RESEARCH PROGRAM ON
Dryland Systems

CGIAR

Report on

"Capacity Building on drip irrigation system in dryland system"

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Introduction:

Agriculture is the largest user of water, which consumes more than 80% of the country's exploitable water resources. The overall development of the agriculture sector and the intended growth rate in GDP is largely dependent on the judicious use of the available water resources. While the irrigation projects (major and medium) have contributed to the development of water resources, the conventional methods of water conveyance and irrigation, being highly inefficient, has led not only to wastage of water but also to several ecological problems like water logging, salinization and soil degradation making productive agricultural lands unproductive (Sivanappan et al., 1987). Among the improved irrigation methods, drip irrigation can increase the water use efficiency up to 95% and in many states the adoption level is increasing, as central and state governments are investing more money in the spread of the micro irrigation especially drip irrigation. It has been recognized that use of drip irrigation is one of the most efficient method of irrigation (Keller and Blisner, 1990).

The estimated potential of micro irrigation (MI) in the country is about 42 m.ha (Raman, 2010) and the current coverage of area under MI in the country as on March 2013, is only about 6.6 m.ha. Recently it is in the process of revision as per which the potential is estimated to be 47 million hectares (NCPAH, 2014). Out of this potential, about 70 percent is suitable for sprinkler irrigation for crops like cereals, pulses, oilseeds in addition to fodder crops, while the rest is under cotton, sugarcane, fruits and vegetables, spices and condiments. In addition to drip and sprinklers, there is potentiality for bringing an area of about 2.8 million ha with mini-sprinkler for crops like potato, onion, garlic, groundnut, cabbage, cauliflower etc. (Raman, 2010). The coverage under MI also varies considerably amongst states signalling the constraints in expanding the area (for more details on state-wise MI potential and adoption, see Palanisami et al., 2011). The factors such as huge initial investment, lack of technical support, cropping pattern, access to water and socio-economic conditions of farmers are found to be the major factors influencing adoption of drip irrigation (Narayanamoorthy, 1997). In several cases, even after the adoption of drip irrigation, the farmers discontinued drip irrigation due to lack of maintenance, irrelevant cultural background and unreliable water supply (Kulecho and Weatherhead, 2005). In order to enhance the adoption of drip irrigation technology among farmers on a sustainable basis, it is important that farmers should possess adequate knowledge and skill on the maintenance of the drip system at field level.

The earlier studies from IWMI-TATA program has found that the very less farmers had the knowledge on the drip operation, maintenance and fertigation practices. It was also revealed that the drip fertigation with proper system maintenance resulted in yield increase in various crops to an extent of 6-8 % (Sureshkumar and Palanisami, 2010). Considering the importance of drip maintenance practices, drip irrigation capacity building and management initiative for maximizing productivity and income was conceived and implemented in Andhra Pradesh and Karnataka States under Dryland System Program during 2015.

Implementation of drip irrigation to various crops (chilli, Tomato, onion, Brinjal, castor, etc) was initiated during 2015 in Indian action sites. Ananthapur and Kurnool districts from Andhra Pradesh state, Bijapur district from Karnataka state were identified as action sites for capacity building and implementation of IWMI activities.

The content of the training program is to mainly focus on operation and maintenance of drip irrigation system beside irrigation and fertigation scheduling. This helps farmers in a bigger way to learn the drip and fertigation technology along with the periodical maintenance.

A series of training programs were conducted in the action sites during June, August and September 2015. The training programs were focused on drip system maintenance, water and fertigation scheduling. Farmers (men and women), Assistant Project Director (Andhra Pradesh Micro Irrigation Project), Jain Irrigation System Limited (JISL) staff, Joint direct of agriculture (JDA)-Bijapur, ICRSIAT and IWMI took part in the trainings. The details of the trainings were illustrated below with the support of pictures.




Training farmers on maintenance of drip system and fertigation in Mallapuram, Ananthapuram district (11/08/2015)




Training program at V.Bonthrialla, Kurnool district, Andhra Pradesh on chilli drip irrigation maintenance and castor (12/8/2015)


Training program at Balaganur, Karnataka district on water management activities (3/6/2015)

Mr.Manjunath JDA, Mr. S R Sudi ICRISAT and ICRISAT Staff at Bijapur, Dr.P.Sampath Kumar , Scientist IIHR and other line department officers visited the solar drip sites and drip demo plot and interacted with the drip farmers (2/9/2015).

As a part of capacity building, practical know-how on drip irrigation and fertigation techniques, problems encountered and their solutions were explained in question and answer mode as given below:

1. What is drip irrigation and its prime objective?

Drip irrigation is one of the micro irrigation methods. The others include, sprinkler, micro-sprinkler, mini-sprinkler etc. Drip is a precise and regulated application of irrigation water and plant nutrients at low pressure over a period of time at short intervals through emitters/drippers with close network of pipes is known as drip irrigation system.

In drip irrigation, water is conveyed only through pipe network from point to point (i.e.,) water source to plant rhizosphere unlike surface irrigation wherein water is conveyed in open channels leading to evaporation, percolation and seepage losses. In the surface irrigation we are irrigating the entire “land” but we are irrigating the crop/plant in drip irrigation. Irrigation efficiency is as high as 95 per cent under drip while it is 50 per cent under surface irrigation.

2. What are the advantages of drip irrigation system?

- Improvement in water use efficiency and thereby the savings in water
- Low application rate
- Uniformity of water application
- Efficient fertilizer and chemical application
- Better control of root zone environment
- Crop yield enhancement
- Improvement in crop quality
- Reduction in pest incidence including weed problem
- Savings in electrical energy
- Use of saline water
- Reduction in labour cost
- Suitable for irrigating difficult terrain and marginal lands
- Maintains soil health

3. Enlist the crops where drip irrigation can be employed?

Drip irrigation is suited for almost all orchards, vegetables, cashcrops, flowers and oilseeds. The detail crop information can be seen in Table 1.

Table 1: crops suitable for drip irrigation

Crop Group	Crops
Orchard and fruits	Banana, Grapes, Papaya, Pomegranate, Oranges and Lemons, Mango, Custard apple, Aonla, Sapota, Guava, Litchi, Melons, Coconut, Arecanut, Cashewnut etc
Vegetables	Tomato, Chillies, Capsicum, Cabbage, Cauliflower, Onion, Bhendi, Gourd crops, Peas etc.
Cashcrops	Sugarcane, Cotton, Turmeric, Garlic, Cloves etc
Flowers	Rose, Carnation, Gerbera, Anthurium, Orchids, Jasmines, Dahlia, Marigold etc
Oilseeds	Sunflower, Oilpalm, Groundnut etc

4. For which crops mini sprinklers/micro sprinklers are used?

Micro sprinklers are designed for wide range of applications. It is best suited to short statured crops (less than a meter high), non-flowering crops, pulses, groundnut, greens, curry leaves, cabbage, cauliflower, beet root, leafy vegetables, lawn and nurseries and in green houses. It can also be used in intercropping systems in orchard crops

5. What is the extent of area irrigated by drip in India?

As on 2013, drip irrigation is adopted in about 2.85 million hectares in India (NCPAH,2013). Maharashtra was the leading state covering 0.83 million hectares followed by Andhra Pradesh with 0.73 million hectares. Gujarat and Karnataka followed this with 0.35 and 0.33 million hectares respectively. Raman (2010) estimated to be 45 million hectares in the country and the contribution of drip to this was estimated to be 15 million hectares. Based on this estimation the coverage under drip, till 2013 is estimated to be around 20 per cent.

6. Is it a myth under drip irrigation and the crops will be lodged?

Since there will be more of surface root development under drip, there is a possibility of lodging in crops like sugarcane. But, it can be overcome by adopting to subsurface irrigation technique.

7. How are the drippers designed for different types of soils?

In sandy soils higher discharge drippers are preferred. On the other hand, in heavy clay soils low discharge of 2 lph will be effective. But, on the whole under Indian soils 4 lph works well.

8. What are the different types of drippers?

Basically the drippers are classified as Laminar drippers, Turbulent drippers, orifice drippers, Typhoon drippers and bubblers. They are also classified into pressure compensating and non- pressure compensating drippers. They may be also either online or inline drippers based on their insertion on the laterals

9. What type of drip emitters are ideal for water scarce and power shortage areas?

In several regions of the state, water scarcity is acute besides limited power supply. Hence, drip system with micro-tubes would be the ideal solution, which would require lesser irrigation period at high discharge rate. This facilitates larger area coverage in short span of time. Thus, both limited water and power supply can be managed. But the micro-tubes have limitations. Unless it is properly designed for uniform discharge throughout the field with adjustment of the length of the micro-tube at head, mid and end portions of the field, the discharge will be highly variated.

Presently, there is tendency of designing the system with 2 lph drippers spaced at 40 cm. But, with 4 lph of 60 cm spacing, we can save 30% of energy without having any moisture stress to the plant.

10. How the drip system efficiency can be classified based on moisture distribution?

The efficiency of drip system can be classified based on the distribution uniformity % as shown below in table:

Table 1: classification of drip system based on distribution uniformity

Classification	Uniformity %
Excellent	More than 90
Good	81 -90
Fair	71-80
Poor	61-70
Unacceptable	Less than 60

11. What are the essential components of a typical drip irrigation system?

- Water source (Well with motor or water tank)
- By pass valve
- Non-return valve
- Filtration system
- Fertigation device (ventury or fertilizer tank or fertigation pump)
- Pressure regulators
- Pressure gauges
- Water meters or hydrometers
- Back wash valve
- Air valve
- Main pipe (75, 63 mm PVC pipe)
- Sub main pipe (50, 40 mm PVC pipe)
- Laterals (12 or 16 mm LLDPE)

- Emitters (drippers, micro tubes)/emitting tubes in case of drip line /inline drippers
- Flush valves at Sub main and laterals
- End cap

The main components with a typical layout is illustrated in Figure.1

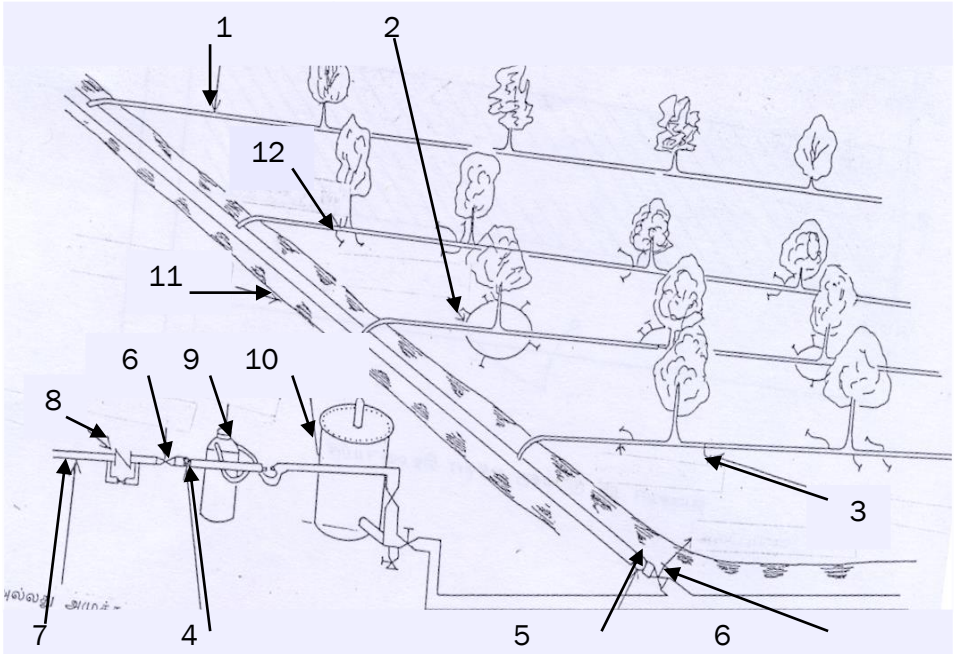

Fig. 1 Fertigation - Basic components

1. Flexible tube
2. Lateral tube
3. Distibutory tube
4. Pressure changer
5. Pressure preventing valve
6. Closure valve
7. Pressure distribution
8. Check valve
9. Fertilizer tank
10. Filter
11. Primary sub tube
12. Multi points irrigation tube

12. What are the essential considerations in designing a drip system?

- The water availability/ discharge of well
- Daily irrigation requirement of crops
- The HP of motor
- Deciding the size of main and sub main pipes
- Deciding size and length of laterals
- Selection of drippers based on soil and crop types
- The quality of irrigation water (EC, pH)
- The soil characteristics like salinity, alkalinity, acidity, infiltration rate etc.
- Seasonal crop water requirement
- Computing frictional/head loss and designing drip system with 20 per cent allowable variation in flow and 10 per cent variation in discharge of emitters.

13. What is the operating pressure for desired discharge uniformity in drip system?

In drip irrigation, the operating pressure should be 1.2 to 1.5 kg/cm^2(including fertigation) for achieving a discharge uniformity of more than 90 percent.

14. What are the common problems encountered for adoption of drip system?

* High capital investment.
* Lack of technical skills on maintenance.
* High salinity in water
* Poor service after sale
* Time-lag for installation

15. what are the different field problems encounter in drip system

In field conditions the major problems encountered in maintenance and operation of drip system are clogging, displacement of laterals, rat and other animal bites, human damage due to inter-cultivation activities, harvesting in sugarcane etc.

16. What are the causes of clogging in drip system?

Irrigation water usually contains calcium and magnesium salts which precipitate along with carbonate and bicarbonates causing deposits in pipes and emitter points. Also when irrigation water is drawn from lakes or ponds contain bacterial slimes, algae, which get deposited along the pipe network and emitters. Thus, the discharge and flow rate in emitters and pipes are reduced.

17. How damages to drip system be avoided in field conditions?

The surface drip system usually get damaged at times of intercultural operations and by dogs, rats, squirrels etc. Hence, drip system can be installed under sub-surface method wherein narrow trenches would be formed 15 to 30 cm deep.

18. What are the remedial measures for clogging and salt encrustation?

When low flow rate is detected in pipes, diluted HCl of 35 per cent concentration can be injected into irrigation system through ventury or fertigation pumps. The salts in pipes and emitters are dissolved after few hours and flushed out step by step procedure, first the main flush valves are opened, then sub main flush valves and finally the lateral end caps are removed for flushing away all the wastes.

The quantity of acid to be used depends on the flow rate of irrigation system. For instance, if a pump discharge is 20 m3, 20 litres of acid would be needed at

1 litre /m3. The commercial HCl is available at Rs.6.00/litre and hence it would require Rs.120 for acid flushing.

19. How the clogging due to bacterial stains are cleaned in drip system?

If the drip system is clogged due to bacterial slimes and algae, sodium hypochlorite (10 per cent chlorine) is to be injected. This chlorination kills bacteria and other microbes and

cleans the whole system. Depending upon the degree of clogging, chlorination can be done at 5 ppm to 500 ppm and then flushed out as described in acidification procedure.

20. What are the important aspects of drip system maintenance?

- Filters are to be cleaned periodically.
- All the dusts/ waste materials at the time of drip installation are to be first removed by flushing.
- Ensure that first dripper in each lateral are functioning properly
- If there is clogging due to salt, dilute HCl injection is to be done (as detailed earlier)
- If there is clogging due to algae, bacteria, chlorination is to be done (as detailed earlier)
- The drip laterals are to be wounded back at harvest after cleaning to enhance the life. Small wheels can be used for winding laterals.
- During fertigation recommended fertilizer (soluble) alone is to be used. After fertigation, system needs flushing to keep clean for next fertigation.
- The flow rate in main/sub main pipes and discharge of emitters should be checked periodically with pressure gauge and measurements. Maintaining minimum operating pressure would result in higher discharge uniformity.
- Open line ends once in a month to drain all the dirt accumulated

21. What is the importance of filtration system and what are the different types of filters and their uses?

Filtration is the heart of drip system. It prevents solids from clogging of valves or accumulating in water distribution piping system including emitters/drippers,

Basically there are four types of filters:

a) Screen filter/disc filter

b) Gravel/sand filter: Used mainly for waters containing organic matter and from open source

c) Hydrocyclone filter: Designed mainly to separate suspended solid particles, especially when the well water is used for irrigation.

While the screen or disc filter is a must any of the other is selected as per local situation

22. How fertigation is done?

Fertilizers can be efficiently applied along with irrigation water through drip irrigation system. This is called fertigation. Fertilizers which are completely soluble should be injected. Fertilizers like super phosphate, which are not soluble and create precipitation problems should not be used. The soluble fertilizers are injected into micro irrigation system through any one of the three devices viz., ventury, fertilizer tank and fertigation

pump. The cost of ventury would be Rs.1200; a fertilizer tank at Rs.6000 (60 lts) and a fertigation pump would be Rs.12000.

23. How fertigation is useful in present day agriculture?

- Fertigation ensures uniform and regular flow of both water and nutrients, resulting in increased crop growth and yields.
- Through fertigation, the three major nutrients are supplied in one solution to the active root zone resulting in greater absorption.
- Small quantities of fertilizers can be applied at closer intervals.
- The system enables uniform distribution of nutrients in the root zone.
- Each irrigated plant receives the same proportion of nutrients
- When combined with proper management, fertigation can avoid fertilizer leaching beyond the root zone, resulting substantial saving in quantum of fertilizers (30-50 per cent)
- Considerable savings of labour and energy in the application of fertilizers.
- Micronutrients can be effectively applied through fertigation.

24. What are the fertilizers suitable for fertigation?

The fertilisers that are water soluble can be used for fertigation. So that clogging can be reduced. For nitrogen and potassium, the presently used fertilisers by farmers viz., urea and potassium chloride can be applied as water soluble fertilisers. For phosphorus, the presently used DAP or super phosphate are not water soluble. But recently the GSFC, Vadodara are manufacturing urea phosphate (17-44-0), which is water soluble and can be used by the farmers for fertigation. All other micro-nutrients like Zinc sulphate and Iron sulphate etc are also water soluble and can be used for fertigation.

25. What is the water requirement under drip system?

The water requirement of crops varies according to crop geometry and the climate especially evaporation rate. Approximate water requirement of crops under drip as well as surface irrigation system is furnished in Table 2.

Table 2. Water requirement of horticultural crops under drip and surface irrigation

Crops	Water requirement (lit/plant/day)	
	Drip irrigation	Surface irrigation
Coconut	75-100	200-300
Grapes	25-30	90-100
Mango	30-50	90-150
Guava	20-30	70-100
Sapota	20-30	70-100
Pomegranate	20-40	60-130
Banana	12-16	30-40
Citrus	10-20	25-65
Papaya	5-8	18-26

Vegetables	1-2	4-8

Source: Reddy et al, 2010

26. How the water requirement under drip system is computed?

Following are the chief considerations for computing water requirement through drip system

- Daily pan evaporation rate (Pe)
- Pan co-efficient (Kp)
- Crop co-efficient (Kc)
- Crop spacing (A)
- Percent wetted area (Pw)

For example, the water requirement computation for tomato is illustrated below.

Assume

1. Daily pan evaporation rate (Pe) : 7 mm
2. Pan co-efficient (Kp) : 0.8
3. Crop co-efficient (Kc) : 0.9 at flowering
4. Crop spacing (A) :75 x 60 cm
5. Percent wetted area (Pw) :80 per cent

Volume in litres = Pe xKp x Kc x A x Pw

= (7/1000) x 0.8 x0.9 x(75*60)/10000 x (80/100))

= 0.0018m3

1 m^3 =1000 lit

Volume in litres = 0.0018 x 1000

= 1.8 lit/day/plant

No. of tomato plants/acre = 8888

Water requirement for one acre/day = 8888 * 1.8 = 16000 litres

No. of drippers in one acre at one dripper for two plants = 4444

Irrigation period=16000/4444 = 3.6/4LPH * 60 min = 54 minutes

27. Does the government provide any financial help to the farmers for adopting drip irrigation?

Yes, the Government of India and state governments provide subsidy since 1990's. As per the recent guidelines of Government of India. The subsidy pattern is as below.

Table 3: cost of drip irrigation and norms of state government

S.No	Item	Practices	Cost norms & central Share	State Share
1	Micro irrigation	Drip Irrigation (wide Spaced crops)	35% of the total cost of installations for small & marginal farmers and 25% of actual cost installation for others in non-DPAP/DDP/ NE&H regions. 50% of the actual cost of installations for small & marginal farmers and 35% of cost of installation for others in DPAP/DDP areas and NE&H States Estimated cost of installation is Rs. 37200/ha (average). However, assistance to farmers will be as per norms of individual crop spacing. Maximum permissible assistance will be restricted to 5 ha per beneficiary/group.	Additional 110% assistance to be provided by state Government to all categories of farmers
		Drip Irrigation (closed Spaced crops with rows at less than 1.2 meter)	35% of the total cost of installations for small & marginal farmers and 25% of actual cost of installation for others in non-DPAP/DDP/NE&H regions 50% of the actual cost of installations for small & marginal farmers and 35% of cost of installation for others in DPAP/DDP areas and NE&H States Estimated cost of installation is Rs. 90,000/ha	Additional 10% assistance to be provided by state Government to all categories of farmers

			(average). However, assistance to farmers will be as per norms for different land sizes. Maximum permissible assistance will be restricted to 5 ha per beneficiary/group.	

*DAPA: Drought Prone Area Program, DDP: Desert development program, NE&H States – North Eastern and Himalayan States
Source: NMSA, 2014

28. What is the unit cost for the drip system fixed by Government of India?

The Government of India has fixed the unit cost for different spacing as presented below

Table 4: Cost of drip system for different spacing and land size (Rs/ha)

Lateral Spacing	1 ha	2 ha	3 ha	4 ha	5 ha
Wide spacing					
8m & above	23,500	38,100	59,000	74,100	94,200
4m to <8m	33,900	58,100	89,300	131,200	142,400
2m to <4m	58,400	108,000	161,800	220,600	271,500
Closed spacing					
1.2m to <2m	85,400	161,300	243,400	332,800	412,800
<1.2m	100,000	193,500	292,100	399,400	495,400

Source: NMSA, 2014

29. How the total drip system cost could be reduced?

The major cost of drip system goes towards laterals and drippers (40 per cent each) Hence, by suitable crop geometry, the number of drippers and laterals could be reduced by adopting paired row planting system wherein one lateral for two rows and one dripper/emitter for two plants. In this system, the plant population per unit area is maintained and hence there is no compromise in yield inspite of reducing the drip system costs.

30. Where the famers should seek support from, for trouble shooting?

Famers can contact Agri-engineers from nearby research station of the university, Supplier, micro-irrigation program field staff etc.

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RESEARCH PROGRAM ON
Dryland Systems

The CGIAR Research Program on Dryland Systems aims to improve the lives of 1.6 billion people and mitigate land and resource degradation in 3 billion hectares covering the world's dry areas.

Dryland Systems engages in integrated agricultural systems research to address key socioeconomic and biophysical constraints that affect food security, equitable and sustainable land and natural resource management, and the livelihoods of poor and marginalized dryland communities. The program unifies eight CGIAR Centers and uses unique partnership platforms to bind together scientific research results with the skills and capacities of national agricultural research systems (NARS), advanced research institutes (ARIs), non-governmental and civil society organizations, the private sector, and other actors to test and develop practical innovative solutions for rural dryland communities.

The program is led by the International Center for Agricultural Research in the Dry Areas (ICARDA), a member of the CGIAR Consortium. CGIAR is a global agriculture research partnership for a food secure future.

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