There is a global crisis about water and its management. How-
over, water is becoming increasingly scarce worldwide due to various reasons (Rosegrant, et al., 2002). With the fast
decline of irrigation water potential and continued expan-
sion of population and economic activity in most of the
countries located in arid and semi-arid regions, the prob-
lems of water scarcity is expected to be aggravated further
(Biswas, 1993 and2001; Rosegrant, et al., 2002).

DEVELOPMENT OF DRIP IRRIGATION IN INDIA

Drip method of irrigation was introduced in India dur-
ing the early seventies at the Agricultural Universities
and other Research Institutions. The scientists at the Tamil
Nadu Agricultural University (TNAU), Coimbatore, who are
considered to be the pioneers in drip irrigation research
in India, have conducted large-scale demonstration in the
farmers’ field for various crops, which received encourag-
ing response from the farmers (INCID, 1994). However,
the adoption of drip method of irrigation was very slow
until Mid-eighties mainly because of lack of promotional ac-
tivities from the State and Central governments. In spite of
having the largest irrigated area in the world, India too has
started facing sever water scarcity in different regions. Ow-
ing to various reasons the demand for water for different
purposes has been continuously increasing in India, but
the Potential water available for future use has been de-
clining at a faster rate.

The agricultural sector (irrigation), which currently con-
sumes over 80 percent of the available water in India,
continues to be the major water-consuming sector due to
the intensification of agriculture (Iyer, 2003). Though India
has the largest irrigated area in the world, the coverage of
irrigation is only about 40 percent of the gross cropped
area because of the low coverage of irrigation is the pre-
dominant use of flood (conventional) method of irrigation,
where water use efficiency is very low due to various rea-
sons. Available estimates indicate that water use efficien-
cy under flood method of irrigation is only about 35 to
40 percent because of huge conveyance and distribution

INTRODUCTION
There is a global crisis about water and its management. The
crisis is significantly about availability of water for use
and its highly uneven spatial distribution. The situation
of water availability has changed drastically over the last
4-5 decades. Measures to increase water supply such as
completion of storage dams, interlinking of rivers, desali-
nation of sea-water and artificial recharge of groundwater
and rainwater harvesting are costly and long term steps
(Sipes, 2010). Agriculture accounts for a majority of global
freshwater withdrawals and almost all in some fast-growing
economy. At the global level more than two thirds of the
blue water withdrawals are for irrigation. Irrigated agricul-
ture represents almost a fifth of the total cultivated land
but contributes more than one third of the total food pro-
duced worldwide and therefore it is of critical importance
to sustenance of the human race. The rapid declining and
dwindling of ground water resources cause a threat to
farming community and forced to adopt better water man-
agement practices to get sustainable production. The con-
cept of irrigation is as old as the human civilization; how-
ever there has been enhanced efficiency in the irrigation
patterns over a period of time. Adoption of improved wa-
ter management practices is an important need of the day.
India’s crop production suffers not only from drought but
also from indiscriminate use of irrigation water. There is
wastage of huge quantity of water with the present meth-
ods of irrigation which were in vogue.

Studies carried out across different countries including
India have confirmed that irrigation plays a paramount
role in increasing the use of yield increasing inputs and
enhancing cropping intensity as well as productivity of
crops (Vaidyanathan, et al.,1994). Apart from benefiting
the farmers, irrigation development also helps to increase
the employment opportunities and wage rate of the agri-
cultural landless labourers, both of which are essential to
reduce the poverty among the landless labour households
(Saleth,2004;Narayanamoorthy and Deshpande,2003). How-

ABSTRACT Irrigation is critical for successful summer vegetable production and it should be efficient and effective to
avoid over or under application. The water use efficiency under conventional flood method of irrigation, which
is predominantly practised in Indian agriculture, is very low due to substantial conveyance and distribution loss-
es. Recognizing the fast decline of irrigation water potential and increasing demand for water from different sectors, a
number of demand management strategies and programmes have been introduced to save water and increase the
existing water use efficiency in Indian agriculture. One such method introduced relatively recently in Indian agriculture
is Micro-Irrigation(MI), which includes drip method of irrigation. Micro-irrigation is proved to be an efficient method in
saving water and increasing water use efficiency as compared to the conventional surface method of irrigation, where
water use efficiency is only about 35-40 percent. Many factors influence appropriate drip irrigation management, in-
cluding system design, soil characteristics, crop and growth stage, environmental conditions, etc. The influences of
these factors can be integrated into a practical, efficient scheduling system which determines quantity and timing of
drip irrigation. It provides the ideal vehicle to deliver nutrients in a timely and efficient manner and also achieving high
water- and nutrient-use efficiency while maximizing crop productivity requires intensive management for commercial
vegetable production.

KEYWORDS Drip irrigation, Intensive Management, Irrigation efficiency

Narayanaswamy.T
Associate Professor of Agril. Engg., College of

Anandakumar B.M
Principal, Diploma (Agri) College, AHRS, Kathalagere,
Karnataka.

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Scope of Drip irrigation for Vegetable Production in India

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losses (Rosegrant, 1997; INCID, 1994). The area under DMI has increased from a mere 1500 ha in 1985 to 70,859 ha in 1991-92 and further to 5,00,000 ha as of March 2003 (INCID, 1994; GOI, 2004).

The development of drip irrigation was very slow in the initial years and significant development has been achieved especially since 1990s. Due to various promotional schemes introduced by the Government of India. In irrigated vegetables production, it is important to reduce water loss through evaporation from the soil uncovered by vegetation. This can be accomplished by achieving rapid and uniform soil coverage through transplanting rather than direct sowing and choice of optimal density and planting geometry. In tomato, decreasing the row spacing from 0.7 to 0.5 m and 0.35 m increased fruit yield when drip irrigation was used. Micro-irrigation is also found to be reducing energy (electricity) requirement, weed problems, soil erosion and cost of cultivation. Investment in micro-irrigation also appears to be economically viable, even without availing State subsidy.

### Table 1: Water Saving and Productivity Gains under Drip Method of Irrigation: India.

<table>
<thead>
<tr>
<th>Vegetable Crops</th>
<th>Water consumption (mm/ha)</th>
<th>Yield Tonne/ha</th>
<th>Water saving over FIM(%)</th>
<th>Yield increase over FIM(%)</th>
<th>Water use efficiency(mm/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FIM</td>
<td>DIM</td>
<td>FIM</td>
<td>DIM</td>
<td>FIM</td>
</tr>
<tr>
<td>Ash gourd</td>
<td>840</td>
<td>740</td>
<td>10.84</td>
<td>12.03</td>
<td>12</td>
</tr>
<tr>
<td>Bottle Gourd</td>
<td>840</td>
<td>740</td>
<td>38.01</td>
<td>55.79</td>
<td>12</td>
</tr>
<tr>
<td>Brinjal</td>
<td>900</td>
<td>420</td>
<td>28.00</td>
<td>32.00</td>
<td>53</td>
</tr>
<tr>
<td>Beet root</td>
<td>857</td>
<td>177</td>
<td>4.57</td>
<td>4.89</td>
<td>79</td>
</tr>
<tr>
<td>Sweet Potato</td>
<td>631</td>
<td>252</td>
<td>4.24</td>
<td>5.89</td>
<td>61</td>
</tr>
<tr>
<td>Potato</td>
<td>200</td>
<td>200</td>
<td>23.57</td>
<td>34.42</td>
<td>Nil</td>
</tr>
<tr>
<td>Lady’s Finger</td>
<td>535</td>
<td>86</td>
<td>10.00</td>
<td>11.31</td>
<td>84</td>
</tr>
<tr>
<td>Onion</td>
<td>602</td>
<td>451</td>
<td>9.30</td>
<td>12.20</td>
<td>25</td>
</tr>
<tr>
<td>Radish</td>
<td>464</td>
<td>108</td>
<td>1.05</td>
<td>1.19</td>
<td>77</td>
</tr>
<tr>
<td>Tomato</td>
<td>498</td>
<td>107</td>
<td>6.18</td>
<td>8.87</td>
<td>79</td>
</tr>
<tr>
<td>Chilli</td>
<td>1097</td>
<td>417</td>
<td>4.43</td>
<td>6.09</td>
<td>62</td>
</tr>
<tr>
<td>Ridge Gourd</td>
<td>420</td>
<td>172</td>
<td>17.13</td>
<td>20.00</td>
<td>59</td>
</tr>
<tr>
<td>Cabbage</td>
<td>660</td>
<td>267</td>
<td>19.58</td>
<td>20.00</td>
<td>60</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>389</td>
<td>255</td>
<td>8.33</td>
<td>11.59</td>
<td>34</td>
</tr>
</tbody>
</table>

Source: INCID(1994) and NCPA(1990)

The table-1 shows that the productivity of different crops is significantly higher under DIM when compared to FIM. Productivity increase due to drip method of irrigation is noticed over 40 percent in vegetable crops such as bottle gourd, potato, onion, tomato and chillies, While reducing water consumption, it also reduces substantial amount of electricity required for irrigation purpose, by reducing working hours of irrigation pump sets (Narayananmoorthy, 2004).

A study of simple micro-irrigation methods done to improve irrigation efficiency on vegetable gardens by decreasing soil evaporation and drainage losses and by creating and maintaining suitable soil moisture conditions for crop growth. Evaluation of micro irrigation techniques on crops i.e. maize, tomato, rape, okra and cabbage was done under low-head drip irrigation, pitcher irrigation and subsurface irrigation using clay pipes. The study reported the mean best improvement in water use efficiency as 35.5% for subsurface drip irrigation treatments which was indicated to be significantly higher than other techniques (Batchelor et.al 1996). The positive impact of drip irrigation on soil quality, and on improving the capacity of agriculture to cope with power, labour and water scarcity. Findings indicate for a wealth maximizing impact on various kinds of farmers, it is very important to provide support to the farmers after the sales. (Vaibhav Bhamoriya and Susan Mathew 2014)

### MANAGEMENT OF DRIP IRRIGATION

With drip irrigation water is conveyed under pressure through a pipe system to the fields, where it drips slowly onto the soil through emitters or drippers which are located close to the plants. Drip irrigation requires little water compared to other irrigation methods. Drip irrigation is a technique in which water flows through a filter into special drip pipes, with emitters located at different spacing. Water is distributed through the emitters directly into the soil near the roots through a special slow-release device. If the drip irrigation system is properly designed, installed, and managed, drip irrigation may help achieve water conservation by reducing evaporation and deep drainage.

Source: (RCSD 2008) Schematic design of a low-cost Drip irrigation system.

The principle that Irrigation can be closely matched to the crop
water use on a daily basis is the overriding principle of drip irrigation and sets it apart from all other irrigation systems.

Water is applied directly to the plant root zone. With drip irrigation only the root zone of the plant should be wetted. Thus in the horizontal plane for row crops only the hill or bed is wetted, not the furrow area, and in the vertical plane the water is kept in the root zone by not allowing drainage below it. Elimination of irrigation run-off. Rainfall run-off should be much reduced as it can be stored in the dry soil between the drip lines. Reduction in water consumption due to drip method of irrigation over the surface method of irrigation varies from 30 to 70 percent for different crops (INCID, 1994, Narayanamoorthy, 1997; Postal, 2001).

CONCLUSION

With agriculture striving to increase crop yield while relying on a critical resource that is gradually diminishing, the need to increase Water Use Efficiency (WUE) becomes progressively more crucial. Little success has been obtained so far through genetic approaches to modify complex traits such as transpiration efficiency. This is partly due to our limited understanding of the molecular basis and physiological mechanisms regulating WUE in stressed and non-stressed plants. There are various irrigation techniques to enhance the efficiency of the applied water to the crop. Improving irrigation techniques can directly affect WUE by increasing the yield per unit of water applied and reducing the amount of water loss. Major improvements could be obtained through management and innovative design of integrated water delivery and application schemes. Innovative decision support systems integrated by sensor networks to monitor soil and plant water status will help farmers to efficiently allocate limited water resources.

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