WATER MANAGEMENT PRACTICES TO IMPROVE COTTON PRODUCTION

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Introduction

Limitation in productivity of ELS cotton exists in truly rainfed areas because of water scarcity and relatively longer duration of *Barbadense* (Suvin) and *Hirsutum* x *Barbadense* types (DCH-32, RCHB 708 Bt and MRC 6918) with of course exception to bimodal rainfall regions (Salem & Dharmapuri, T.N.) and extended rainfall tracts (Southern transitional Zone of Karnataka). As per the recommendations of the working group of *National Workshop on Increasing ELS cotton production in India*, the areas identified for ELS cotton include Anand, Talod & Surat in Gujarat, Ratlam, Dhar & Burhanpur in Madya Pradesh, Coimbatore, Erode, Theni, Salem, Namakkal & Dharmapuri in Tamil Nadu, Guntur, Prakasam, Karimnagar, Warangal & Krishna in Andra Pradesh, Belgaum, Dharwad, Haveri, Raichur, Mysore, Shiomoga & Uttar Kannada in Karnataka, Phatan, Baramathi & Sangli in Maharastra, Banswara & Chittore in Rajasthan, and Kalahandi & Navarangpur in Orissa. Since most of the identified areas are comes under semi-arid, thus, managing the water plays the key role in profitable cotton farming.

Besides this, provision for protective/supplemental irrigation, adoption of appropriate soil & water conservation including water harvesting measures and introduction of micro-irrigation with fertigation wherever feasible, are some of the scientific measures for water managers that would expand acreage under ELS cotton by augmenting both its production & productivity.

Crop water use

Water need in cotton varies with cultivar, length of growing season, temperature, sunshine hours, the amount & distribution of rainfall and the characteristics of soil. The dynamics of water use pattern for cotton (with 160 days duration) shows that with the advancement in crop growth, the water use increases progressively from 2.5 mm/day in seedling stage, 2.5 to 6.2 mm/day from squaring to first bloom, and goes to a maximum of 6.2 to 10 mm/day in peak flowering and decreases to 5.1 mm/day thereafter during boll development and falls below 2.0 mm/day during boll bursting stage. In terms of percentage of total seasonal water use, crop water requirement is 20 % till 1st flower, 40 % during 1st flower to peak flower, 30 % during peak flower to bursting of few bolls and only 10 % till maturity. Trials conducted in different states reveals that total water use is estimated as 85 cm in Punjab, 51 cm (irrigation & rainfall contributions (IRC) is 35 & 16 cm resp.) in Haryana, 44 cm (IRC is 11 & 33 cm resp.) in Karnataka & 69 cm (IRC is 47 & 22 cm resp.) in Tamil Nadu.

Study conducted on a typical sandy loam soil shows that under adequately watered situation, soil moisture extraction pattern from different depths by a cotton crop is estimated as 47, 29, 13 and 11 % from 0-30, 31-60, 61-90 and 91-120 cm depth of soil respectively.

Irrigation scheduling

It is important to workout an economically feasible and technologically efficient irrigation scheduling for optimum water use under any given set of agro-climatic condition for realizing higher crop/water productivity. Therefore, irrigation scheduling should be based on crop(s), soil air and plant water relations. Contrary to the normal genotypes (150 days), since ELS cotton (Suvin, DCH 32 and TCHB 213) requires irrigation for longer time (up to 160 days of crop growth), thereby these require continuous crop maintenance for higher productivity efficiency.

Indicator plant

Crops like sunflower and tomato show stress symptoms earlier than others since these are highly sensitive to water stress. These crops are planted at random throughout the field and scheduling of irrigation can be made based on the stress symptoms noticed in these plants. If the plants fail to recover in the afternoon following wilting of leaves during the normal midday hot weather, it is a sure sign for immediate watering. Even the cotton plant can act as the indicator in itself for irrigation scheduling. Here a pit of 1.5 x 1.5 x 1.5 m is dug within the field in a most frequently visited location and the dug out soil is mixed with 5 % sand and is filled in and the level of pit is brought to approximately original level (of compaction) and a few cotton plants are planted with normal spacing in this pit. These plants normally start wilting under moisture stress before the rest of the plants in the same field, and irrigation scheduling is made observing the wilting symptoms in these.

Critical stages of plant

Sensitivity to water stress is high in a few but distinct phenophases during crop cycle. Squaring, flowering and boll development are the critical stages for water at which irrigation is applied after giving the due allowances for the rainfall. Irrigation at 10 to 12 days interval during these stages seems to be the optimum for most of the tracts in India. Irrigation should be curtailed in the early stages to prevent excess vegetative growth since it leads to stunted growth and delays in formation of fruiting parts. Depending on climatic condition and soil type etc, irrigation at 10-15 days interval for light soils and 15-25 days for medium & heavy soils is normally recommended. In Dharwad, normally 2 irrigations before flowering and 4 irrigations during post flowering gave the highest yields.

Soil moisture depletion and climatological approach

Irrigation schedules based on per cent depletion in available soil moisture (50 to 75% depletion) or soil water potential of 0.5 bars in a soil profile of 30 cm depth is recommended for cotton. Trials conducted at Coimbatore and Dharwad (with MCU 5 & hybrid Varalaxmi) reveals that cotton is irrigated at 75% depletion of available soil moisture for good yield.

On climatological approach, scheduling of irrigation at 0.40 and 0.60 IW/CPE (Irrigation Water/Cumulative Evapo-Transpiration) ratio during vegetative & reproductive phases respectively is recommended. There was no difference in yields obtained under 0.45 & 0.60 IW/CPE ratios as well as between 40 and 60 mm depth of irrigation.

Protective irrigation

Trials reveal that protective irrigation significantly and positively influences the seed cotton yield at Coimbatore (Sankaranarayanan, 2007). Although scheduling of irrigation at 0.8 IW/CPE ratio produced the highest seed cotton yield, yet it was on par with that in single irrigation at squaring, flowering & boll development, double irrigations at squaring + flowering, flowering + boll development, squaring + boll development and three irrigations at squaring + flowering + boll development. Moreover, application of 1 to 4 irrigations showed similar response with above, thereby indicating role of single irrigation for both higher crop performance and water use efficiency.

Amongst three different stages of the crop, irrigation at boll development period showed the highest WUE and IUE, thereby revealing the boll development period as the most critical for moisture stress. As the number of irrigation increased from one to more, IUE decreased because of non linear response yet seed cotton yield increase numerically although non-linearly.

Surge irrigation

Surge irrigation, wherein water is applied into the furrows intermittently has the potential to increase the uniformity of surface irrigation by increasing the advance rate. It also minimizes the infiltration opportunity time differences across the field by decreasing the infiltration rate of the upstream ends of the borders. The cycle time varies from 30 minutes to several hours (Pathak et al, 2000). It is also showed that surge irrigation layout with furrows longer than 50 cm can make better use of available land than check basin/short strip lay outs or long furrows (Senthilvel *et al*, 2000).

Irrigation methods

Check Basin

Convenient check basin of square (2 m x 2 m to 4m x 4m) or rectangular size is used for irrigation. Here, accurate leveling is not necessary, since bunds are provided on all the four sides of the small basin. The water is kept within the basin and not allowed to run off. The size of ridges or bunds depends upon the depth of water to be impounded in the basin. The water is turned on to the upper side and is turned off following application of the required quantity of water. This method is more efficient in fine textured soil. Leaching of salts is also possible by impounding water and giving more opportunity time for infiltration. Yet, the drawback of this is the requirements for high degree of leveling for uniform distribution of water. However, for small streams, this method can be suitably adopted.

Furrow irrigation

This is most common in South Zone since wastage of water is minimized in this method. It is well adapted to deep soils that are nearly level or have uniform & moderate slopes. In Tamil Nadu, the farmers are adopting a furrow length of 10 to 20' .On sloppy lands, furrow slopes may be limited to 0.3 % and the length of the furrow may be reduced to control erosion and provide the needed drainage. Loam and clay loam soils are best adopted to furrow irrigation because the water holding capacity and intake rate are generally within the range that will permit uniform distribution of water. Furrow irrigation is not suitable for very sandy soil due to high intake rate.

Skip furrow

Here, the distance between the two rows of cotton is 60 cm for supplying irrigation and the gap adjacent to the row is 90 cm (Normal row spacing is 75 cm). The space available in skip furrow can be intercropped with pulses if two rows of cotton is spaced at 60 cm and the gap adjacent to the row is 120 cm for intercropping (conventional row spacing is 90 cm).

In 2:1 skip row planting, recommended for very scarce water available areas where one out of 3 furrows is skipped i.e., not planted. The population in unit area is maintained as in solid planting by reducing the plant to plant spacing in the planted rows by one third (i.e. 22.5 cm instead of 30 cm). Sprout irrigation is given for the planted rows and the other irrigations are given only in the furrows between the planted rows. Here, 60 to 67% saving of irrigation water can be achieved without sacrificing cotton yield.

Alternate Furrow Irrigation

Here, the crop is planted just like in the conventional method as there is no variation in spacing but variation in water application (areas). Water is applied in alternate rather than in all furrows (Irrigating odd & even furrows alternatively). Thus, 1st irrigation is applied in furrows which do not receive the 2nd irrigation and so on. Scheduling of irrigation at surat reveals that alternate furrow method recorded the highest seed cotton yield (and was on par with 0.4, 0.6 and 0.8 ETc) and tested significantly superior to flood irrigation.

Irrigation under paired row planting

In paired row planting, instead of making ridges & furrows at 75 cm apart, furrows are made 150 cm apart and seeds are sown (at 60 cm apart) on the both sides of furrows and irrigated. This system provides the same number of rows and the same plant population per unit area as conventional planting. Yet it allows each row to receive more light on one side than the other. Cotton is strongly responsive to light and could produce 70 to 80 percent of bolls on the open side. Moreover, less water would be lost by evaporation in 2 inner sides because of more rapid and complete shading by the plant (resulting in less weedy). Control of weed is also easier in the outer side because of availability of space. Soil aeration is maintained at a higher level because of the dry inter-space between the paired rows. It reveals that at Coimbatore, paired row planting and irrigation between paired rows result in highest seed cotton yield and saving of 50 per cent water over normal planting and normal irrigation (Table-1).

A comparison between furrow irrigated raised bed (FIRB) system of irrigation versus conventional one (on equivalent water use basis) indicated that additional area could be planted (1.29 times) with saved water that would lead to an extra yield. Thus, FIRB system of irrigation saves 30 to 38 per cent of water (Table-2, Nehra and Nehara, 2004).

Table-1. Efficiency of different planting and irrigation techniques on MCU 5 VT Cotton

Irrigation Methods	Seed cotton yield (Kg/ha)	Water Saving (%)	Additional area to be irrigated (%)
Control (Normal planting & normal irrigation (75x30cm)	1418	0	0
Normal planting & alternate furrow irrigation	1633	50	100
Paired row planting & irrigation to row pairs only 40-110 cm x 30 cm	1732	50	100
Alternate furrow planting irrigation to planted rows only (150 cm x 15cm)	1530	50	100
2:1 skip row irrigation to planted rows only (75-75-150 cm x 22.5cm)	1811	33	50
2:1 Skip row planting (irrigation between 2 planted rows only)	1821	67	200
C D (0.05)	119	-	-

Table-2. Comparison between conventional vs. FIRB methods

Particulars	Conventional	FIBR
Irrigation(cm)	6.04	4.67
Total depth of water applied (cm)	24.16	18.68
Equivalent acres	1.00	1.29
Equivalent yield (kg/ha)	1427	1841

Table-3. Water balance and water use efficiencies under different irrigation layouts

Water balance component	Check basin	Short strip furrow	Long furrow continuous flow	Long furrow surge flow
Deep percolation + Run off loss (cm)	36.62	36.51	36.05	32.20
Consumptive use (cm)	62.45	62.43	62.79	65.24
Soil moisture charge (mm)	2.02	2.15	2.25	3.65

Micro irrigation

Good quality water is having multifarious application such as for irrigation, industrial use, power generation, livestock use, and domestic use both in urban and rural areas. Due to increasing cost of irrigation projects and limited supply of good quality water, water becomes a high value commodity and is known as liquid gold. As quoted by Sir. C. V. Raman, *water is the ELIXIR of life that makes wonders in earth if it is used properly, efficiently, optimally, equitably and judicially.* For this, the best known technique is micro-irrigation that is proven for its efficiency, water & input saving.

Sprinkler Irrigation

This is specially suitable to shallow sandy soils of uneven topography, where leveling is also not practicable, and to the regions where both labour and water are scarce. Sprinklers are advantageous compared to the surface methods as water can be delivered at a desired and controlled rate, thereby ensuring a uniform distribution of water and high (water use) efficiency (Table-4). Although more extensively used in advanced countries, it is not popular in India because of high initial investment cost. Today, sprinklers can be employed for any type of soil/crop except very fine texture soil.

Table 4.Yield & water saving of surface and sprinkler irrigations (Sivanappan 1998)

Location	Yield(Kg/ha)		Irrigation water (cm)		Advantage (%)	
	Surface	Sprinkler	Surface	Sprinkler	water	yield
Navasari, (Gujarat)	699	704	40.64	29.65	27	0.71
Punjab	1000	1500	91.10	58.60	35.7	50

Drip Irrigation:

Used in diverse soil types, this system, however, is more suitable for porous soils, water scarcity areas and undulated lands. Since the water is applied daily/alternate days at low rate and at low pressure (up to 1 kg/cm^2) over a long period of time and directly into the vicinity of plant roots, it maintains the soil moisture level around the root zone at/close to field capacity. Trials reveal that considerable flexibility is offered through the frequency of irrigation right from daily interval to once in eight days in cotton that also implies no response of cotton crop for a fixed/ closed drip schedules in drip. Other advantage includes the use of saline water up to 8-10 dS/m without affecting the yield. In addition, fertilizers can also be combined and delivered simultaneously with irrigation water (drip-fertigation) more precisely to the root zone the efficiency of fertilizer use tremendously. It is also reported that lint yield of >2250 kg/ha was realized using drip irrigation at Arizona, U.S.A. Improvement in quality of cotton is also observed in relation to fibre fineness & maturity.

Economics of drip-fertigation

For successful adoption, a technically feasible irrigation method should also be economically viable. Studies on drip irrigation under Akola condition on a pre-monsoon cotton (AHH 468) reveals maximum gross return (Rs.16,085/- per hectare), net return (Rs.8,159/per hectare) and net return per rupee invested (2.02) at high level of drip irrigation (1.5 lit/day/hill) as compared to lower one (0.5 lit/day/hill, Narkhade et al., 1996). At Bangalore, however, DCH 32 gave the maximum net return per hectare both for main & ratoon crop in cotton-cotton under furrow irrigation (Rs.61,710/-) followed by turbo tap drip (Rs.61,253/-) and emitter type of drip irrigation (Rs.53,375/-) and the pay back period for both was 3 years and 5 years respectively.

Higher net income of Rs. 80,000/- and B:C ratio of 1.59 were obtained under drip irrigation in Maharashtra whereas the corresponding values were Rs.50,000/- and 1.20 only under flood irrigation (Patil, 1998). The drip system of cotton planted in pair row geometry (at the cost of Rs. 47, 000/-) yielded a B:C ratio of 1.83 with a pay back period of 1½ years. Higher net return and cost benefit ratio were also calculated with drip system at Coimbatore (Sankaranarayanan, 2004). Moreover, use of laterals in paired row planting (cost is Rs 65, 000/ha) is better than single row planting (cost is Rs 1, 05,000/ha) since considerable saving is made due to reduced cost of laterals (Patil *et al*, 2004).

Although drip irrigation system lowers B:C ratio due to high initial investment, yet a net income of Rs,14,828/ha could be obtained by adopting drips over that in furrow system. The net return per unit water applied was also higher with drip irrigation. Since the pay back period of drip irrigation is 2.3 years, hence larger feasibility is evident with drips for higher productivity and sustainable production (Table-5, Veerauthiran and Chinnusamy, 2005).

Alternate low cost drip system

Drip irrigation, though is an acceptable technology, its adoption by the farmers is very slow which is mainly attributed to high initial installation cost of the system especially for annuals crops including cotton. Thus, developing low cost drip irrigation system by suitable means is of immense help for wider adoption of this technology. After three years of successful testing at CICR, Coimbatore. and subsequent modification, two low cost drip systems (micro tube and poly tube drip systems) were developed for cotton. In micro tube drip system, cotton is planted in paired rows (60/120 cm) and single lateral is placed in the middle of the two paired row (60/120-60/120). Micro-tubes are connected to the laterals to deliver water on either side of the pair to supply water for two plants**.** In polytube drip system, polytubes (150 gauge thickness) were punctured at regular intervals (60 cm) on single side, tied by waste cloth to avoid jet action and are placed within the paired row or along the single row. The microtubes (cost of Rs 32,000/ha) and poly tubes (cost of Rs 17,000/ha) drip systems are 49 and 73 per cent cheaper respectively over the existing drip system (Rs 62,750/ha). Water saving to the tune of 44 per cent is achieved following adoption of this low cost drip system (Table-6, Sankaranarayanan, 2005).

Table-5.Economic feasibility of drip irrigation system

Particulars	Drip	Furrow
Cost of cultivation (Rs./ha)	22080	15157
Gross income (Rs./ha)	57943	54047
Net income (Rs./ha)	35873	38890
Benefit cost ratio	2.6	3.6
Pay back period	2.3	-
Additional area irrigated (ha)	0.55	-
Additional net income (Rs/ha)	17845	-
Net extra income (Rs/ha)	14828	-
Net profit per mm of water	91	66.7
Seed cotton yield (kg/ha)	2187	2040

Table-6. System cost of low cost drip irrigation system

Particulars	Existing drip system	Micro tube drip system	Polytube drip system
Main pipe (30 m, 2 ½ " PVC)	3750	3750	3750
Sub main (2"-12 m 1 ¼" 18 m)	3800	3800	3800
Laterals	27500	13750	-
Dripper	22500	--	-
Microtube/poly tubes	--	5625	4450
Other accessories	5000	5000	5000
Total	62750	32125	17000

Is ELS cotton a candidate crop for drip irrigation and fertigation?

Yes. It is, in fact, attributed to many factors and these are discussed as under:

Longer duration: ELS cotton varieties and hybrids are longer in duration favoring greater utility of the drip system as compared to short duration varieties. The adoption rate of drip irrigation system is more with long duration crops than short duration annuals.

Suitability of growing environment: The drip irrigation system is the best suited for water scarce areas. For e.g. most of the ELS cotton growing districts of Tamil Nadu viz, Coimbatore, Dharmapuri, Salem and Namakkal rated as dark (80 per cent of ground water utilized, GWU) and grey (65-80 per cent of GWU) on the status of irrigation water availability.

Soil type: Suvin and other ELS cotton varieties are grown in red soil rated as hungry and thirsty soil in Northern districts of Tamil Nadu. The drip-fertigation is suitable to provide soil moisture and nutrient for the specific environmental situation.

Time of sowing of ELS cotton: ELS types are sown in advance in the month of June-July as compared to normal sowing during August-September, resulting in reliance on timely rain for sowing. Depending on the distribution of rainfall, sowing is risky and occurrence of delayed rain led to late sowing, poor establishment of crop, poor yield, diversification of land to non-cotton crop and current fallow. Drip irrigation has resulted in timely sowing.

Flexible drip system: The ELS cotton tract is competing with other high value crops such as turmeric, sugarcane, tapioca and vegetables. Planning of flexible drip system by permanent laying out of main and sub-mains on field bunds and using laterals for cotton and other succeeding crops has a greater applicability of the system in a holistic manner.

Higher Economic return*:* Adoption of drip-fertigation system could result in enhanced marginal, physical and value product because of high responsiveness and market value associated specifically with ELS cotton. Unlike short/medium staple cotton varieties, the prices of which fluctuate widely as against the relatively stable price of ELS. For e.g., in the last decade, the prices of the medium staple cotton varied between Rs. 1600/- and Rs. 2500/- per quintal, while that of DCH 32 stood firm & steady in the range of Rs. 2800-3000/- for the last five years and Suvin at Rs. 5,000/- per quintal.

Import substitutes for high priced Pima or Giza cotton: The strong reason to promote ELS cotton is the potential of these varieties as import-substitutes for highly priced Pima & Giza cotton cultivated outside India.

Higher fertilizer use: Higher application of (360:180:180 kg/ha) NPK gave more yield in DCH 32. Hence, drip-fertigation system can effectively utilize these nutrients to enhance the fertilizer use efficiency.

Enhancement of fibre quality*:* Enhanced uniformity ratio and maturity ratio are the desirable quality reported under drip irrigation although ELS cotton is usually associated with lesser uniformity and maturity coefficient.

The trials conducted at CICR, Regional Station, Coimbatore revealed that application of 80 ha-cm of water through drip with 75% RDF recorded the highest number of bolls and seed cotton yield indicating a saving of 25 % in fertilizer cost in water surplus/irrigated areas. Similarly, application of 50% water through drip with 100% RDF also produced comparable yields in water scarcity areas. Seed cotton yield increases due to drip irrigation over surface irrigation was 11.6 and 20.4 per cent, respectively for winter and summer (Veeraputhiran and Kandasamy,1999). Since the yield obtained with 60 kg N/ha through drip was comparable with that in 120 kg N/ha by conventional soil application, thereby a saving of fertilizer to the tune of 60 kg N/ha. Besides, the WUE was **31.4 and 53.1** per cent higher under drip irrigation compared to surface irrigation. Drip fertigation increased the N use efficiency by 27.8 and 31.6 per cent over soil application in both the seasons. Thus, fertigation through drip system resulted in saving of 50 per cent irrigation water and 60 kg N/ha with higher water and N use efficiency in hybrid cotton.

Application of 100 kg N/ha through fertigation produced significantly higher seed cotton yield (SCY) in *vertisols* than conventional soil application at Parbhani (Bharambe *et al*, 1997). The lint quality, WUE and N use efficiency were increased with N application by fertigation as a result of higher N, P and K uptake under fertigation (Patil *et al*. 2004). Compared the drip irrigation (SCY of 2570 kg/ha and WUE 34.6 kg.ha/cm) with alternate furrow irrigation (SCY of 2564 kg/ha and WUE of 48.3 kg.ha/cm) were equally good. However, considerable saving in water is possible with drip irrigation.

Yet with proven advantages of drip system, best suited terrains include relatively steep slopes, sandy soil, fields with extreme variation in soil texture and salt affected fields. In Texas, the conversion from furrow to drip irrigation with its frequent application of small amounts of water had a dramatic impact on the cotton yield and quality. For the most parts, growers use the lease expenditure drip tubing/tape product available.

Water logging

The ideal condition for crop growth and development in upland crops is maintenance of relative volume of both soil air and soil moisture in equal proportion in the pore space. Soil containing excess water in the pore space by replacement of soil air (main source of oxygen for the roots as well as soil microbes) is said to be waterlogged. Due to high amount of CO_2 in soil air under water logged condition will kill plant roots because of inhibition in root respiration. Indirect effect of waterlogging includes wastage of large amount of water, leaching of plant nutrients, destruction of beneficial microbes and increase on drainage cost, accumulation of salt leading to salinity & alkalinity, physiological stress, yield loss and crop failure.

Rooting density increase with depth when cotton plant at flowering is subjected to drought where as this tendency is not observed with plants supplied with sufficient moisture. A study at Rhodesia shows that growth decreased rapidly after 70% of available water depleted from top 120 cm of soil but yield was unaffected by a short period drought at 100% depletion of available water. A marked yield reduction was however, observed when such a condition was maintained for two and a half week. Thus, cotton shows some degree of tolerance to drought. On the other hand, cotton cannot tolerate water stagnation even for a day as yield is reduced on an average by a quintal per hectare for each day of water logging.

In the north Indian states, the excess moisture and inundation of crop due to heavy monsoon rains hamper crop production prospects rather than moisture deficit. Thus, sufficient drainage arrangements are to be made to remove excess water to increase productivity. Study conducted at CICR revealed that water logging for 5 days at squaring phase did not have any significant impact on morphological, physiological and yield attributes. However, prolonged waterlogging for 20 days brought about significant physiological changes affecting the productivity. In addition, ground water level should be kept at least a meter below soil surface for better crop growth and development.

Farmers' adoption

Many surface water saving methods evolved by research institutes are usually not adopted by farmers even under water scarce situation. In alternate and skip furrow methods, every alternate ridge is to be turned on for irrigation is also laborious one. Instead, simultaneous irrigation of 5-8 furrows is possible for every turn in all furrow methods. Cotton is preferred crop over other commercial crops in many water-scarce farms, as it could be raised successfully by providing 2-3 protective irrigations at critical stages. Thus, water saving irrigation practices have to be refined as per the farmers' preference and need to be popularized for wider adoption.

Although the farmers are well versed with multiple advantages of drip system, yet their decision on adoption of drip irrigation was influenced by many factors, notably among them is high initial cost and scarcity of water in over exploited groundwater regions. Other application problems include salt encrustation and clogging of conveyance pipes irrigating salt water. As per Garetts ranking technique for non adoption of drip techs include salt encrustation and clogging of conveyance pipes as 1st rank, high initial cost as 2nd followed by delay in subsidy amount disbursement. (Palanisamy and Venkitapalanisamy, 2000). Government of India has at present extended subsidies for varying categories of farmers up to 50 % of the drip cost to meet the high installation cost and to popularize these water saving methods in the long run.

Truly speaking, adoption of drip-fertigation will definitely bring an additional area (up to 50 %) under irrigated cultivation of ELS cotton by efficient use of irrigation water saved through drip irrigation. Moreover, enhanced yield and quality advantages along with increased water/fertilizer use efficiency recorded under drip-fertigation could be the bonus to increased acreage. Therefore, for adoption of drip technology, an effective area expansion in ELS cotton, adoption of flexible or low cost system, provision for reasonable financial support, field level training to farmers & technical guidance to manage clogging, salt encrustation and maintenance of the system are the pre-requisites requiring concerted efforts by all concerned.

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