MICRO-IRRIGATION AN INNOVATIVE TECHNOLOGY- ITS IMPORTANCE, CHALLENGES & PRESENT SCENERIO IN INDIA

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ABSTRACT

Water is considered as the most critical resource for sustainable agricultural development. However, the increasing population, and more erratic rainfall, is likely to reduce the water supply for agriculture. Resource-wise, the country accounts for 16 per cent of the world’s human population and nearly 30 per cent of the cattle with only 2.4 per cent of the land and 4 per cent of the water resources.

The total surface water availability of the country is estimated to be 1869 Billion Cubic Metres (BCM) of which only about 690 BCM is utilizable. As per the latest assessment of Dynamic Ground Water Resources of India (as on 31st March, 2013) carried out jointly by Central Ground Water Board (CGWB) and State Ground Water Departments, the Annual Replenishable Ground Water Resources of the Country are 447 Billion cubic Meters (BCM) out of which the annual ground water draft/utilization is 253 BCM (Billion Cubic Meter), out of which 228 BCM is used for irrigation and 25 BCM is used for domestic and industrial purpose. Even if the full potential is exploited, about 50 per cent of the cultivated area will remain under rainfed agriculture. Water is the life-blood of agriculture and it consumes over 80 per cent of the fresh water resources. Judicious exploitation and management of water, therefore, holds the key for the future growth of Indian agriculture. Therefore, time has come when Indian agriculture should appreciate the fact that water is a precious and limited resource and should be conserved and handled carefully in the most efficient manner, to minimize the dependence of agriculture on monsoon. The solution lies in examining the innovative models for their contribution to higher efficiency of water usage. Micro irrigation is proved to be a one such efficient method which enables better control and monitoring of existing water which can be translated into higher water usage efficiency. Recognizing the importance of micro irrigation, the current government manifesto has talked about Per Drop More Crop under PMKSY. Raising the physical productivity of water in crops without due considerations to economic will not have much relevance to small farmers in developing countries. The rationale of the paper is to appraise micro-irrigation as an innovative technology for sustainable agriculture in India and the challenges faced while adopting Micro-Irrigation Technology and suitable measures to overcome the problem. However, in spite of the sustained efforts made by central and state governments, the extent of success in adoption of Micro irrigation by farmers needs a review.

Keywords: Micro-irrigation, PMKSY, challenges, Scheme of Funding, Suggestions

Note: The Information referred in the paper is based on data available on PMKSY website and other publication mentioned in “References”

1. INTRODUCTION

Agriculture, a way of life in India, has shaped the thought, outlook and culture of the people for centuries. The agro-climatic condition of the country is suitable for growing a variety of crops, which are found in most parts of the world. Agriculture will continue to be the engine of country’s growth and development. Besides being the backbone of the national and household food and livelihood securities of over 650 million people, agriculture sector accounts for 25 per cent of the nation’s Gross Domestic Product (GDP), 15 per cent of the export and employs about 60 per cent of the workforce.
The requirement of water by different sectors by 2050 is estimated to be 1180 BCM, but the share of water for agriculture is expected to get reduced from the present level of around 80 per cent to 69 per cent by 2050. On the other hand, the demand for water for agricultural purposes is estimated to increase to 611 BCM in 2025 to 807 BCM in 2050. During the same period, the demand for non-agricultural use of water will increase to 232 BCM in 2025 to 373 BCM in 2050. The vulnerability of Indian agriculture is bound to be severe lest the present trend of water use and management is changed. The per capita availability of water in India has decreased from 2209 m³/year in 1991 to 1545 m³/year in 2011 and it is estimated to decline further up to 1140 m³/year in the year 2050.

Micro irrigation which allows application of water to root zone of the crops through specially designed equipment known as emitters, has already been adopted by some countries for transforming their agriculture. India introduced this technology on a commercial scale in the 8th Plan and during the past decade about 1.20 M ha could be covered under micro irrigation, mostly under horticultural crops. However, the coverage so far has been minuscule in the face of the fact that almost 69 M ha could be covered through this improved system.

The irrigation sector, mostly due to the overwhelmingly high prevalence of surface irrigation will have to address the challenges of low WUE in face of the depleting water resources. The efficacy of development and need-based adoption of micro irrigation system to meet the challenges should be examined. As witnessed in developed and selected developing countries, including those in India, micro irrigation, comprising drip, mini sprinkler and sprinkler, must become a pivotal element of integrated water use system with many agro-ecological, socio-economic and environmental advantages. Micro irrigation has emerged as a tool for effective management of resources which saves water, fertilizers and also electricity and is one of the interventions in high value agriculture leading to diversification. In short, it is a versatile solution provider- distributing the benefits completely, evenly and equitably unlike other irrigation systems.

Water productivity is considered as a performance indicator of irrigation compared to old concept of irrigation potential. Water productivity can be defined as the ratio of actual yield achieved and the water actually used. In the case of micro-irrigation, the crop yield is increased and the amount of water required is very less compared to any conventional methods. Hence the water productivity will be increased significantly due to the increase in numerator and decrease in the denominator. The real water saving in arid and semi arid regions can be achieved in crop production through efficient irrigation technologies. Hence, micro-irrigation has been considered as an innovative technology for sustainable agricultural growth.

WHY MICRO-IRRIGATION? OR REQUISITE OF MICRO IRRIGATION

According to a recent estimate, thirty four countries in the world will be facing water scarcity by 2025 indicating that per capita availability of fresh water supplies will be less than 100 m³ person per year. A country with renewable water availability on an annual per capita basis exceeding about 1700 m³ will suffer only occasional or local water problems. Below this threshold, countries begin to experience periodic or regular water stress. India (1400 m³) and China (1700 m³) will come first into this category in the year 2025, while USA will have more than 7000 m³ person·1 year-1 and will not face any scarcity. Rising demand for urban and industrial water supplies in the world pose a serious threat to irrigated agriculture. The allocation of water for agriculture will come down to 50% from the present level of 70%. However, to achieve required food and fiber production with increasing population, India has to boost the current irrigation potential of 91 Mha to 160 Mha but, the total water resources estimated are 230 Mha will have to cater the need to the nonagricultural uses also.
country is likely to be water stressed in the coming years. Therefore hand in hand with technologies for water harvesting and storage, technologies for precision water application methods need to be adopted. The major problem associated with decreasing amount of fresh water for irrigation is conveyance losses, reducing the net utilization of irrigation water to 46 per cent only. However, to fulfill the additional requirement of the irrigation with improved technologies for water harvesting, excess runoff collection, storage and recycling for precision water application by economizing the available amount of irrigation water needs to be adopted.

Micro-irrigation will increase the irrigation cover using the existing available water. Micro-irrigation with Fertigation will enhance production per unit input in these nutrient poor, shallow and sloppy soils. Micro irrigation is a co-ordinated and controlled water management system where water is made to flow under pressure through a network of pipes of varying diameters, the main-line, the sub-main lines and the lateral lines with appropriately placed emitters along the length of the latter through which water is discharged to the root zone.

**Sprinkler Irrigation System**

**Drip Irrigation System**

The net utilization of irrigation water in drip system is 90 per cent and through sprinkler system, it is 82 per cent. In view of the same, micro irrigation is having paramount importance with brighter future prospects.

**IMPORTANCE OF MICRO-IRRIGATION**

- Water scarcity in various parts of the country has created awareness about micro-irrigation systems and its implementation results in significant economic and social benefits in the country. The benefits are noticed in terms of crop yields, reduction in energy consumption, conveyance loss is minimal.
- Evaporation, runoff and deep percolation, the use of chemical fertilizers & pesticides are also reduced by using micro irrigation methods.
- It also ensures additional benefits like non-exploitation of groundwater, reduction in the cost of weeding and relief from water scarcity induced labour migration. The real water saving can be obtained from the irrigation efficiency at field level. To improve the water productivity for agriculture, initiatives can be taken at field level and the saved water can be used for the irrigation of additional acreage or for environmental and social needs. Another water saving advantage is that water source with limited flow rates such as small water wells can be used.
- Micro irrigation provides significantly higher water usage efficiency due to proximity and focused application. Efficient water use leads to additional benefits such as increase in the area under irrigation as well as more usage of marginal/ degraded land.
2. **PRADHAN MANTRI KRISHI SINCHAYEE YOJNA**

The Government of India has implemented Centrally Sponsored Scheme on Micro Irrigation under PMKSY with the objective to enhance water use efficiency in the agriculture sector by promoting appropriate technological interventions like drip & sprinkler irrigation technologies and encourage the farmers to use water saving and conservation technologies. The Scheme was launched by the Department of Agriculture & Cooperation, Ministry of Agriculture in January, 2006 as Centrally Sponsored Scheme on Micro Irrigation (CSS).

From 1st April 2015, Micro Irrigation component of OFWM has been subsumed under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY). It will be implemented as Centrally Sponsored Scheme on Micro Irrigation under PMKSY during the financial year 2015-16 as per the same pattern of assistance and cost norms as were prevailing under OFWM, unless revised. In the FY 2016-17, funding pattern between Central Government and State Government under PMKSY has been fixed as 60:40%

Micro-Irrigation is considered as an integral part of Per Drop More Crop under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) and they have listed many advantages of this technology compared to conventional water application methods due to proximity and focused application. These are:

(i) Micro-irrigation technology ensures water use efficiency as much as 50- 90%. This can be achieved due to the fact that micro-irrigation helps to reduce conveyance losses, runoff, evaporation losses, seepage and deep percolation losses significantly. The saved water can be used to increase the area under irrigation or for the reclamation of degraded/ waste land;

(ii) Since low flow rate is required, small wells can also be used as a source and it helps for energy savings upto 30.5%. The potential savings in power may be utilized in other sectors.

(iii) The direct application of fertilizers to the roots results in the saving in fertilizer consumption up to 28.5%. This has a long term impact to achieve land productivity;

(iv) The crop yield is increased and it was stated that the productivity for crops & fruits is increased up to 42.4 % and the increase in productivity for vegetables up to 52.7%. This ensures good economic return for the better yields.

(v) Farmers can judiciously add more new crops due to improved water scenario and it was estimated that as many as 30.4% farmers have done it; and

(vi) More focused and judicious use of water has resulted in the increase in farmers income

2.1 **Holistic Approach for Micro Irrigation System**

- **Poverty alleviation**: essentially through increasing income, converting vast rainfed areas into irrigated areas which are endowed with greater productivity and stability and through the creation of additional employment opportunities, especially by involving the private sector.

- **Horticulture-led diversification of agriculture**: leading to the promotion of high value commodities with tremendous prospects for capturing new markets, particularly under the WTO regime. The system also permits commercialization of protected horticulture with tremendous economic returns.

- **Enhanced productivity**: through the increase in yield improved quality of the product and reduced labour and input costs – resulting in greater competitiveness in the liberalized world market. “More crop per drop” must be the driving force.
• Environmental protection and ecological security: by promoting precision farming where the correct quantity, correct time and correct place of application of the irrigation water is assured. There is a significant reduction in accumulation of salt in the root zone in the associated problems of water table rise and water logging, in salinization and in the fall of the water table in tubewell command areas.

• Promotion of equity: by adopting micro irrigation technology in varying settings as it is non-specific to location, topography, commodity and the quality of land. Its adoption in waste lands and in hill and mountainous regions will greatly improve the socio-economic condition of the people in such hitherto un-reached areas.

2.2 Micro-Irrigation: Current Status
(Source: Pradhan Mantri Krishi Sinchayee Yojana website)

• Area Covered under Centrally Sponsored Scheme on Micro Irrigation since 2005-06 to 2018-19 is 5.67 Lac Hectare, fund released as on 31.03.2018 under PMKSY Scheme is Rs.8, 63, 40, 35,000.00/-.

<table>
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Sub-scheme wise outlay (Central Share) for PMKSY scheme for five years (2015-16 to 2019-20) (Rs. in Crores)

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<tr>
<th>SLNo</th>
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<th>2015-16</th>
<th>2016-17</th>
<th>2017-18</th>
<th>2018-19</th>
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<td>1010</td>
<td>1400</td>
<td>1980</td>
<td>2780</td>
<td>3900</td>
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<tr>
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<td>1690</td>
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Per Drop More Crop - Micro Irrigation (Data collected from PMKSY Website)
3. SUCCESS STORY OF MICRO-IRRIGATION TECHNOLOGY IN INDIA

A study in the semi Arid region of India was carried by Neelam Patel and T.B.S Rajput WTC, IARI, New Delhi in the district Alwar, Rajasthan. Alwar has an important place in agriculture production in Rajasthan. Total geographical area of the district is 7,82,897 hectares which is about 2.5% of the State. In Alwar district, 68% of the working population is employed in the agriculture sector. In this district, 82% of the farmers come under small (1–2 ha) and marginal (<1 ha) land holding categories. The main source of irrigation is tube wells. About 35470 electric motors and 66502 diesel pump sets are being used for irrigation purposes as villages having no canal irrigation facility. The normal rainfall for the district is 657.3 mm. Two villages namely Chidwai and Pehal were selected in the Alwar district each representing the normal irrigation practices in vegetables–wheat cropping system of the area. Participatory Rural Appraisal techniques were conducted in the villages to get an insight in to the farmers’ perceptions. Total 2.5 ha area belonging to five farmers was placed under drip irrigation during 2012 and 2013, utilizing low discharge of tube wells which is not possible in
flood irrigation in cotton and kharif onion. Fifteen moveable Raingun sprinkler systems were installed for irrigation of wheat crop in the villages. Cotton under drip irrigation could save 50% (5120 m$^3$ water under drip and 10240 m$^3$ under flood) of water besides 75% enhance in yield (2.8 t/ha in drip against 1.6 t/ha in flood). Kharif onion under drip irrigation could save 40% (3388 m$^3$ water under drip and 5646 m$^3$ under flood) of water besides 50% enhance in yield (24 t/ha in drip against 16 t/ha in flood). Impact of this technology motivated other farmers of nearby villages and now many farmers are coming forward for the large scale adoption.

Another successful story is from Narmada canal Project in Sanchore, a town in Jalore District of Rajasthan wherein after adoption of Sprinkler system in place of conventional methods following benefits has occurred:

- The CCA has been increased from 1.35 Lac hectare to 2.46 Lac hectare i.e 78% increased.
- No of Villages benefited for irrigation increased from 89 to 233.
- Drinking water facility in 1541 villages and 3 Towns has been provided.
- Increased in food production has been assessed 534 Cr to 2200 Cr (312%) based on year 2015-16.
- Kharif crop had been introduced.

4. IMPACT ON ECONOMICS OF IRRIGATION

The technology also has a positive impact on the economics of irrigation as it has a positive impact on the pumping hours required for irrigating a field. This helps save a lot of cost and energy as well and also helps to reduce the wear and tear of the pump and increase its longevity. This is enabled by the reduction in water quantity used for irrigating a field due to the implementation of this technology and this is perceived by both adopters as well as non-adopters. However the cost of economics might work out but the resource conservation can take a hit as these savings in irrigation also help to expand the irrigated area thereby increasing the total water quantity used to earlier levels and also more energy will be required to irrigate the expanded area. Thus some of the benefits of drip irrigation in terms of irrigation economics can be lost as well for better farm economics. However to irrigate this expanded area without drip irrigation would result in considerable increase in draught of water which could have very detrimental environmental impacts. Drip irrigation helps to avoid such extremes. The economics of irrigation is also positively impacted by the technology in many other indirect ways as it ensures adequate and timely water supply to the farm this helps take away most of the variability of farming and productivity thereby assuring yield and productivity and revenue to the farmer. The assurance of yield and total production enables a farmer to enter into long term contracts and exercise greater market power as well. The technology also has a positive impact on transaction costs of irrigation as it helps to reduce the conflicts and increases adaptability in irrigation. However the true economics of irrigation will be beneficial only once the scale of adoption in space and time is significant to transform savings into inter-farm and inter sectorial transfers even if only at the village or household level.

5. CHALLENGES FOR ADOPTING MICRO-IRRIGATION TECHNOLOGY:

Indian agriculture still continues to be a gamble on monsoon. Only 18% of precipitation is used while the rest is lost through surface runoff, which aggravates the problem of soil erosion. Therefore, harvesting the rainwater, checking soil erosion through various methods, and efficiently utilizing the harvested/conserved water, needs to be integrated in order to justify the huge investments on high cost irrigation projects. In the absence of large-scale
adoption of efficient modern irrigation technologies such as drip and sprinkler irrigation, the present irrigation efficiency in the country is only 30-40 percent. Past efforts in promoting Micro irrigation technologies have been rewarding and they did bring vertical growth in their adoption. However, their adoption has remained limited with slow progress, particularly due to the following reasons:

- The initial cost of establishing micro irrigation system is high, hence generally out of the reach of resource-poor farmers.
- Micro irrigation technology was not integrated with farm irrigation management systems, as they were generally viewed in isolation.
- Adequate credit facilities to the farmers, trained human resources, appropriate technical know-how and infrastructure for training of farmers were lacking.
- Micro irrigation is generally perceived as technology intensive, hence its acceptance by farmers needed much persuasion.
- There was a lack of information on temporal and spatial variation in soil moisture, the optimal fraction of soil to be wetted, location specific and crop-specific irrigation and fertigation scheduling and lack of availability of low cost water soluble fertilizers and other agro chemicals.

6. SUGGESTIONS FOR BETTER ADOPTION OF MI SYSTEMS

- Large scale adoption of micro irrigation technologies needs to be encouraged as a key Government Policy in order to take complete advantage of the benefits offered by these technologies.
- Micro irrigation should not be viewed as an end in itself. It needs to be promoted in a holistic manner having end-to-end approach with integration of agronomic practices and linkages for marketing.
- Micro irrigation technologies should be viewed as total plant support systems instead of just considering them as water conservation measures, as these technologies help in improving the individual and combined efficiency of all other agricultural inputs such as fertilizers, energy, plant protection measures, etc.
- It is accepted that Major & Medium irrigation projects have created islands of prosperity amidst surrounding poverty. This is because, the upstream population as well as population beyond the tail end of the canal have been deprived of the project benefits. The deprived lot has also lost even what they once received as their natural share in the water flowing through the river. Farmers on upstream and beyond tail-end have no option but to resort to cost intensive lift irrigation schemes. Even here, inefficient use of water through conventional methods results in prohibitive water and energy costs rendering the scheme uneconomical. If the government adopts the policy of making MIT mandatory for all commercial crops under both canal and lift irrigation system, it will provide/ensure larger benefits to greater number of farmers with same volume of water. This will obviously lead to greater equity.
- Groundwater is the only source of water being used for drip method of irrigation in India. Unlike other countries, in India water from surface sources (dams, reservoirs, etc) is generally not used for drip method of irrigation. Since water use efficiency under surface sources is very low owing to heavy losses through conveyance and distribution, farmers should be encouraged to use water from surface sources for drip method of irrigation. This can be done by allotting certain proportion of water from each irrigation project only for the use by micro irrigation.
- Water Users Associations (WUAs) are being promoted in a big way with the support of internal and external agencies in India in recent years. Since one of the main objectives of the WUAs is to improve the water use efficiency, some arrangements need to be made to introduce the micro irrigation through WUAs.
Since there is shortage of electrical energy in the country, its conservation in the agricultural sector with the help of micro irrigation should receive due consideration even in framing future power policy.

Micro irrigation encourages commercial agriculture through crop diversification and motivates the farmers to switch over from conventional cropping pattern to high value commercial crops. It also improves quality of the produce because of timely and uniform nutrient application.

GST should not be imposed on micro irrigation system as it should be viewed as an infrastructure support for the overall development of agriculture.

Capacity building of the manufacturers is equally important for ensuring development of quality products and their application. There should be regular interaction between the micro irrigation industry and the research organisations for updating the skills and knowledge.

CONCLUSION

Micro irrigation led agriculture, armed with knowledge and technologies, with farmer as centre point, should be viewed as one of the eco-technological approaches to attain sustained and enhanced agricultural production and productivity. The noted benefits due to micro-irrigation technology are increase in yield, improvement in the water use efficiency, reduction in the cost of water, fertilizers and manures and weed removal. All these added up in the increase in the overall economical benefits accrued due optimum utilization of water. The technology is bound to maximize the synergistic interactions of improved seeds, water and fertilizer – the three components of the Green Revolution. Through micro irrigation, the Green Revolution could be transformed into an Evergreen Revolution to ensure the congruence of sustainability, productivity, profitability and equity this technology is highly relevant and praise worthy. Since micro irrigation greatly enhances water, fertilizer and energy use efficiency and promotes precision agriculture, the Evergreen Revolution could be achieved without the burden of environmental degradation. Hence economic considerations can be incorporated with more engineering approaches to keep water productivity more relevant in economic criteria.

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1. GoI, Ministry of Agriculture, PMKSY website