MICRO IRRIGATION – A technology to save water

1. Introduction

Efficient utilization of available water resources is crucial for a country like, India, which shares 17% of the global population with only 2.4% of land and 4% of the water resources. The annual food grain requirement of India, works-out to be 450 million tones by the year 2050 and the per capita availability, in terms of average utilizable water resources, which was 6008 m^3 in 1947 (presently 1250 m^3) is expected to dwindle down to 760 m^3 by 2050. Agriculture, a main stay in the India, accounts for 25 % of the Nations Gross Domestic Product and 15% exports has dependence of 65% of Indian population. Agricultural sector is the largest consumer of water. The overall efficiency of the flood irrigation system range between 25 to 40%. To meet the food security, income and nutritional needs of the projected population in 2020 the food production in India will have to be almost doubled. Adoption of Micro irrigation, may help in saving significant amounts of water and increase the quality and quantity of produce. All these emphasize, the need for water conservation and improvement in water-use efficiency to achieve ***More Crop per Drop***.

National Committee on the Use of Plastics in Agriculture (NCPAH) was constituted by Ministry of Agriculture for the promotion of micro irrigation in India. The committee established 17 Precision Farming Development Centres (PFDC) in different agro climatic zones of India for conducting research on micro irrigation through farmers participation and to submit guidelines to the NCPAH, Ministry of Agriculture to take beneficial technologies to the farmers. We are one of the PFDC situated at Indian Agricultural Research Institute, New Delhi in the semi arid region of India and have been conducting systematic research on micro irrigation through farmers' participation.

The research works presented here were conceptualized as per the need of the time, keeping the central theme of enhancing water use efficiency through micro irrigation technology, during the period 1997 to 2006. Micro irrigation system came to India in seventies but its adoption

started only in late eighties. Government started making efforts to promote micro irrigation through part financial support to offset its high initial cost syndrome. During initial stages it was important to investigate its benefits to convince the farmers for its adoption. Initial researches included the comparisons of micro irrigation system with conventional systems in terms of water savings and yield enhancements.

After establishing the superiority of micro irrigation systems, the focus of research shifted to estimate water requirements, modifications of crop geometry and use of mulches in drip irrigated fields for realizing the potential benefits of the system. With passing time that is in nineties the emphasis gradually shifted to different hardware and software aspects for cost reduction, design modifications and fertigation and chemigation. In the recent years the emphasis has emerged on precision farming, including the use and application of software and more efficient instruments in agriculture besides the use of simulation and modeling of moisture and nutrients movement under different soil and dripper characteristics. Improved micro irrigation systems including automated systems and subsurface drip systems.

2. Summary of research activities and significant achievements

A. Mechanics of water movement under drip irrigation

The mechanics of soil moisture flow under drip system is a function of dripper spacing, application rate of the drippers and the duration of operation of the irrigation system. Extensive field experimentation with point source, twin and triplet dripper arrangement and line source of water application resulted in the comprehensive understanding of appropriateness of water application mechanism under different soil and crop conditions. It helped in improving the design of drip system by matching soil wetting with rooting pattern of the crops (peach, lemon, mango, guava and citrus) and seasonal vegetables.

B. Estimation of water requirement of orchard and vegetables

Micro irrigation is used more often for orchard crops in India but water requirement of crops under drip were not available. The data about the crop canopy with growth of plants were generated. The values of crop coefficients were also estimated at different stages of crops. The water requirement of important horticultural crops was then estimated.

C. Saving of water and enhance in yield

Micro irrigation system was found to result in 30 to 70 % water savings in various orchard crops and vegetables from along with 10 to 60 % increases in yield as compared to conventional methods of irrigation. Mulching with drip further enhanced the crop yield to the tune of 10-20 % and controlled weeds up to 30-90%.

D. Determination of optimal crop geometry

Spacing of laterals is dependent on the crop spacing. Different crop geometries lead to different lateral spacing. Optimal crop geometries (Line and plant spacing) were developed to minimize

lateral length hence drip cost, without effecting yield. The optimal crop geometry for tomato, okra and onion were determined to reduce the over all cost of drip.

E. Determination of optimal dose and scheduling of fertigation

The efficiency of utilization of chemical fertilizers in the India is very low e.g. nitrogen use efficiency seldom exceeds 40 % under lowland. Drip irrigation enables the application of water-soluble fertilizers and other chemicals along with irrigation water uniformly and more efficiently. But liquid fertilizers are not available in India and unit cost of liquid fertilizers is also very high, therefore for conducting the field experiments on fertigation, we used commonly available granular fertilizers eg. urea, muriate of potash and phosphoric acid. Before conducting the field experiments, the solubility of fertilizers was determined in laboratory at different temperatures. We found up to 40 % of fertilizers can be saved in comparison to conventional method of fertilizer application. Optimal dose and frequency of fertigation for onion, tomato and garlic were determined and was determined, appropriate fertigation scheduling eliminates the chances of ground water pollution.

F. Design, development and selection of appropriate fertilizer injector

During fertigation investigations it was found that only one size of venturi was available in the Indian market. The higher cost of fertigation pump restricts its use among farmers. We also found that farmers generally don't practice fertigation for application of fertilizer, and applied fertilizers through broadcasting. Tto make fertigation technology more popular, we designed, developed and tested various sizes of venturies including all other fertilizer injectors and guidelines printed in simple local language.

G. Use of alternate energy for operation of micro irrigation systems

Average daily uniformity of solar photovoltaic (SPV) operated micro sprinkler was found more than 70.0 %. SPV operated micro irrigation systems are dependable and economically viable alternatives for irrigation under conditions of uncertain availability of electricity and diesel oil particularly in remote and tribal area of Rajsthan, Gujarat, M.P. India.

H. Development of low head drip irrigation system for poor and marginal farmers

Uncertain electric supplies in remote areas and small sizes of the holdings present a situation where operation of drip system has to be made independent of the electricity supply schedule. A 4 m head was found sufficient to apply water at 90 % coefficient of uniformity in a field as large as 1600 m^2

I. Software development

After conducting the long term field experiments on hydraulics of water, estimation of water requirements of horticultural crops, determination of optimum crop geometry, fertigation study, fertigation frequency study, performance evaluation of fertigation injectors and then design, development and testing of different sizes of venturi, we generated the database for the production of horticultural crops and provided the guidelines for the selection and design of hardware. The generated database and other available literature on the subject were used in

the development of different softwares to promote the standard micro irrigation technology among common Indian farmers. All softwares were developed in Visual Basic version 6.0 developed and are user friendly. Softwares were made available free of costs to different users and modifications were made on the suggestions of users.

i. VENTURA- software for selection of venturi

ii. FRONT ADVANCE – software for estimation of wetting patterns of drippers

iii. DRIPD - software for designing of drip irrigation system. Adequate database (including monthly PET values of more than 250 locations in the country, crop coefficients and water requirements of most vegetable and fruit crops, details of components of drip systems along with their costs) has been provided.

iv. FERGON – software for designing the fertigation system including duration of operation of drip system, concentration of fertilizer mixtures, amount of water required to dissolve commonly used granular fertilizers, size of fertilizer tank required, injection rate of fertilizer and injection period.

v. MICROS – software for designing micro sprinkler system

J. Simulation & modelling of nutrient distribution in vegetables

Exhaustive field experimentations were done to monitor the movement of soil moisture and nutrients under micro irrigation. Hydrus-2 D was found as appropriate model for simulation of nutrients and moisture under different horticultural crops of semi-arid region.

K. Scheduling of irrigation on the basis of root growth of cauliflower and cabbage

Scheduling of irrigation were done for cauliflower and cabbage on the basis of the hydraulics of water movement and root development of crop

L. Design of subsurface drip irrigation (SDI) for vegetables

The soil moisture movement is an important aspect of planning and management of SDI system. The maximum yield of potato, okra and onion was obtained by placing the lateral pipe/ drip tape at 10 cm below the soil surface in sandy loam soil.

M. Application of photodegradable mulch in potato

Plastic mulch although conserve the moisture and enhance the yield but it also creates environmental pollution and nuisance in the field. Photodegradable mulch of different colours was used in potato and tomato and was found as a viable option for mulching.

3. Capacity building of farmers

To promote any technology the capacity building of farmers are of utmost important. It was achieved through various trainings.

i. On farm farmers Training

Total 60 training programs were conducted on the installation, operation, use, maintenance and trouble shooting in micro irrigation system for the benefit of 1800 farmers at their fields

ii. Advisory services to farmers:

We are providing all the necessary information to the needy farmer with suitable literature.

iii. Demonstration of micro irrigation technology

A fine technology display center showcasing all precision farming technologies and their field demonstrations are maintained through out the year for the benefit of the farmers

4. Outcome of adopted technology

i. Farmers at large scale adopted, the technology developed at Precision Farming Development Centre. Production guidelines developed for the cultivation of horticultural crops pertinent to northern states of India, identified under National Horticulture mission and Micro Irrigation scheme i.e. Punjab, Haryana, U.P. and Rajsthan had adopted in large scale at farmers field. About 6750 ha area in U.P., 700 ha area in Haryana, 2000 ha in Punjab and 1600 ha area in Rajsthan are already covered under mango, guava, citrus, okra, potato, onion, cabbage, cauliflower and tomato etc..

ii. More than 1800 farmers have been trained in installation, operation, use, maintenance and trouble shooting in micro irrigation system

iii. Designed venturies will be made available commercially with in two years at a lower cost after its manufacturing start by a local company.

iv. One of our developed software i.e. “DRIPD” were used at large scale by the extension officials and private manufactures to design the most economic drip system and to use data base about water requirement of most horticultural crops.

v. We initiated work on subsurface drip irrigation and used drip tape in 2001 in potato, now more than 3500 ha area is already under subsurface drip tape and micro sprinkler in potato in Chambal, M.P.

vi. Our research efforts in conjunction with the effort of the Government of India in the form of partial financial support have translated in to in an area of about 12, 350 ha brought under micro irrigation in four north Indian states. Designs of micro irrigation developed by us and production guidelines developed for most crops suggested by us are being adopted, in general and in the four north Indian states in particular. Adoption of micro irrigation in 12, 350 ha has resulted in the saving of water to the tune of 24.8 per cent amounting to 61.5 M m^3.

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