size of laterals may have to be slightly increased costing a little more per unit its length. Similarly, a single micro sprinkler would cost more than an emitter but the overall installation should be requiring lesser cost with micro sprinklers than with drip systems. Additionally, micro sprinklers can use less clean water than emitters without clogging. They may therefore, not require costly media filters as required by normal drip system. They may, however, require slightly more discharges than drip systems. The micro sprinklers may however would have one disadvantage that it may not be feasible to apply fertilizers with it for some crops with sensitive foliage. Also, it may have to be used with caution for some crops during the time of its flowering. On an overall basis, however, this system seems to be more promising for future applications. In this very reference it may be pointed out that there has been an increasing trend of use of microsprinklers in U. S. A., Spain, Mexico, Japan France, Thailand Columbia, Cyprus and Italy.

2) Study of Line Sources and Applicability to High Water Requiring Crops

Irrigation of sugarcane and similar crops requiring line source poses a problem. Products like biwall cane wall drip tape and others have come up in the market and some have failed. Appropriate line source for different crops and soils with economic installation needs to be established.
All these have different lives some based on the principle of disposability, after one to two seasons others based on at least some life of say five years. The economics of growing vegetables with drip systems will have to take into account not only the feasibility of adoption but also the life assigned to the components.

Special Applications

They consist of. Feasibility of Micro irrigation in Canal Commands, Off-season Crops, Use of Green Houses and Low Tunnels, Possibility of Intercropping during Orchard Establishment

1) Feasibility of Micro irrigation in Canal Commands

An appropriate system to utilize drip irrigation in canal commands with rotational system of supply needs to be established.

2) Off-season Crops

The installation of drip system would be profitable on vegetables only if they can be grown off-season, such that a little earlier than normal season crops is available, and the produce can be marketed at higher costs. It is possible to grow such off-season crops either in hills or using different varieties of seeds for the crops.

3) Use of Green houses and low tunnels

Green Houses offer an attractive opportunity of growing vegetables in adverse environmental mental conditions though high technology. But it involves high investment. Therefore only for crops that can be exported or otherwise fetch high returns this proposition may be economical. This technology can also be used to produce costly seeds for important crops. Green houses have been constructed in large areas in Bangalore for producing Capsicum seeds. For high altitudes as required for defence this may be an essential and important alternative. It may be pointed out that presently the maximum area under greenhouses lies in Japan followed by U.S.A.Portugal and Jordan. Besides going for very high technology in developing countries low tunnels can also be used quite profitably with smaller investment.

4) Use of Mulches

Along with drip irrigation and green houses if mulches are also provided for growing crops it is found that not only the yield is increased due to moisture conservation but the quality of the produce, flower or vegetables is also improved. Mulches have been found to be useful not only for growing vegetable crops in green houses but also for growing vegetable crops in the field. To encourage use of mulches Government of India has been providing appropriate subsidy.

5) Computer controlled automated system

A computer controlled automated Irrigation and fertilization system which consists of soils metric potential sensors located in the main root zone, has been developed in other countries and has a scope in India also. This system provides a means of controlling the size of the root system as well as the root environment.

6) Adoption of micro irrigation by old trees

Changes in root distribution of old surface irrigated orange trees converted to pressurized systems show that the trees irrigated by trickle basin and spray appear to have higher dry roots concentration at depths greater than 120 cm compared to trees irrigated by the sprinkler and border-flood method. The results show that the trees roots adapted and proliferated in areas where water was applied.

7) Waste water use for drip irrigation

Trials were done in an experimental plant regarding suitability of municipal wastewater use. Irrigation plant operation as regards water quality was not difficult. Bacteriological studies of fruits from the vine yards and olives and pistachio groves concerned confirmed that application of the waste water by drip irrigation after a simple primary treatment was possible without risk to consumers.

8) Fertigation

Fertigation has several important aspects to study. Studies on suru sugarcane for the effect of fertilization through drip in vertisols. The application of water-soluble fertilizers NPK is applied in 20 equal splits or more N, P K uptake. The straight fertilizers may be applied with N through urea in 20 equal weekly splits and P and K as basal. The quality parameters viz. RS NRS N and P contents in cane were more in water soluble fertilizers compared to straight fertilizers. Application of fertilizers through drip resulted in increase in cane yield (28%)

Issues of Standardization

Since the introduction of technology has been comparatively recent in India there are various specific problems of standardization peculiar to Indian conditions that have been addressed. Some technical issues of possible general interests, which are discussed here, include; emitter classification criteria, materials and other issues of laterals such as life, working hours, OD/ID basis.

1) Coefficient of Variation (CV) of Emitters

In India, BIS has laid down specifications similar Indian Standards Organisation (ISO). For non-pressure regulated emitters it is possible to maintain CV within the BIS norms. However, Indian manufacturers have had difficulty in maintaining CV less than 5 percent for A-class regulated emitters.
According to Soloman (1979), the control variables for mol ding machine are injection pressure, temperature, injection speed, mould temperature, cycle time, mould operation, quality of elastomeric material and its being able to maintain a resilience over a period of time. It appears that getting a level of precision and standard is a function of combination of materials; precision of die and various factors involved which for a high level can be manufactured at high cost. The industries can optimise for a cost efficient overall process with appropriate margin for desired level of standards.

2) Issues Related to Laterals

Salient aspects associated with laterals were material, outer diameter (OD) or inner diameter (ID) basis, life, temperature working hours and marking of pipes.
Therefore a consensus was evolved to select the standard material as PE 25. When improved grades of PE are openly and conveniently available, the standards could be revised. In specifying diameter of tubes, there were differing views.

3) ID versus OD system

Both systems ID control and OD control have their own merit and are used in different parts of the world. In the USA, ID control is used, as the flow capacities are better expressed based on ID control and the tolerances are much less than OD control. However, in India most plastic pipes were designated by OD. So to avoid confusion for consumers, an OD basis was selected. Otherwise specifying tolerances, probably both systems could be used.

4) Equipment Life

This is important both from the point of durability as well as calculation of economics as well as subsidies given by the Govt. Specification of equipment life is a complex issue, because in addition to the quality of material and fabrication, it is also a function of level of handling in field conditions by a farmer. It is difficult to design an experiment for such an issue in other countries it may not be that important, but in Indian conditions this becomes important for computing economics of system and giving subsidies. The standards were based on BIS 8779 pipes conveying irrigation water at 45^{o} C. The life of 10 years was provided at 35^{o} C. Under note to clause 2.1 and Appendix 8.1 of this document the possibility of use at 45^{o} C was also covered. Regarding working hours it was selected as 800 hours/year.

5) Study of Different Type of Filters

i) In filters mostly mechanical details strength and dimensions of different components are specified. In the hydraulic aspect only clear pressure drop is generally provided. No standard of even clean pressure drop is yet established by ISO or BIS, which needs being established.
ii) It is important to identify the objective of the filters in terms of job it is required to do. This means to what range of turbidity it is required to clean with what time (rate of flow/total volume of flow). In some sense filter efficiency should be defined and values determined and specified for filters made available.
iii) In case of media filters whether vertical filter is better or the horizontal one should be established. Also whether homogeneous media in horizontal or stratified media is better needs to be established.
There are various issues related to screen, media and hydro cyclone filters which need be considered for proper identification and setting procedures for standard specification and testing. Some issues may be specifying procedures for determining clean pressure drop, efficiency criteria of filters as related to different degree of turbidity of irrigation water, comparative performance of homogeneous and layered media filters etc.

FUTURE STRATEGIES AND ACTION PLAN

With a view of minor differences in strategy of growth and action plan for future the two themes have been combined and dealt collectively. Also, except that sprinklers use Aluminum and other materials also besides PVC and HDPE, most of the other strategies of promotion tend to be more or less similar for sprinklers as for drip systems. Both methods are therefore taken up simultaneously.
1. The policy regarding subsidy size of holding categories of farmers, crops, gender emphasis, schedule caste, scheduled tribes facilities specially for drip irrigation, have been changing from time to time They need be streamlined and rationalized.
2. To reduce excessive cost the possibility of reducing excise and import duty may be explored. Steps may be taken of making appropriate raw material available to manufacturers on reasonable cost.
3. In water scarcity areas and in undulating lands and porous soils micro irrigation should be encouraged.
4. In arid and semi-arid regions or areas which is either waterlogged or threatened with water logging micro irrigation should be encouraged.
5. In many areas in India with intensive use of ground water the water table has been gradually going down, so much so that they have been declared as dark area for minor

irrigation. In such areas DIS needs being encouraged. This implies permitting minor irrigation works along with and DIS.
6. The feasibility of encouraging DIS through pilot schemes in the canal command areas and tank command areas needs being explored. This will economize water use and reduce percolation losses through surface irrigation and reduce water table rise and salinity in some areas.
7. Sugarcane cultivation in Maharashtra and Gujarat states of India, requires very high water requirement. Government should impose restrictions on surface irrigation of these crops and encouraged SIS and DIS in such areas.
8. The nodal departments if belong to one discipline should have support of other related disciplines. If the nodal consists only of Horticulture Department sufficient backing staff of Agricultural Engineering should be supplemented with the department to work for design installation and monitoring. In case nodal department is Agricultural Engineering or Minor Irrigation, supplemental staff for horticultural should be provided for necessary backing.
9. State level committee for promoting DIS and MIS need to be properly structured for being effective in field implementation.
10. Training of field officers implementing the schemes and farmers using the system are essential so as to provide requisite awareness and background. In this connection, it is sometimes necessary to provide them educational tour in areas where drip irrigation has been installed extensively.
11.. Demonstrations units should also be established in all Agricultural Universities, ICAR Institutions and other important institutions such as various commodity boards of Tea Coffee Rubber etc
12. Very few firms have an R & D section just on skeletal basis. Most of them work only for selling or marketing their products either manufactured by themselves or imported. The government should insist that they have a reasonable level of R & D in their set up relating to product manufacture and testing or system installation. The industry should also carry out R & D to explore the possibility of use of better and more economic plastic material so as to reduce the cost.
13. The state governments, Agricultural Universities, the Plastic Development Centers and PDC and Industry should work for establishing a data base relating to various soil-crop-climate parameters relating to BIS and DIS and come out with more scientific estimates of water requirement of horticultural crops in different regions.
15 Feasibility of new concepts like.High density orchards, Partial Wetting, Minute Micro irrigation (MMI).Cropping in High Salinity.Deficit Irrigation should be explored

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