Socio-economic-techno-environmental assessment of IDEI products

Low cost KB Drip

Submitted to
International Development Enterprises (India)
C 5/43, Safdarjung Development Area (1st & 2nd Floor)
New Delhi 110 016

Project Report No. 2006RR24

The Energy and Resources Institute
www.teriin.org

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Abbreviations

ADITI	Affordable Drip Irrigation Technology Intervention
BERI	Biomass Energy for Rural India Project
BM	Build Margin
BT	Bacillus thuringiensis
CEA	Central Electricity Authority
CM	Combined Margin
CO_2	Carbon dioxide
DAP	Di-ammonium Phosphate
Dr	Drip
Fl	Flood
FMI	Flood Method of Irrigation
FYM	Farm Yard Manure
GHG	Green House Gases
HH	Households
hp	Horse Power
IDEI	International Development Enterprises India
KB	Krishak Bandhu
BISI	Bureau of Indian Standards
MOP	Muriate of Potash
MoU	Memorandum of Understanding
OM	Operating Margin
PVC	Poly Vinyl chloride
SSP	Single Super Phosphate
WUA	Water Users Association

Units

ac	Acre
ft	Feet
h	Hours
ha	Hectares
kg	Kilogram
km	Kilometre
kW	Kilowatt
kWh	Kilowatt hour
l	Litre
Lps	Litres per second
MW	Mega watt
mm	Millimetre
m^2	Metre square
m^3	Metre cube
Rs.	Rupees
Sec	Second
Sq. m	Square metre
%	Percentage

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Executive Summary

The objective of the study was to conduct a socio-economic-technical analysis of low cost drip irrigation namely KB Drip and to assess the CO_2 emissions reduction potential.

The performance of the KB Drip vis-à-vis the flood method of irrigation (FMI) was assessed for the following parameters:

- The output
- Water saving and electricity saving,
- Impact on the cost benefits of KB Drip over the flood method of irrigation and the crop productivity.

Irrigation in flood method consists of distribution of water by passing through the furrows. The time required to irrigate one acre land is about 6 hours.

The study was carried out in the regions of Erode (Tamil Nadu), Indore (Madhya Pradesh), Jalgaon (Maharashtra) and Tumkur (Karnataka). The crops covered were banana, chilli, cotton, groundnut and sugarcane. The number of villages covered under the study was 61 across these various states.

The method involved, a primary survey, focus group discussions for socio-economic assessment, technical measurements backed with survey feedback for technical evaluation, and estimating the CO_2 reduction potential using feedback from various stakeholders and measurement of results.

Primary survey was conducted through structured questionnaires covering 208 households in 61 villages. Focus group discussions, in the four regions (one in each region) were held with farmers to understand their perception on benefits and limitations/problems faced in KB Drip adoption. Personal interviews were also held with dealers of KB Drip to understand the dynamics of supply and demand.

To conduct the technical assessment, the details of capacity of electrical pump, depth of water, discharge of water at source and delivery point and electricity consumption were assessed. The instruments used for the technical evaluation were stop watch, digital weighing machine, container of known volume, flow metre, measuring tape and three phase power analyser.

The family size in the surveyed households in the four regions varied between 5 and 8 members. Majority (33%) of the surveyed farmers in Erode were small farmers with landholding[1] of 2.5–5 acres. Most (77%) of the farmers in Indore district were also small farmers. In Jalgaon, most (26%) of the surveyed farmers were medium farmers with landholding of 10–25 acres. In Tumkur, majority (35%) of them were marginal farmers with landholding of less than 2.5 acres.

Irrigation in flood method consists of distribution of water by passing through the furrows. The time required to irrigate one acre of land is about 6 hours. A substantial

[1] Marginal farmers: < 2.5 acres; Small farmers: 2.5 to 5 acres; Medium farmers: 10 to 25 acres, large farmers: >25 acres

quantity of water is wasted due to distribution and evaporation losses. In drip method of irrigation, water is fed to the root zone of the crop with the help of micro tubes connected to pipes which are kept in pressure above atmosphere. These systems can also operate at gravitational pressure if water source is kept at an appropriate height. It is observed that water is fed batch wise through micro tubes ranging from 1000 – 4000 in a batch.

The farmers said that the benefits from adoption of KB Drip were that there was saving in terms of labour cost, water saving, higher yield, weed growth control and low consumption of electricity.

The survey results showed that there is an increase in yield with the adoption of KB Drip. About 76% increase in yield was found in the chilli crop (Indore) and 56% increase in yield of cotton crop (Jalgaon). The increase in yield for sugarcane, banana *(Rasthali)* in Erode, banana *(Sreemanthy)* in Jalgaon and groundnut (Tumkur) was found to be 18%, 39 %, 5% and 36% respectively.

The performance tests indicated that about 60% of them were functioning below the specification. The low efficiency results in higher consumption of electricity and longer duration of irrigation.

Their perception of KB Drip adoption was:

a) The area under irrigation can be increased when a farmer adopts the drip method of irrigation due to more water availability.
b) No extra attention is needed in case of KB Drip. Water supply to the plant is quite automatic and mechanical.
c) Cost of drip (KB) is less compared to other drip systems. In addition one year warranty is provided by KB increasing the credibility of the product.
d) Storage is easy in case of KB Drip (Can be stored in urea bags).
e) Installation cost is much less compared to other drip systems.
f) Transportation of KB Drips is much more convenient due to its light weight, volume and size.

The efficiency of the pumps in the four regions profiled ranged from 20% in Indore to a pump efficiency of 47% in Tumkur. The pumps in Tumkur were submersible. In the region of Indore, mono-block pumps (centrifugal pumps) are used to lift the water from open wells. In the regions of Erode and Jalgaon, mono-block (centrifugal pump) and submersible pumps were used.

The performance tests indicated that about 60% of them were functioning below the specification. The low efficiency results in higher consumption of electricity and longer duration of irrigation. This results in multiple losses both to the farmer and the nation. Some of the factors responsible for lower efficiency are:

1. Mismatch of capacity and the load
   - In ideal conditions, 3 hp pumps will suffice for the irrigation purposes in India. But being more conservative towards future expansions or ignorant about the technical aspects of the pumps, higher capacity pumps were preferred by the farmers. All such installations were resulting in low efficiency in the fields.
   - The pumps were improperly fixed causing vibration in the motor.
2. Operational drawbacks
   - The fluctuations in the supply voltage would cause damage to the motor that runs without a regulator.

- Inappropriate handling of pumps such as running of pumps under 2 phase electricity supply (in Erode), and providing more copper winding to more power (in Indore).
- The silt present in the well often creates clogging of the suction pipes resulting in the lowered discharge of water.

3. Factors due to improper usage and lack of knowledge
   - The farmers are normally misguided by the dealers/service centres about the selection and maintenance of the pump. It leads to inappropriate use of pumps.

There is substantial water savings in the usage of KB Drip vis-à-vis flood irrigation. Water saving was found to be *77%* in banana *(Rasthali variety)* crop in Erode district and 74% in case of cotton in Jalgaon district.

There is substantial electricity savings with the usage of KB Drip vis-à-vis flood method of irrigation. The electricity savings ranged from 17-65% for various crops in the study area.

Central Electricity Authority (CEA), 2007 database indicates that for every unit of electricity saved the emission factor for the southern grid is estimated at 0.86 kg CO_2 and every unit of electricity saved for the western grid would abate 0.81 kg of CO_2.

The overall study done in four regions indicates that with the drip intervention, the average water saving potential is about 54% and electricity saving potential is about 39% against flood method of irrigation. Simultaneously, the average annual CO_2 emission abatement for every acre of KB Drip adoption would be 675 kg/acre/year. The details of CO_2 emission reduction of individual crop are given in table, below

With the installation of pump sets for irrigation increasing over the years, there is vast potential to introduce energy saving and water conservation techniques, such as the drip irrigation, overhead tanks etc.

CO_2 Emission reduction

Method of irrigation	Electricity units saved (kWh/ac/yr)	Emission factor (kg CO_2/kWh)	kg CO_2 emission abated/acre/year
Erode			
Sugarcane			
Drip	415	0.86	357
Banana			
Drip	847	0.86	728
Indore			
Chilli			
Drip	1104	0.81	894
Jalgaon			
Banana			
Drip	1104	0.81	894
Cotton			
Drip	887	0.81	718
Tumkur			
Groundnut			
Drip	536	0.86	461

Chapter 1

Introduction and Methodology

1.1 Introduction

International Development Enterprises, India (IDEI) is an Indian not-for-profit organisation registered in India in 2001 under Section 25 of the Companies Act, 1956, with a mission "to improve equitably the social, economic and environmental conditions of families in need, with special emphasis on the rural poor, by identifying, developing and marketing affordable, appropriate and environmentally sustainable solutions through market forces".

Working with the poorer sections of the society as their target group, they have developed several products and services such as:

- Water lifting devices for irrigation that are alternative to conventional methods of water pumping (Treadle pumps to lift water from small depths of 20 ft., Rope & washer pump – 50 ft, pressure pumps – 25 ft,) etc.
- Water conservation devices (Low cost drip irrigation systems, improved sprinklers).
- Promotion of sustainable agricultural practises through promotion of
  - Vermi wash – liquid from vermi- composting for pesticides effects,
  - Nursery – with the concept of reducing cost of production,
  - Concept of Integrating Poor into Market Systems (IPMAS).

IDEI is working on water saving technologies and has developed Affordable Drip Irrigation Technology Intervention (ADITI) which is benefiting the small and marginal farmers.

IDEI is working on water saving technologies and has developed Affordable Drip Irrigation Technology Intervention (ADITI) for benefit of small and marginal farmers. In 1997, IDEI started working on low cost drip technology and developed variety of low-cost drip irrigation kits. KB Drip system is one of the products which is affordable to small and marginal farmers and has advantages over flood method of irrigation through saving in water, increase in productivity, reducing labour and saving electricity consumption for irrigation. To assess the performance of KB Drip, IDEI felt that there was a need to carry out detailed study. TERI was assigned this study to conduct the socio-economic benefits and also the energy saving potential resulting in carbon reduction.

1.2 Scope of Study

The objective of the study was to conduct a socio-economic-technical analysis of low cost drip irrigation namely KB Drip and assess the CO_2 emissions reduction potential. The scope of work involves the aspects elaborated in Table 1.1.

1.3 Study Location

The study was carried out in the districts of Erode (Tamil Nadu), Indore (Madhya Pradesh), Jalgaon (Maharashtra) and Tumkur (Karnataka). The crops covered were Banana, Chilli, Cotton, Groundnut and Sugarcane. The number of villages covered under the study was 61 across the four states. The names of villages covered are given in Annexure1.1.

Table 1.1 Scope of work

Products to be focus include	Water Saving Technology – KB Drip
Technical assessment	To assess the comparative performances of the KB Drip vis-à-vis the flood method of irrigation (FMI). The output, water saving and electrical saving will be analysed.
Socio-economic assessment	To assess the impact on the cost benefits of KB Drip vis-à-vis flood method of irrigation. Crop productivity will be analysed.
Carbon dioxide emission reduction potential	To assess CO_2 emission reduction potential based on the methodologies recommended by the CDM executive board and inputs of saving potential procured from the field.

A brief of the state and district of the study location is mentioned below:

Tamil Nadu

Tamil Nadu is situated at the South-eastern extremity of the Indian peninsula and has about 13.02 million ha of geographical area. The annual normal rainfall in Tamil Nadu is 925 mm. 5.2 million ha is the net sown area. It has got a total irrigable area of 6.72 million ha. The net area irrigated during 2005–2006 constituted 55.7% of the net area sown in the state. Soil type includes red loam, laterite soil, black soil, sandy coastal alluvium and red sandy soil.

60% of the population depends upon agriculture. Erode district falls under the agro-climatic zone of Southern plateaus and hills. The soil of the district is predominantly red sandy to red gravely type. The red soil differs greatly in consistency, colour, depth and fertility. Alluvial soils are found in small patches along Noyyal and Bhavani rivers. The red soils are low in moisture retaining capacity. They are ideally suited for cultivation of most crops under irrigation. The average annual rainfall is 925 mm and number of rainy days is 50 in a year. The total cultivation area is about 309175 ha. Paddy, turmeric, sugarcane, banana, tapioca are some of the main crops of the region.

Madhya Pradesh

Madhya Pradesh, the second largest state in the country, has about 66% of the total geographical area (30.76 million ha) available for cultivation. It has got a total irrigable area of 6.72 million ha. 2.09 million ha irrigation potential i.e. about 31% has been created. But the potential utilised is about 0.98 million ha, about 50% of the potential created. Madhya Pradesh is predominantly agricultural and about 80% of the population depends on agriculture for its livelihood. Soil type ranges from rich clay to gravel. Most important crops grown are paddy, wheat, maize and jowar among cereals; gram, tur, urad and moong among pulses; while soybean, groundnut and mustard among oilseeds. Cotton and sugarcane are grown as commercial crops and potato, onion, garlic, papaya, banana, oranges, mango and grapes are grown as horticulture crops. Chilli is a major horticulture crop in Madhya Pradesh.

Madhya Pradesh is predominantly agricultural and about 80% of the population depends on agriculture for its livelihood.

In Indore district, the soil pattern is black cotton soil with localised rock strata and is covered with deep medium black soil, alluvial soil and shallow and medium black soils. These soils have fine textures and their clay content varies from 40-60%. They are plastic and sticky when wet and hard when dry. These soils have high water retaining capacity.

Maharashtra

Maharashtra encompasses a geographical area of 3.81 million ha, and is the third largest state in India.

The gross irrigated area was 3857800 ha (1998-1999). Net area irrigated is 2725900 ha. The annual rainfall in Maharashtra state varies from 400 mm to 6000 mm. Two-thirds of the population (67%) in Maharashtra is engaged in agriculture. Crops grown in the state are rice, jowar, bajra, wheat, tur, mung, urad, gram and other pulses. The state is a major producer of oilseeds. Groundnut, sunflower, soyabean are major oil seed crops.

Jalgaon district is situated in the north-west region of Maharashtra. The total geographical area is 1175700 ha covered to a large extent with rich volcanic soil which is best suited for cotton cultivation.

Soil types found in Jalgaon region are:

- Medium black which are clay loams, brownish-black to black in colour with excellent drainage,
- Deep black highly clayey and sticky with impeded drainage,
- Loam–soil are grey in colour with excellent drainage
- Sandy soils are highly eroded and stony reddish in colour with excessive drainage requiring frequent irrigation.

Jalgaon district is recognised as a role model in India for production of bananas and cotton under drip irrigation.

The district receives an average rainfall of about 750 mm and it has diversified temperatures varying from 10 to 48°C. Banana, cotton, sugarcane, oil seeds, pulses are major crops of the district. Jalgaon district is recognised as a role model in India for production of bananas and cotton under drip irrigation. It is the largest banana growing district in India. Bananas grown are exported outside the state and to other countries. It has 47424 ha area under horticulture and is well known for its advances in horticulture.

Karnataka

The state of Karnataka, the eighth largest in the country has an area of 1.91 lakh sq km. More than 71% of this population is engaged in agriculture. Normal net cultivated area is about 106 lakh ha and the gross cultivated area is about 123 lakh ha under all crops. The state has 10 different agro-climatic zones viz. North Eastern Transition Zone, North Eastern Dry Zone, Northern Dry Zone, Central Dry Zone, Eastern Dry Zone, Southern Dry Zone, Southern Transition Zone, Northern Transition Zone, Hill Zone and Coastal Zone. Major crops grown are ragi, jowar, rice, sugarcane, coconut, groundnut, coffee and cotton. The state has 2564908 ha of net irrigated area.

Tumkur district has red soil type. The soil is low in moisture retaining capacity and due to good permeability it responds well to irrigation water. They are ideally suitable for cultivation of most of the crops like groundnut, sunflower, millets, pulses and fruits.

The map of the study location is given in Annexure 1.2.

1.4 Survey Tools and Sample Size

The tools used for the survey were structured questionnaires and checklist. The questionnaire was field tested in Tumkur, Karnataka and finalised. It was developed for drip and flood farmers.

The aspects covered in the questionnaire were as follows:

- General profile: Village, occupation, family size, details of landholdings
- Details of the drip system: Year of installation, cost of the system, problems faced
- Service details: Warranty period, dealers details
- Cropping pattern: Crop, acreage, production per unit and price per unit
- Hours of operation of system: Hours of operation in the rainy, summer and winter seasons
- Benefits perceived: Water savings, increase in area under irrigation.

A checklist was prepared to conduct the technical assessment of the drip and flood systems. The details of capacity of electrical pump, depth of water, discharge of water at source and delivery point, electricity consumption were assessed. The instruments used for the technical evaluation were stop watch, digital weighing machine, container of known volume, measuring tape and three phase power analyser. Details of the methodology of technical assessment are discussed in Chapter 3. The questionnaire and checklist are given in Annexure 1.3.

The sample survey was conducted for the purpose of assessing the cropping pattern, production and hours of operation under flood and drip method of irrigation. The details of the drip system, installation cost, problems faced and benefits perceived were also collected. The farmers adopting flood and drip method of irrigation were interviewed. Focus group discussions were held to understand the crop season, hours and duration of operation, benefits and problems in KB Drip as perceived by the farmers. A total of 208 farmers were interviewed for the study. In each of the districts in targeted states, five each of drip and flood farmers were covered for the technical evaluation. The sample size of the study is given in Table 1.2.

Table 1.2 Sample size for the survey and technical evaluation

District	Crops	Sample size		
		Drip	Flood	Total
Erode	Sugarcane	20	20	40
	Banana	10	10	20
Indore	Chilli	23	20	43
Jalgaon	Cotton	21	21	42
	Banana	10	10	20
Tumkur	Groundnut	22	21	43
Total		106	102	208

1.5 Organisation of the Report

The report is organised into five chapters.

Chapter 1 furnishes the introduction and methodology.

Chapter 2 furnishes the findings of the socio-economic assessment for the various districts in different states.

Chapter 3 presents the findings of the technical assessment.

Chapter 4 presents the assessment of Green House Gases (GHG) mitigation potential.

Chapter 5 contains the conclusion of the study.

Chapter 2

Socio-economic Assessment

This chapter focuses on the socio-economic assessment of KB Drip farmers and flood irrigation farmers in the study area. Survey was conducted using structured questionnaires. The demographic and land details, cropping pattern, cost of cultivation and discussion with dealers of KB Drip are presented in the subsequent sections.

2.1 Erode Region (Tamil Nadu)

2.1.1 Demographic details

Two crops namely sugarcane and banana were considered and assessment was done on the farms using both drip and flood method of irrigation.

Socio-economic assessment was conducted for 60 farmers in 34 villages spread across 5 districts namely, Erode, Dindigul, Karur, Namakkal and Salem. The average family size of the surveyed households was 5 (Tables 2.1 and 2.2). The average distribution of family is 2 men, 2 women, and 1 child.

Table 2.1 Family size of sugarcane farmers

	Men	Women	Children	Total
Drip	43	34	11	88
Flood	44	39	12	95
Total	**87**	**73**	**23**	**183**
Average	2	2	1	5

Table 2.2 Family size of banana farmers

	Men	Women	Children	Total
Drip	21	19	6	46
Flood	20	18	9	47
Total	**41**	**37**	**15**	**93**
Average	2	2	1	5

2.1.2 Occupational profile and land holding pattern

The main occupation of the surveyed households was agriculture. Very few of them (2%) were engaged in other occupations such as teaching, trading etc.

About 33% of the farmers were small farmers and 3% of them belonged to "marginal farmers" category (Table 2.3).

Agriculture through irrigation is being practiced in the region for more than 50 years. In earlier times, only dug wells were used for irrigation purposes but at present tube wells/bore wells are used as main source of water. Since electricity is free in Tamil Nadu, for agricultural purpose every farmer tries to put up more bore wells for irrigation.

Table 2.3 Land holding pattern

Farmer category	Sugarcane		Banana		Total	%
	Drip	Flood	Drip	Flood		
Marginal (< 2.5 acre)	0	2	0	0	2	3
Small (2.5 - 5 acre)	6	6	5	3	20	34
Semi medium (5 -10 acre)	3	5	3	7	18	30
Medium (10 - 25 acre)	7	2	2	0	11	18
Large (> 25 acre)	4	5	0	0	9	15
Total	**20**	**20**	**10**	**10**	**60**	**100**

Sugarcane farmers

The interview with 40 sugarcane growing farmers indicated that 20 farmers under KB Drip adopters owned total land of 319 acres (Table 2.4). In the total cultivated land, about 31% is under rain fed cultivation and the remaining 69% is under irrigated cultivation. The record shows that the farmers adopting drip are still practising flood irrigation to a large extent. They are practising drip in the small portion of their flood irrigated land. The reason being initial investment to purchase drip and free electricity retains the farmer to continue flood irrigation.

Similarly the distribution of total land holding for 20 farmers under flood method of irrigation is 292 acres with the average of 14.6 acres. Irrigated land comprised about 67% of the total cultivated land. The remaining land (33%) is rain fed and low water intensive crops are grown in that area of land.

Table 2.4 Land details of sugarcane farmers

	Farmers adopting KB Drip		Farmers adopting flood	
	Land	(%)	Land	(%)
Land under drip (acre)	63.0	20	31.0	11
Land under flood (acre)	157.5	49	163.5	56
Land under rainfed (acre)	98.5	31	97.5	33
Total	319	100	292	100
Average land holding (acre)	16.0		14.6	

Banana farmers

The interview with 10 drip adoptive farmers indicated that the total land holding is 74.4 acres with the average land holding per farmer being 7.4 acres. About 83% of the area is cultivated under irrigation and remaining 17% under rain fed conditions. Table 2.5 gives land holding pattern in case of banana crop formers.

The survey conducted among10 flood adoptive banana growers shows that the total land holding is 64.5 acres and the average distribution of land per farmer is 6.5 acre. About 94% of the area is irrigated and remaining 6% is under rain fed conditions.

Table 2.5 Land details of banana farmers

	Farmers adopting KB Drip		Farmers adopting flood	
	Land	(%)	Land	(%)
Land under drip (acre)	43.0	58	2.0	3
Land under flood (acre)	18.4	25	58.5	91
Land under rainfed (acre)	13.0	17	4.0	6
Total	74.4	100	64.5	100
Average land holding	7.4		6.5	

Banana and sugarcane being perennial crops, the farmers prefer drip system and flood irrigation system is usually adopted for short period crops.

2.1.3 KB Drip system

In Erode district, IDEI introduced KB Drip system in 2004. The sale of KB Drip had increased in successive years. The sale of KB Drip in the year 2005-06 reached maximum quantity of 12000 kg. Both 125 micron and 250 micron drip system were recommended in the region. The cost of KB Drip per kg is Rs.150 and the average quantity of drip system recommended per acre is about 25 kg costing about Rs. 3750. The total cost of KB Drip installation per acre including raw materials such as laterals, PVC pipes, filtering unit and labour is estimated at about Rs.10000. The respondents had self financed the purchase of drip system. The average annual cost for the maintenance is about Rs. 350. The farmers said that majority of them have replaced the parts of drip once a year. The typical problem mentioned by the farmers is the damage of tubes due to rat and ant bites and clogging. The respondents told that they would hire local technicians for the repair of drip systems.

The respondents had self financed the purchase of drip system. The average annual cost for the maintenance is about Rs. 350. The farmers said that majority of them have replaced the parts of drip once a year.

2.1.4 Cropping pattern

The main crops grown in the region are sugarcane, banana, turmeric, sunflower, and tapioca. Sugarcane and banana are annual crops while tapioca and turmeric are seasonal crops especially grown in rainy season. According to drip users, the gross area of irrigation has increased by 30% out of which the gross cropped area for sugarcane and banana crop are 23% and 36% respectively.

Sugarcane crop

Sugarcane is one of the major crops in Tamil Nadu and it is extensively produced in this region. It is an annual crop and highly water intensive. The harvested sugarcane is sold to the sugar mills in the region. In this region, it is usually grown in kharif season after monsoon showers and the harvesting is during the months of May and June. The average yield of sugarcane is about 55 tonnes per acre and the turnover of sugarcane is about Rs. 55000 per acre. Table 2.6 provides the irrigation pattern for sugarcane crop.

Table 2.6 Irrigation pattern of sugarcane crop

Month	Development stage	Irrigation	Season
June - July	Germination	Mild irrigation	Rainy
July - September	Tilling	Peak season	Rainy
September - February	Grand growth	Peak season	Winter
February - June	Maturity	Mild irrigation	Summer

Table 2.7 Acreage and yield of sugarcane

	Drip method of Irrigation	Flood method of irrigation
Acreage under sugarcane (Average)	2.6	3.4
Production/acre (tonnes/acre)	57.2	48.6
Hours of Irrigation per acre (h)	304	398
Average Price(Rs./tonne)	1067	1058

Farmers irrigating the sugarcane through drip system

The survey among 20 farmers indicated that the average acreage of sugarcane cultivation per farmer is 2.6 acres. The production of sugarcane per acre is about 57.2 tonnes and the existing average selling price of sugarcane is Rs. 1067 per tonne.

Farmers irrigating sugarcane through flood system

Feedback from 20 flood adopted farmers shows that the average acreage of sugarcane cultivation per farmer is 3.4 acre (Table 2.7). The average production per acre is about 49 tonnes per acre.

The above result indicates that there is an increase of 18% in yield by the use of KB Drip irrigation system which results in proportionate increase in income. The other benefits such as less labour, application of fertilisers etc are the attractive features of drip system. However the benefits of water and electrical power are not direct to the farmer due to free electricity distribution in the state. But in some areas with very low water table, drip irrigation is a crop saver for the farmer.

Other crops cultivated

The other crops cultivated in the region are coconut, groundnut, paddy and sunflower.

Table 2.8 Acreage and yield of other crops in the study region

	Rainy (Kharif)			
	Acreage	Acreage/Farmer	Production/Acre	Price/kg
Coconut (No.)	13	4.3	4833	3
Groundnut (tonnes)	18.5	4.6	2.2	7.5
Sunflower (tonnes)	10	2.5	0.9	19.3
Banana (tonnes)	5.25	1.75	10	5.3
Paddy (tonnes)	19.4	6.47	10.4	11.5

Banana crop

In this region, varieties of banana are grown for own use as well as export to other states. Rasthali, Karpooravalli, Robusta, Cavendish were some of the main varieties. The plantation usually starts in the months of February and March. The duration of crop is around 14 months.

Table 2.9 Irrigation pattern of banana crop

Month	Development stage	Irrigation	Season
February	Planting	Mild irrigation	Summer
March	Vegetative phase (leaf growth)	Peak seasons	Summer
April	Vegetative phase, (leaf growth and sucker production begins)	Peak seasons	Summer
May	Vegetative phase	Peak seasons	Summer
June	Vegetative phase	Peak seasons	Rainy
July	Flower initiation	Peak seasons	Rainy
August	Fruit differentiation	Peak seasons	Rainy
September	Elongation of floral axis	Peak seasons	Rainy
October	Leaf emergence stops	Peak seasons	Winter
November	Fruit filling	Peak season	Winter
December	Fruit filling continues	Mild irrigation	Winter
January	Harvesting	Mild irrigation	Winter
February	Harvesting	Mild irrigation	Summer
March	Harvesting	Mild irrigation	Summer

Source: Efficient use of irrigation water

Farmers irrigating banana through drip system

The average production of 10 farmers adopting drip systems is about 13.2 tonnes per acre. The average acreage of each farmer for banana growing is about 2.5 acre. The average selling price of banana is Rs. 8.6 per kg. The result shows that the farmer's average turnover is about Rs. 2,84,000 per annum.

Farmers irrigating banana through flood system

Feedback from 10 flood adopted farmers shows that the average acreage of banana cultivation per farmer is 1.9 acre. The average production per acre is about 9.5 tonnes per acre. The selling price of banana per kg is about Rs. 8.2 which is Rs. 0.4 less than drip system. The result shows that the farmer's average turnover is about Rs. 1,48,000 per annum.

Table 2.10 Acreage and yield of banana

	Drip method of irrigation	Flood method of irrigation
Acreage under banana (average)	2.5	1.9
Production/acre (tonnes/ac)	13.2	9.5
Hours of irrigation (h)	238	430
Average price per kg (Rs.)	**8.6**	**8.2**

There is 39% increase in yield of banana with drip method of irrigation. It is evident that the economy of drip irrigation system is substantial as compared to flood system. Higher yield in banana is possible in drip irrigation system due to adequate and systematic supply of water to root zone of the plant. The irrigation through drip method requires less water and is very helpful in summer season for the plants to survive.

2.1.5 Cost of cultivation

This section focuses on the advantages of drip irrigation system with respect to cost of production per acre. The estimates were made for sugarcane and banana crops on acreage basis in Erode region.

Sugarcane crop

The detailed cost of cultivation has been made on sugarcane crops in the farms of Karur and Erode. The evaluation shows that the total cost of cultivation has a 14% saving in drip irrigation system as compared to flood irrigation method (Table 2.11). The cost is same in operations like ploughing, weeding etc since farmers are still practising normal ploughing methods. Similarly, the mandatory costs such as the costs for weeding, seed sowing, Farm Yard Manure (FYM) application, plant protection and harvesting do not vary in both the cases as

Table 2.11 Cost of cultivation of sugarcane in drip vs flood method

Particulars	Sugarcane (Rs./acre)		Difference (%)
	Drip	Flood	
Ploughing	2650	2650	0
Land preparation	2000	2000	0
Seed and sowing cost	5200	5200	0
Fertilisers	2500	4000	37
Farm Yard Manure (FYM)	11250	11250	0
Plant protection	1700	1700	0
Weed control cost	1500	1600	6
Irrigation cost	0	6000	100
Harvesting	12650	11500	-10
Transportation cost	3465	3150	-10
Total cost of cultivation (Rs.)	**39450**	**45900**	**14**

it involves family labour. The major saving is observed as labour for irrigation in drip system which is nil against an amount of Rs. 6000 in case of flood system. The cost for harvesting and transportation is 10% higher in the crops using drip system. This is due to increase in the yield of crop in case of drip system. The use of fertigation method in drip system has reduced the fertiliser consumption by 37%.

Table 2.12 Cost benefit of sugarcane in drip vs flood method

Particulars	Sugarcane		Difference (%)
	Drip	Flood	
Yield (tonnes/acre)	57.2	48.6	18
Cost per tonnes (Rs.)	1067	1058	1
Cost of production (Rs./tonne)	690	944	-27
Net returns (Rs.)	61032	51419	19
Net profit (Rs.)	21582	5519	291

Sugarcane yield has increased by 18% in case of drip irrigation over flood irrigation. Similarly, net returns are also 19% more in case of drip irrigation adopters (Table 2.12). The net profit benefited by the drip adoptive farmers was 291%. In terms of money, it was Rs.16063.00 more profit over non adopted farmers.

Table 2.13 Cost of cultivation of banana in drip vs flood method

Particulars	Banana(Rs./acre)		Difference (%)
	Drip	Flood	
Ploughing	2400	2400	0
Land preparation	0	0	0
Seed and sowing cost	3500	3500	0
Fertilisers	4900	5750	15
Farm Yard Manure (FYM)	8800	8000	-10
Plant protection	2300	2800	18
Weed control cost	875	2500	65
Irrigation cost	1000	4500	78
Harvesting	1237	1875	34
Total cost of cultivation	25012	31325	20

Banana crop

The cost of cultivation for the banana crop in Karur and Erode region has shown a saving of Rs. 6313 (20%) with the use of drip irrigation systems. Expenditure is same for activities such as ploughing, land preparatory work and seed sowing. Savings observed with fertiliser application was 15% and with plant protection it is 18% with the use of drip irrigation system. The cost of labour for weed control is less in drip irrigation method (65%) over flood irrigation method due to less weed growth (Table 2.13).

Table 2.14 Cost benefit of banana in drip vs flood method

Particulars	Banana		Difference (%)
	Drip	Flood	
Yield (tonnes/acre)	13.2	9.5	39
Cost per tonnes (Rs.)	8.6	8.2	5
Cost of production (Rs./tonne)	1895	3297	-43
Net returns (Rs.)	113520	77900	46
Net profit (Rs.)	88508	46575	90

The economics of the banana crop under drip irrigation indicated additional net profit of Rs. 41933 over flood method of irrigation. This is mainly attributed to the 39% increased yield with the application of drip system (Table 2.14).

2.1.6 Focus group discussion and dealer interview

A Focus group discussion was held with banana farmers in Chennampatti village. Twelve farmers, consisting of 7 KB Drip and 5 non-drip farmers participated in the meeting.

The KB Drip users expressed that common problems in KB Drip are damages in micro tube, connector, washer, and PVC pipe and they had to replace the parts often. The price of new parts is Rs. 40 for micro tube (for one role of 100 m), Rs.150 for connector and washer (for RS. 1000), and Rs. 140 for PVC pipe per metre.

The drip users expressed that yield of banana is high as compared to flood method. No labour requirement to irrigate the banana plots in drip method of irrigation is observed as the most significant advantage. The other advantages are uniformity in irrigation, water saving, less weeding, uniform maturity of plants, loose soil maintenance etc.

The farmers expressed that there is saving of more than 50% of water with the drip irrigation system which is very useful in summer season. The non drip users indicated they suffered loss of crop as the plants do not survive, due to non-availibility of water during summers.

Discussion was held with dealer of KB Drip to understand the business implications in the Erode region. The sale of drip is mainly through the network of dealers and distributors. IDEI plays a major role in promotional activities and marketing of the product. Discussions with a dealer based in Erode city is described as below.

Box-1: Discussion with dealer

Dealer name: Soundirasekar, Barath Agro Tech, Erode,Tamil Nadu

Soundirasekar has 10 years of experience in marketing and servicing the drip irrigation products. Earlier he was involved in promotion of Nagarjuna drip system in Tamil Nadu and he took promotion of KB Drip in the year 2005 as on addition to his existing brand.

According to him, farmers prefer Nagarjuna drip for long term usage and also due to subsidy which can be availed. KB Drip is preferred for short term crops. Till now, he has sold about 3900 kg KB Drip in his area. It is most suitable for small and marginal farmers.

To promote KB Drip, he organises demonstration site visits for the farmers. In addition, he would help the farmers by sending technical staff for the repair work if needed. He recommended IDEI to supply pre-punched drip systems which are low in cost and have less maintenance.

2.2 Indore Region (Madhya Pradesh)

2.2.1 Demographic details

43 farmers spread across 2 districts and 4 villages were interviewed with the questionnaire. 23 farmers adopting drip irrigation and 20 farmers adopting flood irrigation were contacted. 10 farmers were identified for the technical assessment. The average family size of each household in the sample survey is 8. The family distribution is 3 men, 2 women and 3 children. The distribution is given in Table 2.15.

Table 2.15 Family size of chilli farmers

	Men	Women	Children	Total
Drip	57	50	52	159
Flood	49	49	57	155
Total	**106**	**99**	**109**	**314**
Average	3	2	3	8

2.2.2 Occupational profile and land holding pattern

In line with the secondary information it is found that agriculture is the main occupation in the rural areas of Madhya Pradesh. All (100%) of the farmers interviewed had agriculture their primary occupation. About 8 of the 43 farmers interviewed were engaged in secondary occupations like motor winding, coolie (manual labour) etc. Majority (77%) of the households were small farmers with landholding of 2.5-5 acres and 16% of the households were semi medium farmers and few (7%) households belonged to the marginal category (Table 2.16).

Table 2.16 Land holding pattern

	Drip	Flood	Total	%
Marginal (< 2.5 acre)	0	3	3	7
Small Farmers (2.5–5 acreas)	18	15	33	77
Semi medium (5-10 acreas)	4	3	7	16
Medium (10-25 acreas)	0	0	0	0
Large (> 25 acreas)	0	0	0	0
Total acres	22	21	43	100

Chilli farmers

Of the 22 KB Drip adopting farmers interviewed, the average land holding was found to be 4.93 acres. Irrigated land comprised about 77% of the total cultivated land. The remaining land is rain fed and low water requirement crops (23%) are primarily grown.

Of the 21 flood adopting respondents surveyed, it was found that the total land holding was 91.4 acres and the average land holding was about 4.4 acres. The farmers irrigated 26% land under flood irrigation.

Table 2.17 Land details of chilli farmers

	Farmers adopting KB Drip		Farmers adopting flood	
	Total	(%)	Total	(%)
Land under drip (acre)	32.3	30	0.0	0
Land under flood (acre)	51.3	47	23.8	26
Land under rainfed (acre)	24.9	23	67.6	74
Total (acre)	108.5	100	91.4	100
Average land holding (acre)	4.9		4.4	

2.2.3 KB Drip system

IDEI introduced the drip irrigation system in the year 2005 with the majority of the drip irrigation systems being installed between 2005-06. The pre-punched variety is what is recommended by IDEI particularly for the chilli crop. The primary advantage of the pre-punched variety is achievement of higher uniformity in water distribution reducing the chances of blockage. With one component less i.e. micro tubes, the system is simpler and more flexible. The average cost of the tape is Rs. 130/kg and on an average 24 kg of lateral thickness of 125 micron is required for 1 acre of crop. The average cost of KB Drip irrigation is about Rs. 4500 including installation. The system has an expected lifetime of around 3 years, however, certain farmers (30%) expect the system to last for about 5 years. Since the system is new, not many problems have occurred and maintenance costs were negligible. One of the problems mentioned by all farmers interviewed is the blockage of the drip holes. However, this happens due to not installing the filter (recommended by the IDEI) by the farmers.

2.2.4 Cropping pattern

The focus of the study was to assess the energy savings of the drip method of irrigation versus the flood method of irrigation. Due to varying water requirements for different crops it was imperative to choose one crop as the study crop for the region. Since the visit was timed towards the end of March, chilli was chosen for the region of Madhya Pradesh.

Table 2.18 Irrigation pattern of chilli crop

Month	Development stage	Irrigation	Season
June	Nursery/ planting	Mild irrigation	Rainy
July	Vegetative stage	Mild irrigation	Rainy
August	Vegetative stage	Mild irrigation	Rainy
September	Vegetative stage	Mild irrigation	Rainy
October	Flowering stage	Peak season	Winter
November	Flowering stage	Peak season	Winter
December	Fruit development	Peak season	Winter
January	Fruit enlargement	Mild irrigation	Winter
February	Harvest	Mild irrigation	Summer
March	Harvest	Mild irrigation	Summer

Source: Efficient use of irrigation water

Chilli is a major crop in the region of Madhya Pradesh. The sowing of the chilli starts in end May to early June and the crop is harvested in the month of February.

The chilli crop is a major cash crop for the farmers in the region. The major variety grown is the Jhankar variety, other varieties like Sannam are also commonly found. March, April, May months have lower prices due to increased supply of chilli to the markets. The harvesting of the chilli crop begins by January and continues till the end of April-May. During May to August prices of chilli were at peak levels due to a huge demand for dry chilli from the pickle industry. The chilli crop grows in the field for an approximate 10 months period.

Farmers irrigating chilli crop through KB Drip system

23 farmers in the region adopting the KB Drip system were interviewed. The average acreage of chilli under the drip system was 1.6 acres. The yield of chilli per acre of land was 1.9 tonnes (Table 2.19). The average price of the chilli per kg was Rs. 38.0, however, it fluctuated in the range of Rs. 35-45 per kg.

Farmers irrigating chilli crop through flood system.

Farmers irrigating chilli with flood method were also interviewed. The average yield/acre was found to be 1.1 tonnes/acre (Table 2.19). This marked difference in the yield of chilli crop was primarily due to the efficient water distribution by the drip system.

Table 2.19 Acreage and yield of chilli crop

Details	Drip method of irrigation	Flood method of irrigation
Average Acreage under chilli	1.6	1.9
Production (tonnes/ac)	1.9	1.1
Hours of irrigation per acre (h)	190	420
Average price per kg (Rs.)	38.0	38.0

This 76% increase in yield results in a proportionate increase in income. In addition, plant nutrients like fertilisers etc are used in lesser quantities which adds to the savings of the farmer.

The power savings, however, are not a direct benefit to the farmer due to the power tariff defined by the electricity distribution company. The tariff being charged on a per hp basis removes the incentive for the farmer to conserve water (hence power). Hence the crop is, in general, over irrigated by the farmer. Though the energy savings by a farmer adopting drip is high, it is mainly the increase in yield which is a factor that is of consideration for a farmer to install the drip system of irrigation. In certain cases, however, in summers or in areas where the recharge level is low, the drip irrigation is a crop saver for the farmer due to its high distribution efficiency with limited supply of water.

Other crops cultivated

Table 2.20 gives an indication of the other crops grown in the region, the production per acre of each of the crops and the average acreage under each of the crops. The 43 farmers interviewed in the region, were primarily farmers growing chilli. The table below indicates the cropping pattern of these farmers. As can be seen, cotton is the next most important cash crop for the farmer and the crop with an average acreage per farmer of 4.5 indicates the large extent to which it is grown. The average yield of the cotton crop was 2.1 tonnes/acre in rainy season. Certain farmers also cultivated cotton in winter (in place of wheat) with an average yield of 1.5 tonnes/acre.

Wheat is the major rabi crop and is grown widely across the region; the average acreage under wheat is around 1.2 acre and yield around 0.7 tonnes/acre. Channa also happens to be a popular pulse crop grown in the region. Vegetables constitute a small but important part of the crops grown in the region as they fill the gap between the winter and rainy seasons.

Table 2.20 Acreage and yield of other crops in the study region

Rainy (Kharif)				
	Acreage	Acreage/farmer	Production/acre (tonnes)	Price/unit
Cotton	93.3	4.5	2.1	17.4
Soybean	14.0	2.0	0.8	9.5
Groundnut	3.3	0.8	0.4	12.7
Maize	1.3	0.6	1.2	10.0
Winter (Rabi)				
Cotton	6.5	0.2	1.5	17.4
Wheat	38.0	1.2	0.7	8.0
Channa	5.3	1.1	0.2	26.6
Summer				
Vegetables	3.7	0.18	0.5	23.3

2.2.5 Cost of cultivation

In Indore, cost of cultivation for chilli was compared based on drip irrigation and flood method. The results indicated that the cost of production in flood method was 7% more than drip method. All the parameters like ploughing, land preparation, seed sowing cost, fertilisers cost , plant protection cost, harvest cost and transportation cost did not have any major differences. Weeding and irrigation are the two important activities where the maximum cost saving was observed in drip irrigation i.e., 30% and 52% respectively (Table 2.21).

Table 2.21 Cost of cultivation of chilli in drip vs flood method

Particulars	Chilli (Rs./acre)		Difference (%)
	Drip	Flood	
Ploughing	600	600	0
Land preparation	600	600	0
Seed and sowing cost	940	950	1
Fertilisers	1911	1913	0
Farm Yard Manure	1600	1500	-7
Plant protection	2400	2500	4
Weed control cost	1120	1600	30
Irrigation cost	500	1040	52
Harvesting	2760	2700	-2
Transportation cost	500	500	0
Total cost of cultivation	12923	13903	7

The yield difference of 76% was observed between drip and flood method (Table 2.22), which in turn showed comparative difference of net return of Rs. 31160 even though the total cost of production did not vary much due to the yield difference. The production cost per tonne was more in case of flood method (Rs.12639) compared to drip method (Rs. 6802).

Table 2.22 Important economical differences between drip and flood methods

Particulars	Chilli		Difference (%)
	Drip	Flood	
Yield (tonnes/ac)	1.9	1.1	76
Per kg cost (Rs.)	38	38	0
Cost of productivity (Rs./tonne)	6802	12639	-46
Net returns (Rs.)	72200	41040	76
Net profit (Rs.)	59277	27137	118

This indicates that the drip method of irrigation brings the net profit of 118% more, and also reduces the cost of irrigation and weeding.

2.2.6 Focus group discussion and dealer interview

Focus group discussion at Jamli village

About 11 farmers participated in the Focus group discussion conducted at Jamli comprising 6 users of KB Drip and 5 non-users of drip.

Village Profile

Households: 500-550

Population: 3000-3200

Electricity: 3 Phase power daily 4 hours (6 am-10 am); 1 Phase 12 hours (6 pm-6 am)

Agriculture Crops and Electricity Charges

Major Crop

Kharif: Maize, cotton, chilli

Rabi: Wheat, channa

5 hp Rs. 655/month, 3 hp Rs.360/month

70% of the pumps in the village are 3 hp

Main Issues of Deliberation

KB Drip was introduced in 2005 at the village of Jamli. The major crop under drip irrigation was cotton. In 2006, 15% of cotton farmers had installed KB Drip. In 2007 the number was expected to rise to almost 70%. About 15 farmers have installed drip for the chilli crop.

The main advantages of the drip method of irrigation as claimed are water saving, labour savings and an increase in the yield of the crop. The participants also felt that a good percentage of nutrients are saved when water is dispersed through drip system.

The main advantages of the drip method of irrigation are claimed to be water saving method of irrigation, labour savings and an increase in the yield of the crop.

They said that:

a). An additional crop can be grown when a farmer adopts the drip method of irrigation.

b). No extra attention is needed in case of KB Drip. Water supply to the plant is quite automatic and mechanical.

c). Cost of drip (KB) is less compared to other drip systems, in addition 1 year warranty is provided by KB Drip increasing the credibility of the product.

d) Storage is easy in case of KB Drip. (Can be stored in urea bags).

e). Installation cost is much less compared to other drip systems.

f). Transportation of KB Drip is much more convenient.

Some of the problems mentioned by them were:

- Mud/nutrients block the holes of the drip system. The main reason however is due to the farmers not installing the filter (recommended by IDEI) to reduce installation cost.
- Due to the light weight of the system, heavy winds do de-align the drip lines, but this is to an extent controlled. Pipes are blocked in-between due to plant pressure causing disturbance in water flow. They mentioned that the present demand for KB Drip is more than the supply, hence they have to wait for few days to receive the product.
- The non users when enquired as to the reason for not adopting the KB Drip system mentioned reasons of finances and the lack of water storage facility. A couple of them mentioned that water in their well was low and hence felt investment in the drip system may not be worth it.
- The major crop in the kharif season is cotton, sown in the month of May and harvested in October. The second major crop in the village is chilli which is a 10 month crop and stays on field from May till February of the following year.
- The group collectively agreed that almost 70-80% of water is saved by the drip method of irrigation. The group mentioned that an acre of chilli crop irrigated by flood irrigation would take about 24 hours while through the drip method the

same acre of land is irrigated in about 4 hours. The increase in yield of the chilli crop was mentioned to be around 60-70%.

Box 2: Discussion with dealer

Pradeep Birla, Pinky Machinery Store, Sanwad, Kargon district, MP

Pradeep Birla started his business in 1992, selling all kinds of forms related items. Birla has been selling drip system since 2003. He started selling the KB brand drip systems from 2006. He primarily sells the KB 125 micron drip system. Birla expressed satisfaction with the KB Drip product. His annual sale of KB Drip was about 2 tonnes last year and expects to sell around 10 tonnes this year. He is the primary dealer for the district of Kargon and covers 125 villages.

Birla stocks a local variety of drip called Tulsi. This is the standard lateral based drip system and priced at almost the same range as the KB Drip which is Rs. 4500 per acre. When interviewed as to the competitive ability of the KB Drip, he mentioned that the KB Drip scores on two factors: the ease of installation and maintenance and the lower upfront cost. He also mentioned that the KB Drip is more resistant to rat bites and due to its flexibility chances of breakage are low. These factors combined with a one year guarantee help him sell the KB Drip systems as compared to others.

The Jain variety (another brand marginally stocked) is more for the large farmers who can afford a costlier lateral based drip system. Most of the laterals being sold by him are non ISI marked and hence he does not involve in the subsidy scheme provided by the government. Birla feels the subsidy scheme is a deterrent to healthy market.

Two constraints due to the tape structure of the KB Drip mentioned by Birla are that, at times taller plants can press against the tape and block flow increasing the pressure within the system and secondly due to its light weight there are chances of flying against strong winds.

After the good sales in the previous year, Birla is now developing a stocking capacity for KB Drip primarily to maintain inventory for the peak seasons of April, May and June. He mentioned that almost 50% of the annual revenue is concentrated in these months of the year.

2.3 Jalgaon Region (Maharastra)

2.3.1 Demographic details

About 15 villages were covered for the socio-economic assessment in Jamner taluk and one village in Raver taluk. Socio-economic assessment was conducted for 62 farmers in 15 villages spread across 2 talukas. The sample size of drip and flood method of irrigation systems is detailed in Table 2.23.

Table 2.23 Sample size

Type of irrigation system	Cotton	Banana
Drip method	21	10
Flood method	21	10

The average family size is 7 and 8 in the households of cotton and banana farmers respectively. The average family distribution was 3 men, 2 women and 2 children in case of cotton farmer households and 3 men, 3 women, and 2 children in case of banana farmer house holds. Tables 2.24 and 2.25 shows the details of family distribution.

2.2.2 Occupational profile and land holding pattern

It is observed from the interviews that agriculture is the primary occupation in the region. This is due to good soil properties and support by the government of Maharashtra in terms of loans and subsidies on irrigation systems. During interviews, 26% of farmers mentioned that they are engaged in other occupations namely, employed in education departments, police departments, etc. and few of them own shops such as electric shop, provision store, vegetable shop, nursery garden, cement retail business, etc.

Table 2.24 Family size of cotton farmers

	Men	Women	Children	Total
Drip	53	51	51	155
Flood	54	46	35	135
Total	**107**	**97**	**86**	**290**
Average	3	2	2	7

Table 2.25 Family size of banana farmers

	Men	Women	Children	Total
Drip	31	19	13	63
Flood	30	30	30	90
Total	**61**	**49**	**43**	**153**
Average	3	3	2	8

As per the land records of Jamner taluk, there are about 12,687 small farmers, 23,490 medium farmers and 11,167 big farmers. The sample survey on both cotton and banana farmers shows that majority (26%) of the households were medium farmers with land holding of 10-25 acres and 24% of the households were semi medium farmers and few (16%) households belonged to the marginal and small farmers category. The classification of farmers is given in Table 2.26.

Table 2.26 Land holding pattern

Farmer category	Cotton		Banana		Total	%
	Drip	Flood	Drip	Flood		
Marginal (< 2.5 acres)	3	5	1	1	10	16
Small farmers (2.5–5 acres)	6	2	0	2	10	16
Semi medium (5-10 acres)	6	6	1	2	15	24
Medium (10-25 acres)	4	5	5	2	16	26
Large (> 25 acres)	2	3	3	3	11	18
Total	**21**	**21**	**10**	**10**	**62**	**100**

Rain fed agriculture in Jalgaon has been badly affected due to uncertainty of rainfall. Therefore, irrigation plays an important part in improving their economy. However, presence of black or loamy soil has been favourable to hold water for more duration and this helps the farmers to practice irrigation in less water season.

Dug wells and tube wells have an important role in Jalgaon. From the secondary survey, it is estimated that around 12,938 open wells and 1190 bore wells are functioning in Jamner taluk.

Cotton farmers

The interview with 21 cotton growing farmers under KB Drip method indicated that the total land holding is 281 acres. The average land holding was found to be 13.4 acres. The percentage of land under irrigation is about 74% (Table 2.27) and rain fed cultivation is about 26%. The seasonal crops were grown under rain fed cultivation which requires less water.

Similarly the total land holding is 248 acres (Table 2.27) in case of 21 flood irrigating farmers and the average distribution of land for every farmer having flood method of irrigation is 11.8 acres. Irrigated land comprised about 48% of the total cultivated land. The remaining land is rain fed and low water requirement crops are primarily grown in that area of land.

Table 2.27 Land details of cotton farmers

	Farmers adopting KB Drip		Farmers adopting flood	
	Land	(%)	Land	(%)
Land under drip (acre)	150.5	54	8.5	3
Land under flood (acre)	56.5	20	111.5	45
Land under rainfed (acre)	74	26	128	52
Total (acre)	**281**	**100**	**248**	**100**
Average land holding (acre)	13.4		11.8	

Banana farmers

Out of the 10 respondents of banana growing farmers under KB Drip method of irrigation, it is estimated that the total land holding is 293 acres and the average landholding per farmer is 29.3 acres (Table 2.28). Out of total cultivated area, about 79% of the area is under irrigation and remaining 21% of the land is under rain fed conditions.

The survey conducted on 10 banana growers under flood irrigation shows that the total land holding is 326 acres and the average distribution of land for each farmer is 32.6 acre. About 92% of the land is under irrigated condition and remaining 8% is under rainfed situation.

Table 2.28 Land details of banana farmers

	Farmers adopting KB Drip		Farmers adopting flood	
	Land	(%)	Land	(%)
Land under drip (acre)	139	47	9.5	3
Land under flood (acre)	93	32	291.5	89
Land under rainfed (acre)	61	21	25	8
Total (acre)	**293**	**100**	**326**	**100**
Average land holding (acre)	29.3		32.6	

2.3.3 KB Drip system

It was observed that there are about 40 different brands of drip irrigation systems in Jalgaon area. The distribution of drip system for field crop vs plantation shows that the distribution ratio is 20:80 and for KB system the ratio is 80:20.

This shows that more and more farmers of field crop are adopting KB Drip system due to affordability and simplicity.

Cotton crop

In cotton crop, a majority of the KB Drip had been installed during 2003–06. IDEI recommended pre-punched drip system for cotton crop for uniformity and less clogging problems. For cotton crop, 125 micron tube with width 26.5 mm is recommended. The cost of KB Drip lateral is around Rs. 100 per kg.

The average quantity of KB Drip tape requirement per acre is about 20 kg. The quantity varies according to the cropping pattern. Few farmers tried to decrease the quantity of lateral by laying single lateral for adjacent plants. Here, two separate micro tubes (two feet long) were connected between lateral and adjacent plants.

According to the feedback, the average cost of the KB Drip installation is about Rs. 4500 per acre which included filter unit, lateral, main and sub main pipes, and valves. About 15% farmers told that their drip systems are working since 5 years. The average cost of repair for KB Drip system is around Rs. 230 per year and repair work is needed once in a year.

Banana crop

In banana, around 60% of drip systems have been installed in 2002 and 40% in 2004. As explained earlier, 80% of banana plantation is under drip systems of other ISI brands. IDEI recommended 125 micron laterals for banana is having average cost of around Rs. 100 per kg. The quantity of drip lateral required per acre is about 22 kg.

It is found that the average cost of KB Drip system per acre is about Rs. 4400 which included filter unit, lateral, main and sub main pipes, and valves. The average annual maintenance cost was around Rs. 150.

Common problems mentioned by farmers

Some of the common problems mentioned by the farmers were clogging of laterals due to:

- Damage of pipes and laterals due to rat and bird biting
- Clogging of drip holes due to flow of water contaminated with dust particles.

All the farmers expressed that they manage the problems themselves.

2.3.4 Cropping pattern

Cropping is practiced throughout the year using irrigation water. Mono cropping and multi cropping are commonly practiced using high yielding varieties. Climate,

Table 2.29 Irrigation pattern of cotton crop

Month	Development stage	Irrigation	Season
January	-	-	Winter
February	-	-	Summer
March	-	-	Summer
April	-	-	Summer
May	-	-	Summer
June	Sowing – Seedling emergence	Mild irrigation	Rainy
July	First square	Mild irrigation	Rainy
August	First bloom	Peak season	Rainy
September	Peak bloom	Peak season	Rainy
October	First open boll	Peak season	Winter
November	Last flush - Harvest	Peak season	Winter
December	Harvest	Mild irrigation	Winter

Source: Efficient use of irrigation water

soil conditions and socio-economic factors decide the type of crop to be selected in the kharif season when majority of the area is restricted to cotton. During rabi season, winter crops such as wheat, gram, sorghum, etc are taken up.

2.3.4.1 Cotton

The most common varieties used in the region were BT cotton varieties such as Rashi 2, 144 and 138 and other hybrid varieties such as Bunni, Brahma, Bhishma, Mallika etc. In Jamner around 68105 ha of land is cultivated with cotton with annual production of 205 kg lint/ha. Table 2.29 gives the detailed irrigation pattern of cotton crop being classified with respect to season.

Cotton cultivation through drip system

According to the sample survey with 21 farmers, the acreage area under drip system is 4.2 acres. The yield of cotton varies from 0.7 tonnes - 2.25 tonnes per acre with the average yield of 1.4 tonnes and the average price of the cotton per kg is around Rs. 20.8.

Cotton cultivation through flood system

The survey conducted among 21 farmers revealed that the average acreage per farmer is 3.9 acre. The average production of cotton per acre is 0.9 tonnes with variation of 0.6 – 1.6 tonnes per acre and the average price of cotton per kg is Rs. 20.

The comparison of cotton crop grown under drip and flood method of irrigation is shown in Table 2.30. It is evident that the use of drip system claims in higher yield (56%) and price per acre due to sufficient and systematic use of water. All the farmers told that the changing over to drip system is very cost effective; roughly 68% water saving is expected as compared to the flood method of irrigation besides savings in electricity and labour.

Other crops cultivated

The other major crops grown in kharif were maize, jowar, grams (turi, moong and urad), and vegetables like tomato, chilli, brinjal, and leafy vegetables. Sowing is generally done during June - July and harvesting is done during September - November.

Table 2.30 Average and yield of cotton crop

Description	Drip method of irrigation	Flood method of irrigation
Average area per farmer (acre)	4.2	3.9
Quantity of yield per acre (tonnes)	1.4	0.9
Hours of irrigation per acre (h)	105	298
Average price per kg (Rs.)	20.8	20.0

The major crops grown in rabi were wheat, maize, vegetables, and varieties of grams. For these crops, less water is required due to moisture retained by the soil during monsoon shower; dew and rain received from north-east monsoon bring these crops to maturity, though sometimes irrigation has also to be resorted to overcome moisture stress situation.

During summer, vegetable crops like tomato, brinjal, chilli, papaya etc are cultivated under irrigation water.

Table 2.31 Acreage and yield of other crops in Jalgaon

Rainy (Kharif)				
	Total acreage	Acreage/farmer	Production/acre (tonnes)	Price/unit
Maize	37.5	3.1	1.9	6.7
Vegetables	9.5	0.8	4.4	8.4
Grams	4	1	0.8	21.8
Jowar	3.5	1.2	0.8	6.3
Winter (Rabi)				
Wheat	49.9	2.9	1	10
Vegetables	26.5	1.2	4.5	7.7
Maize	37.0	5.3	2.5	5.9
Gram	14.3	1.8	0.6	22.1
Seed onion	2	-	0.6	110.0
Summer				
Vegetables	11	1.2	4.2	8.7
Papaya	10	-	45	5

Cost of cultivation of cotton

In the study area, the cost of cultivation was compared between drip and flood irrigation systems. The feedback shows that there is a saving of 15% (Table 2.32) in overall cost incurred in drip irrigation (Rs. 10,579) compared to flood irrigation (Rs. 12,456).

In drip system, some activities such as sowing, fertiliser application and harvesting expenses have higher expenditure than flood system. On the other side, activities such as labour involved in water supply and application of Farm Yard Manure (FYM) resulted in good savings. The transportation cost is nil as it is borne by the customer.

There is increase in yield of 56% by using drip systems. Similarly the net return from cotton is 62% more with drip adopters. There is an additional profit of Rs. 12,997 for the drip adopted crops due to increased yield. The Table 2.33 shows the details of benefits of cotton.

Table 2.32 Cost of cultivation of cotton in drip vs flood method

Particulars	Cotton (Rs./acre)		Difference (%)
	Drip	Flood	
Ploughing	588	550	-7
Land preparation	250	250	0
Seed and sowing cost	863	760	-14
Fertilisers	2425	1810	-34
Farm Yard Manure	1167	2083	44
Plant protection	2175	2530	14
Weed control cost	763	950	20
Irrigation cost	0	1485	100
Harvesting	2350	2100	-12
Transportation cost	0	0	0
Total cost of cultivation (Rs)	**10579**	**12456**	**15**

Table 2.33 Cost benefits of cotton in drip vs flood method

Particulars	Cotton		Difference (%)
	Drip	Flood	
Yield (tonnes/ac)	1.4	0.9	56
Cost per kg (Rs)	20.8	20	4
Cost of productivity (Rs /tonne)	7556	13840	-45
Net returns (Rs)	29120	18000	62
Net profit (Rs)	18541	5544	234

2.3.4.2 Banana

Jalgaon is the largest banana growing district in India. Banana is exported to other states and countries. It has a total of 49,000 ha irrigable land in the district for banana cultivation. The entire district is producing 31,85,000 tonnes of banana every year. Out of it, the banana consumption in the district is 1,30,000 tonnes; sales outside the district is about 4,55,000 tonnes; and sales done by the state is 26,00,000 tonnes.

The major variety of banana grown in this region is 'Sreemanthy'. The common spacing of banana plantation is 5ft x 5ft, 5 ft x 4.75 ft. The farmers grow around 2000 suckers per acre during plantation. Cultivation usually starts in the months of June, August, and October. The banana cultivation will take 14 to 16 months for harvesting. It is seen that about 80 per cent of the banana cultivation is done under drip irrigation system.

Table 2.34 Irrigation pattern of banana crop

Month	Development stage	Irrigation	Season
June	Planting	Mild irrigation	Rainy
July	Vegetative phase (leaf growth)	Peak seasons	Rainy
August	Vegetative phase, (leaf growth and sucker production begins)	Peak seasons	Rainy
September	Vegetative phase	Peak seasons	Rainy
October	Vegetative phase	Peak seasons	Winter
November	Flower initiation	Peak seasons	Winter
December	Fruit differentiation	Peak seasons	Winter
January	Elongation of floral axis	Peak seasons	Winter
February	Leaf emergence stops	Peak seasons	Summer
March	Fruit filling	Peak season	Summer
April	Fruit filling continues	Mild irrigation	Summer
May	Harvesting	Mild irrigation	Summer
June	Harvesting	Mild irrigation	Rainy
July	Harvesting	Mild irrigation	Rainy

Source: Efficient use of irrigation water

Banana cultivation through drip system

The questionnaires were administered on 10 farmers in the villages of Shendurni, Ughale, Jamner, Samrod and Palaskheda who were growing bananas under drip irrigation.

The average acreage per farmer is 7.1 acre. The average yield of banana per acre is about 25.8 tonnes and the average price of the banana is Rs. 3.2/kg.

Banana cultivation through flood system

10 farmers adopting flood method of irrigation were interviewed in the villages of Raver and Jamner talukas. The average acreage per farmer is 8.9 acres (Table 2.35). The average production of banana per acre is 24.5 tonnes and the average price is around Rs. 3.0/kg.

Table 2.35 Acreage under banana crop

	Drip method of irrigation	Flood method of irrigation
Average acreage of banana (acre)	7.1	8.9
Production/acre (tonnes)	25.8	24.5
Hours of irrigation per acre (h)	695	935
Average price (Rs.) per kg	3.2	3.0

There is an increase in yield by 1.3 tonnes (5%) per acre through the use of drip irrigation system. The reasons being proper and timely distribution of water directly to the roots zones and effective utilisation of fertilisers applied by using fertigation methods.

Other crops cultivated

Among the 20 banana cultivators, the major crops that were grown are cotton, jowar, maize, grams, wheat, sugarcane sorghum, onion, and water melon. Table 2.36 gives detailed view on acreage and yield distribution of other crops.

Cost of cultivation of banana

The cost of cultivation per acre of banana crop was compared with drip and flood irrigation method. The results indicated that the total cost of cultivation is 25% more in flood method of irrigation against drip system (Table 2.37). The major savings being in fertiliser cost, irrigation cost and labour involved in weed control costs as compared with flood method of irrigation.

Table 2.36 Acreage and yield of other crops in Jalgaon, banana farmers

	Total acreage	Acreage/ farmer	Production/ acre (tonnes)	Price/ unit
Rainy (Kharif)				
Cotton	124.0	15.5	1.1	20.0
Jowar	12.0	4.0	2.0	4.0
Gram	37.0	3.7	0.8	18.4
Maize	50.0	12.5	2.3	5.8
Winter (Rabi)				
Wheat	56.0	6.2	1.2	9.9
Sugarcane	23.6	7.9	37.9	12.0
Sorghum	20.0	20.0	2.1	8.0
Onion	2.0	2.0	2.0	4.0
Summer				
Water melon	7.0	2.3	16.0	16.0

Table 2.37 Cost of cultivation of banana in drip vs flood method

Particulars	Banana (Rs./acre)		Difference (%)
	Drip	Flood	
Ploughing	450	450	0
Land preparation	250	275	9
Suckers and planting cost	4300	4300	0
Fertilisers	4050	5875	31
Farm Yard Manure	2250	2000	- 12.5
Plant protection	500	500	0
Weed control cost	875	1790	51
Irrigation cost	1000	3640	72.5
Harvesting	1450	1400	- 4
Transportation cost	0	0	0
Total cost of cultivation per tonnes	15125	20230	25

Table 2.38 Cost benefits of banana in drip vs flood method

Particulars	Banana		Difference (%)
	Drip	Flood	
Yield (tonnes/ac)	25.8	24.5	5
Cost per kg (Rs.)	3.2	3.05	5
Cost of productivity (Rs./tonnes)	586	826	-29
Net returns (Rs.)	82560	74725	10
Net profit (Rs.)	67435	54495	24

The increase in yield of 5 % was noticed in drip method of irrigation compared to flood method of irrigation (Table 2.38). There is an additional net return of Rs. 7835 with drip adoptive farmers and additional profit of about 24 per cent higher as compared to flood method.

2.3.5 Focus Group Discussions and Dealer Interview

All the 31 farmers growing banana and cotton were interviewed as to find the benefits in terms of water, electricity, labour and other benefits. The farmers told that the shifting to KB Drip system was very cost effective due to low investment, yield increase and savings in water use as compared to the flood irrigation methods. There were also suggestions such as to make ISI standard KB Drips, to adopt inline drip technologies, to align with government subsidy scheme etc. They also expressed that KB Drip system is suitable for field crops such as cotton, sugarcane etc. This is evident from the fact that Purushottam Patil, a farmer in Jamner, has purchased 3 tonnes of KB Drip for his cotton as well as banana cultivation.

Benefits of drip irrigation as mentioned by the respondents

Among the respondents, about 32% farmers opinioned that there is saving in labour, 23% farmers expressed higher yield, 22% farmers observed the water saving, 9% farmers felt that weed growth is under control and 7% of farmers noticed that there is saving in electricity and better quality of the product.

Problems of the drip system as mentioned by the respondents

Among all the respondents, 57% of the farmers expressed the clogging problem and 43% expressed that pipes were damaged by the biting of animals like monkeys, dogs, rats and birds. Most of the farmers were not satisfied with the performance of pre-punch drip systems being supplied to them and expressed will to adopt hot punch. According to them, due to manual punching chances of non uniformity in water discharge will be high which can affect the yield of crop.

Focus group discussion held in Jamner

A Focus group discussion was held at Gajanan Nursery. 25 farmers participated in it consisting of 15 KB Drip users and 10 non-drip users of both cotton and banana crops. Most of the participants were from villages nearer to Jamner town.

The other participants included were IDEI staff and professionals from TERI.

Main points of the discussion

The discussion was held to discuss the experiences with KB Drip systems installed for the cotton crop. The drip using participants mentioned that the main advantages in drip method are water saving and labour saving. They expressed that due to water shortage they were not able to grow cotton with flood method. Introduction of drip system has enabled them to grow cotton. They added the fact that despite short supply of electricity, they are able to irrigate their lands with the help of KB Drip system.

Non-drip users said that they are aware of the advantages of drip system. They told that most of the non-drip users are marginal farmers and the investment for drip system is quite high for their economy.

According to them, the electricity bills for irrigation pumps are fixed on capacity and do not vary with the usage. They have to pay the charges whether they use pump or not. Therefore, the farmers adopt drip system to save water and not electricity. But the advantages are even more if electricity is charged through metre basis.

Box- 3: Discussion with dealer

Kishore Chapmanlal Bohra, Jamner, Jalgaon district

Kishore has the establishment under the brand 'Bohra parivar' in Jamner city which has been a popular name to sell form inputs such as seeds, fertilisers, special irrigation related equipment, etc to the farmers in and around Jamner taluk. The shop was established in 1979. He started selling KB Drip since two months. When asked about the experience in selling KB Drip he told that the KB Drip price is very low compared to other brands which are very attractive to the farmer. The other advantage is the formalities/procedures are nil for KB systems and only one person is enough to install the system in the farm. The price of ISI brand drip system is about Rs. 12000 per acre of land whereas KB system costs only Rs. 5000 per acre of land.

He sold about 1.4 tonnes of KB Drip system in 2 months and now he had order for about 8 tonnes of KB Drip. The short supply was due to limited facility to manufacture drip pipes. The owner says that the market has very good demand for KB Drip system and no subsidy is needed to sell the product. He wants one year support from IDEI to promote the technology through him in order to bring more stability. He suggested that new technologies such as inline type drip systems should be adopted in KB Drip to give competition to others.

Box-4: Sanjay D Patil, Shendurni, Jamner taluk

This shop was established in the year 2000 and KB Drip trade was started in 2001. Here, only drip irrigation related items are sold. The owner is authorised dealer for Jain drip systems and KB Drip systems. He also sells another brand called 'Datta systems' before dealership of KB Drip systems.

He said that the price of KB Drip is 25% less than other brands and that has created a demand in the market. The other brands such as Jain, Netafim, Plasto, Das, Nirmal, Premier etc are selling ISI brand drip systems costing Rs. 11,000 – 12,500 per acre with 50% subsidy from Government of Maharashtra. In his area maximum quantity of KB systems were sold to horticulture crops. In 2001, he started selling KB Drip system for Brinjal crop for experimentation purpose. In that year he sold around 200 kg of KB laterals. In 2002 the sale was around 1.2 tonnes. Subsequently the sale of KB systems grew gradually until 2004 due to severe drought that made farmers hesitate in investing money. But since the year 2005 the sale of KB lateral is increasing. In 2006, the sale of KB Drip lateral was around 0.5 tonnes. He mentioned some problems such as variation in discharge and punching techniques adopted in KB systems. However these problems are not severe and no farmer has made any complaint of them.

Box-5: Discussion with Marketing Executive of IDEI

Dyaneswar Patil, Marketing Executive

Patil joined IDEI in 2001 as marketing representative for IDEI products in Jalgaon district. He had served IDEI for three years. He is covering nine blocks of Jamner taluk. Everyday he travels around 50-60 km and meets at least 20 farmers and 3–4 dealers in his work area. His work includes convincing new farmers to adopt KB Drip systems, monitor the performances of existing systems and provide necessary support to the farmers, and business transactions with the dealers. In addition, he manages to conduct 10-15 demonstrations, short campaigns, video shows, mobile campaigns, etc in every month to promote the technology. He says convincing a farmer to adopt KB Drip is a difficult task as there are many brands available with subsidy and at least 4 to 5 interactions are required. The duration to buy will be 2 – 6 months which depends on the customer's desire to invest money on it.

2.4 Tumkur Region (Karnataka)

2.4.1 Demographic details

In Karnataka, the study was conducted in 7 villages of Koratagere taluk of Tumkur district.

43 farmers were interviewed with the structured questionnaire. Out of these 22 farmers adopted drip irrigation all having 0.5 acre of groundnut crop and 21 farmers adopting flood irrigation for 1 acre. For technical assessment 10 farmers were identified.

Table 2.39 Family size of groundnut farmers

	Men	Women	Children	Total
Drip	49	44	25	118
Flood	47	51	56	154
Total	96	95	81	272
Average	3	3	3	9

Table 2.40 Land holding pattern

	Drip	Flood	Total	%
Marginal (< 2.5 acre)	13	2	15	35
Small Farmers (2.5–5 acre)	5	9	14	33
Semi medium (5-10 acre)	2	7	9	21
Medium (10-25 acre)	1	2	3	7
Large (> 25 acre)	1	1	2	5
Total	22	21	43	100

The family size details of each household within the sample are given in Table 2.39.

2.4.2 Occupational profile and land holding pattern

The main occupation of all the farmers interviewed was agriculture. About 20 of the 43 farmers interviewed were engaged in secondary occupation, 8 farmers were also employed as coolies (manual labour). 3 farmers were owning fertiliser shops, 3 had provision shops, 4 represented other activities namely, contractor, teacher, brick manufacturer and employed in NGO.

Majority (35%) of the households were marginal farmers with land holding of 0-2.5 acres and 33% (Table 2.40) of the households were small farmers, and few (5%) HHs belonged to the large farmer category.

Out of the 22 drip adoptive farmers interviewed, the total land holding was 95.5 acres and the average land holding was about 4.3 acres, 58% was under irrigated cultivation and rainfed cultivation was about 42% (Table 2.41).

Among the 21 flood farmers the total land holding was 172.3 acres with the average of 8.2 acres per individual farmer. About 89% of the area was cultivated under rainfed condition and remaining 11% under irrigated conditions.

Table 2.41 Land details of Tumkur farmers

	Farmers adopting KB Drip		Farmers adopting flood	
		(%)		(%)
Land under drip (acre)	21.3	22	3.0	2
Land under flood (acre)	34	36	15.0	9
Land under rainfed (acre)	40.2	42	154.3	89
Total (acre)	**95.5**	**100**	**172.3**	**100**
Average land holding (acre)	4.3		8.2	

2.4.3 KB Drip system

The KB Drip irrigation system was introduced during 2003 to 2006 by IDEI. Out of the 20 installations the majority of them i.e. 13 drip irrigation systems were installed in 2004, 6 installed in 2003 and one farmer got the drip installed in 2005. Drip irrigation can be helpful if water is scarce or expensive, because evaporation, runoff, and deep percolation are reduced and irrigation uniformity is improved. The KB Drip system is the micro lateral based drip system available for the farmers in the region in 2 specifications – 125 and 250 micron. Average cost of the tape is Rs.120/kg and 16-25 kg of drip are being used per acre of groundnut.

2.4.4 Cropping pattern

The food crops like ragi, paddy are the major crops and legumes crops are cultivated as inter crops. In the study area groundnut is grown as a cash crop and sowing season starting from December to first week of January (Table 2.42). Groundnut is the major revenue generator for the farmers in this region.

Table 2.42 Irrigation pattern of groundnut crop

Month	Development stage	Irrigation	Season
December	Sowing/germination emergence	Mild irrigation	Winter
January	Vegetative growth flowering	Peak season	Winter
February	Peg formation	Peak season	Summer
March	Pod formation	Peak season	Summer
April	Kernel development	Mild irrigation	Summer
May	Maturity	Mild irrigation	Summer

Source: Efficient use of irrigation water

Characteristics of the groundnut crop

Groundnut, the 13th most important food crop of the world, is the world's 4th most important source of edible oil and 3rd most important source of vegetable protein. Groundnut seeds contain high quality edible oil (50%), easily digestible protein (25%) and carbohydrates (20%).

Groundnut is grown on wide variety of soil types. However, the crop does best on sandy loam and loamy soils and in the black soils with good drainage. Heavy and stiff clays are unsuitable for groundnut cultivation as the pod development is hampered in these soils. Productivity of irrigated summer groundnut is more since it is not subjected to vagaries of monsoon. In early stages of its growth, evapotranspiration will be low, root and canopy growth will be less. Irrigation will be provided at longer interval. Water requirement will be 510 mm with minimum 9 number of irrigation. The groundnut crop stays on the field for an approximate 3.5 month periods. Flowering stage, peg-penetration and pod development stages are the critical period of the groundnut.

Farmers irrigating groundnut crop through drip system

The 22 farmers in the Korategere taluk adopting the drip system were interviewed with regard to the yield of groundnut crop from 1 acre of their land. The average yield was found to be 0.6 tonnes/acre. The average price of groundnut is Rs. 15/kg. The average acreage of groundnut under the drip system (per farmer) is 0.45 acres.

Farmers irrigating groundnut crop through flood system

The average groundnut yield/acre among the 21 farmers was 0.50 tonnes/acre, with the average price of Rs. 16 per kg. This indicates that the yield level of the groundnut is comparatively less in flood irrigation over drip method of irrigation. Table 2.43 brings out the contrast between the different forms of irrigation. A 36% increase in yield is observed.

Other crops cultivated

Table 2.44 indicates the average acreage per farmer and production per acre of the other major crops (excluding the groundnut crop) grown in the selected villages. These include ragi, jowar, paddy, coconut, different types of vegetables and flowers.

Cost of Cultivation of groundnut

The cost of cultivation of groundnut under drip method of irrigation is low when compared to the crops that are cultivated under flood irrigation. Cost reduction is generally realised more in labour intensive operations like ploughing (12%),

Table 2.43 Acreage and yield of groundnut

	Drip method of irrigation	Flood method of irrigation
Acreage under groundnut (Average)	0.45	1.2
Production/acre (tonnes/ac)	0.68	0.50
Hours of irrigation per acre (h)	553	661
Average price per kg (Rs.)	15	16

Table 2.44 Acreage and yield of other crops in the study region

Rainy (Kharif)				
	Acreage	Acreage/farmer	Production/acre (tonnes)	Price/unit
Ragi	30.8	1.6	0.4	5
Paddy	17.5	1.6	2.6	8
Winter (Rabi)				
Vegetables	13	1	3	9
Jowar	1.8	0.4	2.3	4
Summer				
Coconut	35.3	1.6	2.1	6
flower	0.8	0.3	0.5	-
Others	21.4	1.1	0.8	12

weeding (45%) and irrigation (50%). Cost of irrigation is reduced to a great extent under drip irrigation methods because of the less requirement of labour for managing the irrigation operation under drip and in general water saving is high. To some extent it has reduced the working hours of pump set. Water supplied to root zone has controlled the weed problem and thus labour cost is saved on weeding and intercultural operations. The total cost of cultivation comes to about Rs. 8436 in drip method of irrigation and Rs. 8784 in flood irrigation (Table 2.45). Farmers have used only chemical fertiliser like Di-ammonium Phosphate (DAP), Muriate of Potash (MOP) and Single Super Phosphate (SSP). They did not reduce the fertiliser application in drip method of irrigation. Any reduction of fertiliser might affect the yield of the groundnut, since the fertiliser applied might be lost in the form of leaching during irrigation process. None of the farmers are using plant protection chemicals. Cent percent of the farmers applied silt and Farm Yard Manure (FYM) in sufficient quantity.

Table 2.45 Cost of cultivation of groundnut in drip vs flood method

Particulars	Groundnut (Rs/acre)		Difference (%)
	Drip	Flood	
Ploughing	1200	1368	12
Land preparation	300	300	0
Seed and sowing cost	1188	1196	33
Fertilisers	1996	1752	-30
Farm Yard Manure	2200	1868	-30
Weed control cost	732	1332	45
Irrigation cost	200	400	50
Harvesting	400	320	-25
Transportation cost	220	248	11
Total cost of cultivation	**8436**	**8784**	**4**

Increase in productivity of crops (36%) (Table 2.46) is an important benefit for the drip farmers; in addition the drip method of irrigation has increased the cost efficiency, i.e., the cost to produce 1 tonne of groundnut is reduced by Rs. 5162 over the flood irrigation. The net return from the groundnut was Rs. 2200 more in case of drip irrigation adopters. The overall difference in profit for the drip adopted farmers is nearly Rs.2548 as compared to flood formers.

Table 2.46 Cost benefits of groundnut crop, drip vs flood

Particulars	Groundnut		Difference (%)
	Drip	Flood	
Yield (tonnes/ac)	0.68	0.5	36
Per kg cost (Rs.)	15	16	-6
Cost of productivity (Rs./tonne)	12406	17568	-29
Net returns (Rs.)	10200	8000	28
Net profit (Rs.)	1764	-784	-325

2.4.5 Focus group discussion and dealer interview

Focus group discussion at village Kabbigere, Kortegere taluk

Village Profile

Households – 146
Population – 545
Electricity – 3 Phase power daily 8 -10 hours in summer; 6-8 hours winter
Electric pumps – 21 pumps (6 installed by scheme)
Electrified Households – 99

Agriculture Crops and Electricity Charges

Major crops (Kharif): Groundnut, Rabi, Ragi

Pumps range form 3 hp to 12 hp with bore depths ranging from 200 to 600 feet. The capacity of pumps being used in the region range between 5 hp-7 hp.

Major points of discussion

KB Drip was installed in the year 2001 along with the Biomass conservation programme by BERI. The main aim of the discussion with the farmers was to get a qualitative understanding of the drip programme in the region. On an average the group felt that the major advantage with the drip system is the increase in yield of the crop. Javeregowda, a farmer with experience of irrigating the groundnut by both flood and drip form of irrigation, mentions that about 33% water savings is achieved by irrigating the crop with drip and he has personally experienced a 25%increase in yield of groundnut. Another such farmer, Rajanna feels that 40% savings in water is achievable in drip irrigation and approximately a 30% increase in yield is achievable. One major point noticed during the discussions is that the drip system, in spite of its various advantages, still is not the preferred form of irrigation for the farmers in the region. Due to the turn based operation of the pump within the scheme instituted by BERI, farmers have a tendency to fully utilise the pump during the time allotted to them irrespective of the water requirement of the crop.

Box-6: Discussion with dealer

Uday Kumar, Manjunatha Drip System, JC Road, Tumkur

Uday Kumar established his dealership in the year 2002 and started KB Drip marketing in the year 2004. The two specifications being sold in the region are 125 micron and 250 micron. He has sold 400 kg of 250 micron and 1600 kg of 125 micron in the period. To install the drip system for 1 acre of groundnut inclusive of the main piping filter and all the accessories, the cost is Rs. 6,000. The ISI marked systems on the other hand would cost about Rs. 37,000/acre. The KB tape system costs Rs. 121 per kg.

The life of the KB Drip system ranges from 3-4 years for the 250 micron and 15-25 years for the 500 micron. The 125 micron would last for 2-3 years. He feels that the 500 micron should be converted into lateral based system and should get the ISI mark; he feels that subsidy is a negative point for the KB Drip system. He also feels that the ISI mark would increase credibility of the KB Drip and help him increase the sales.

Chapter 3

Technical Assessment

The chapter focuses on the comparison of drip irrigation and flood irrigation on selected crops that have been cultivated in regions of Erode (Tamil Nadu), Indore (Madhya Pradesh), Jalgaon (Maharashtra) and Tumkur (Karnataka) of India. Tests were conducted to ascertain the performance of pumps, water demand and electricity consumption for the crop per acre of land on annual basis. Finally, comparison was made to assess the water and electricity saving potential by the intervention of drip method of irrigation. In addition, scope on potential for CO_2 mitigation with the intervention of drip method of irrigation was assessed on every crop.

3.1 Technology Definition and Differentiation between Drip and Flood Method of Irrigation

Irrigation based agriculture is widely practiced for crops which require water supply throughout the year and in places where rainfall is uncertain. Commonly open wells and tube wells were used to supply water for the irrigation. In earlier times manual methods such as water wheels or cantilevers were used to pump the water which has now been substituted with mechanical pumps. Various types of pumps are used. Most common among them were diesel pumps, kerosene pumps and electric pumps. Electric pumps of two types – 1) Mono-block pumps, 2) Submersible pumps were commonly used.

Conventionally, farmers use flood method of irrigation to feed water to the crop. This is a ridge– furrow method where crop is grown in the ridge and a furrow of at least 2 feet width and 10 inch depth is dug for the water flow. In an acre of land, the length of furrow ranges from 2500 m to 4500 m which depends upon the inter crop distance. Irrigation in flood method consists of distribution of water by passing through the furrows. The time required to irrigate one acre land is about 6 hours. More quantity of water is wasted due to distribution and evaporation losses.

In drip method of irrigation water is fed to the root zone of the crop with the help of micro tubes connected to pipes which are kept in pressure above atmosphere. It is observed that water is fed batch wise through micro tubes ranging from 1000 – 4000 in a batch. About 1 to 1.5 hours of irrigation is done for one acre of land. The advantage of drip irrigation is that distribution and evaporation is nil and water is supplied to the root zone of the plant. More than 50% of water saving is observed in drip method of irrigation.

3.1.1 Types of pumps

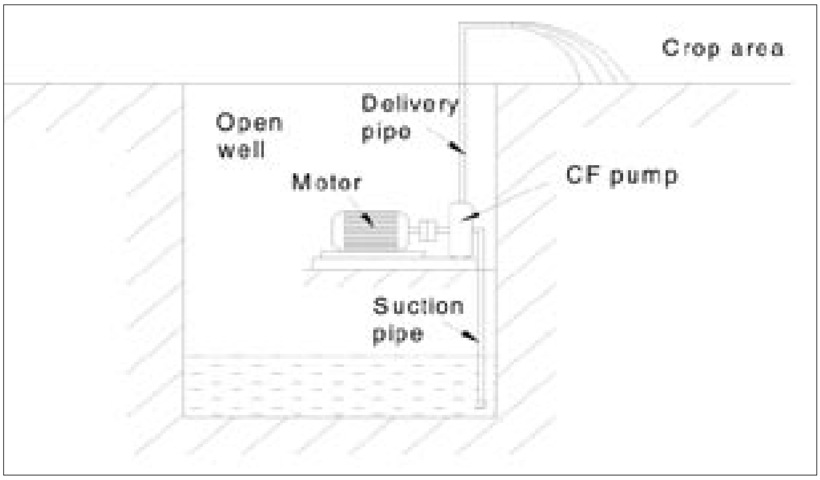
Two types of pumps were used for lifting of water:

1. Mono-block pumps used in open or dug well
2. Submersible pump used in tube or bore well

Mono-block pumps

Schematic diagram of a typical set up of mono-block pump used in open wells is given in Figure 3.1.

Figure 3.1 Schematic diagram of a mono-block pump system connected to open well



Technical details of mono-block pump

1. Electric Motor: This provides the necessary mechanical energy to the pump. Usually, 3 phase motor is used for irrigation water lifting purposes. The motor has a prime mover which rotates due to magnetic intensity created by the electrical power. The speed and capacity of the motor is sized-based on the head and quantity of water to be pumped.
2. Power Transmission System: This is a system to transmit rotary motion from the prime mover to the pump. It can be of the mono-block variety, directly coupled type, or a belt driving arrangement. The pumps under evaluation were coupled type of transmission system.
3. The Pump: Mostly centrifugal type pumps are used. The arrangement develops pressure difference in the water column due to the rotation of specially guided vanes which makes the water to push from lower to higher level.
4. Suction and Delivery Pipes: Suction pipe is required to draw water from sources and delivery pipe to carry water to the required point on the ground. A foot valve is fixed to the end of the pipe to prevent back flow.

Ideally, mono-block pump is located inside the well at a certain height above the water level ensuring delivery head is more than the suction head. The efficiency of such pumps is in the range of 35-40%.

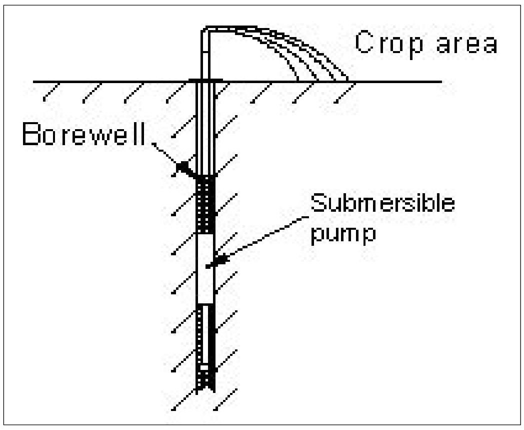
Two sizes of mono-block pumps of capacities 5 hp and 7.5 hp were observed in the study regions. All the pumps were supplied with 3 phase electricity from the regional grid supply. The age of the pumps ranged from 2 to 30 years. The observed major brands were Texmo, Suguna, Bharathi, and Decon.

Mono-block pumps are used as primary source of water in the regions where water level is in the range of 10 – 30 metre. Such type of pumps are observed commonly in the Indore region.

Submersible pump

Schematic diagram of a typical set up of submersible pump used in bore well is given in Figure 3.2.

Figure 3.2 Schematic diagram of a submersible pump connected to bore well



Submersible pumps are more efficient as compared to mono-block pumps and they are especially used in bore wells having depth of 30 metre and above. The pump has a cylindrical casing constituting both motor and pump inside of it and designed to perform under the water (submerged). The pump is a multistage centrifugal pump that runs through single common shaft connected to the motor. The efficiency of this pump will be more than 50%.

Submersible pumps are used as primary source of water in the regions where water level is very low i.e. below 300 ft. In Tumkur region, cent per cent farms were observed using submersible pumps

3.1.2 Selection of pumps

A total of 52 electric pumps were considered which included 15 pumps in the region of Jalgaon, 15 pumps in the region of Erode, 10 pumps in the region of Indore and 12 pumps in the region of Tumkur for the study. The details of pumps are listed in Annexure 3.1.

3.1.2.1 Coding for pumps

In the whole study, to recognise the pumps, codes were provided. The code consists of region, crop and method of irrigation. The detailed structure of code system is represented as below.

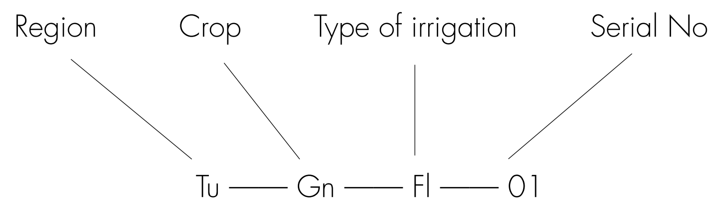


Table 3.1 List of codes for different parameters

Description (region)	Code	Description (Crop)	Code	Description (Type of irrigation)	Code
Erode	Er	Sugarcane	Sg	Flood method	Fl
Jalgaon	Jg	Banana	Bn	Drip method	Dr
Tumkur	Tu	Cotton	Ct		
Indore	In	Groundnut	Gn		
		Chilli	Ch		

3.1.3 Efficiency of electric pumps

Procedure

1. The identified pump was inspected and the technical specifications were noted.
2. Pre-arrangements for the testing were made.
   i. The condition of the pump was ensured to function properly by checking electrical connections, functioning etc. Priming of pump was made if desired.
   ii. To measure rate of water discharge, measuring drum, stop watch, weighing scale etc, were kept ready near the pump.

    iii. To measure electricity reading 3 phase power analyser was kept ready.
3. The pump was put off and 3 phase analyser connected to supply line.
4. The motor was started and phase power readings were recorded. Subsequently the water discharge rate was recorded by collecting the discharged water in a drum for a known period and quantity of water was measured. The testing period was about 5 – 8 seconds.
5. The depth of water (suction head) was noted by enquiring with the owner of the bore/well from which water was being pumped. In select sites, the depth of the water table was measured with the help of a measuring scale.

In every site, the test is conducted 3 times for consistent result.

Instruments used

Table 3.2 Instruments used for the technical analysis

Instrument	Least count	Unit	Purpose
2 liter Measuring Jar	10 ml	Litre	To measure water discharge rate
100 litre Measuring drum	500 ml	Litre	To measure water discharge rate
Weighing scale (0-100 kg)	50 g	kg	To measure the quantity of water
Surveyor's tape (0 -30 m)	1 cm	m	To measure the plot under study
3 Phase power analyzer	0.1 kW	kW	To measure power input
Stop watch	0.1 Sec	Sec	To measure water discharge rate

3.1.3.1 Precautions taken during the testing process to maintain accuracy

1. During the test, discharged water was filled in the measuring drum when the flow rate attained uniformity.
2. For the water discharge test, the outlet of the pump was selected close to the pump to avoid the pressure losses due to orientation of extension pipe.

Sample Calculation

Sample Calculation	
Name of the owner:	Murugeshan
Village	Sangetha palayam
Taluk	Salem
District	Salem
State	Tamil Nadu
Diesel engine	7.5 hp
Manufacturers of pump:	Singari
Age of pump	7 yr
Total head	21 m
Flow rate (Q)	53471 l/h
Electricity input	5.5 kW

Efficiency = (E output/E input) X 100

Output

= Flow rate (m^3/s) x head (m) x density of water (kg/m) x acceleration due to gravity (m/s)

1000

= (0.0148 m/s X 21 m X 1000 kg/m x 9.81 m/s)/1000

= 3.05 kW

Input = 5.5 kW

Efficiency = E output / E input = 3.05 kW / 8.44 kW x 100 = 55 %

The efficiencies of the pumps in the four regions profiled ranged from 20-47%. The details of efficiency calculation are tabulated in Annexure 3.1

The performance tests have indicated that about 60% of them were functioning below the specification provided by the pump manufacturers. The efficiency improvement of these pumps can further reduce electricity consumption.

3.1.3.2 Factors affecting efficiency of the pumping system

The low efficiency results in higher consumption of electricity and duration of irrigation. The details of pump characteristics and the performance are provided in the Annexures 3.1 and 3.2. Following are some of the important reasons for the losses in efficiency of the pumps observed during the field tests.

1. Mismatch of capacity and load
   - In ideal conditions, 3 hp pumps will suffice for the irrigation purposes in India. But being more conservative towards future expansions or ignorant about the technical aspects of the pumps, higher capacity pumps were preferred by the farmers. All such installations were resulting in very low efficiency in the fields.
   - The pumps observed were improperly fixed causing vibration in the motor.
2. Operational drawbacks
   - The fluctuations in the supply voltage would cause damage to the motor that runs without a regulator.
   - Inappropriate handling of pumps such as running of pumps under 2 phase electricity supply (in Erode), and providing more copper winding to more power (in Indore).
   - The silt present in the well often creates clogging of the suction pipes resulting in the lowered discharge of water.
3. Factors due to improper usage and lack of knowledge
   - The farmers were normally misguided by the dealers/service centres about the selection and maintenance of the pump. It leads to inappropriate use of pumps.

3.2 Analysis on Water and Energy Saving by the Use of Drip Irrigation System

The technical analysis was done on the identified crops in the four regions by testing the quantity of water and electricity consumption in drip method of irrigation and flood method of irrigation. The methodology adopted for the technical analysis of drip and flood methodology is described as below:

1. Key parameters for the analysis
2. Performance calculation for the benchmark
3. Comparison of results of drip and flood method of irrigation

1. Key parameters for the analysis

The analysis required three parameters:

a. Electricity consumption
b. Rate of water discharge at delivery side
c. Hours of operation

a. Electricity consumption

This value is obtained from the electricity readings measured during the assessment of electric pumps in the study regions. From the database, the pumps having similar capacity, ground water table, power conditions in a particular region were considered for the analysis. The average value gives the electrical energy consumption of the respective region. The details of the electricity reading calculation are available in Annexure 3.1.

b. Rate of water discharge at delivery side

This value is obtained by the actual measurements done on water discharge at delivery side of the pump. In case of drip, in every site, tests were done at drip level and in flood irrigating sites, tests were conducted at the delivery part of the pump. It was observed that in flood method of irrigation, the water discharge test at patch (furrow) level is inappropriate as some portion of water discharge is lost while travelling from pump outlet to the crop area. Therefore in flood method of irrigation, the quantity of water lost due to evaporation and distribution was also accounted.

The average of total number of test results done on water discharge of pumps is used for the calculation of total quantity of water usage for a particular crop in a year.

c. Hours of operation

This value is the total number of hours of irrigation required in a year for the selected crop. It is obtained from the primary data which is collected during the questionnaire survey. This value is vital in the calculation of electrical and water saving potential in the region.

2. Performance calculation for the benchmark

By obtaining the field level as well as questionnaire survey data, total quantity of water demand and electricity consumption of a particular crop being irrigated by either drip or flood method was estimated.

The water demand is calculated in terms of litres of water consumed per acre of land per year (litres/acre/year) and electricity consumption is estimated in terms of quantity of electrical energy consumed per acre per year for a particular crop (kWh/acre/year).

3. Comparison of results of drip and flood method of irrigation

The calculations were done to find water demand and electricity consumption for crops being irrigated by drip method as well as flood method of irrigation in the regions.

The results were compared to find the water saving and electricity saving potential with the intervention of drip method of irrigation.

3.2.1 Erode region

In Erode region, the tests were conducted on two crops: Sugarcane as a main crop and Banana as the additional crop.

3.2.1.1 Average rate of water discharge at delivery side

Sugarcane crop

A total of 9 sugarcane farms were examined under the study. Out of them, 5 farms were drip and 4 farms were using flood method of irrigation. In drip adopted farms, measurement was done for one batch of drip line consisting number of micro tubes ranging from 1750 – 4500. The spacing between adjacent drip lines is about 4 feet and the space between adjacent micro tubes is about 4 feet. In flood method adopted farms, the spacing between the adjacent plants is about 4 ft and the size of the furrow is about 1.5 ft wide and 0.5 ft deep. The average depth of water measured in these furrows in about 4 inches.

Combined application of mono-block and submersible pumps

In the regions of Erode and Jalgaon districts, both mono-block and submersible pumps were used for the irrigation water supply. The reason being open wells were dug very long ago when water level was high and later they were substituted with bore wells when water level became deep. At present, open wells were used to store the water pumped from the bore wells and supply the stored water for the irrigation.

In the study of combined application of pumps, the operation of bore well was not accounted for the water and electricity consumption as the application is common in both methods of irrigation and also requires in depth details about such situations.

The schematic diagram of the water sourcing mechanism in Erode and Jalgaon is shown in Figure 3.2.

Fig 3.3 Water sourcing mechanism in Erode and Jalgaon regions

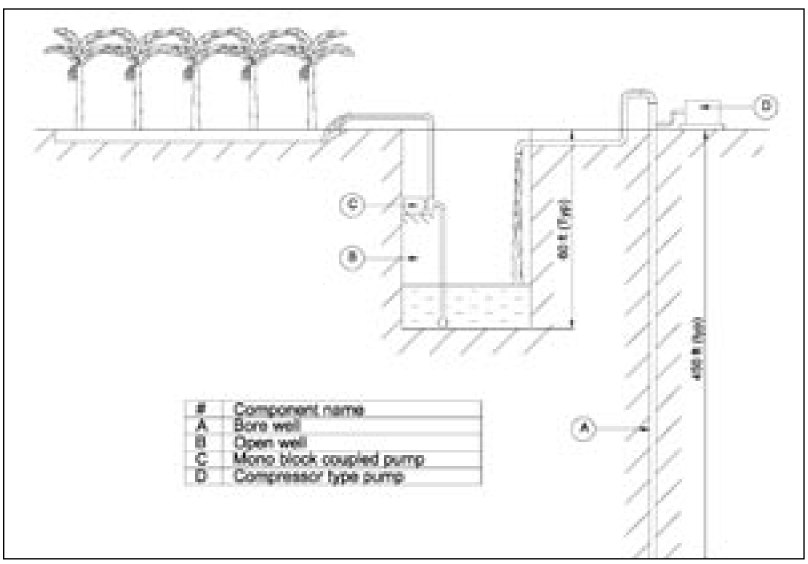


Table 3.3 Rate of water discharge measured in drip irrigation – Sugarcane crop

Code	Name of the farmer	Discharge per micro tube (l/h)	No of micro tubes	Discharge rate of water (l/h)
ER-Sg-Dp-01	Mahalingam	13	1740	22655
ER-Sg-Dp-02	Balakrishnan	5.41	2688	29098
ER-Sg-Dp-03	Ramaraju	12	2688	32256
ER-Sg-Dp-04	Subramanian V S	8.84	4500	39728
ER-Sg-Dp-05	Palaniswamy	11	3000	33000
Average				31347

Table 3.4 Rate of water discharge measured in flood irrigation – Sugarcane crop

Code	Name of the farmer	Time (sec)	Qty of water (l)	Discharge rate of water (l/h)
ER-Sg-Fl-01	Palaniswamy	5	57	38717
ER-Sg-Fl-02	Murugeshan	3	49	53455
ER-Sg-Fl-03	Ramaraju	3	31	37200
ER-Sg-Fl-04	Subramanian V S	4	54	48600
Average				44493

The results indicate that the drip irrigating farms had average water discharge rate of 31347 lph, which is about 70% of the flood method of irrigation.

Banana crop

In Erode region, a total of 6 banana growing farms were chosen for the study which consists of 3 drip method adopted farms and 3 flood method adopted farms.

In drip method of irrigation, one batch of drip lines covers about one acre of the plot and valves are used in case of more than one acre. In case of more acres, the irrigation was done in multiple batches one after the other. The plantation pattern is similar in both flood and drip method of irrigation. The water travels in the furrows made between the plants and the measured size of water column is 2.5 ft wide and 10 inches deep.

Table 3.5 Rate of water discharge measured at drip level – Banana crop

Code	Name of the farmer	Discharge per micro tube (l/h)	No. of tubes	Discharge rate of water (l/h)
Er-Bn-Dp-01	Gopal	11	1000	11000
Er-Bn-Dp-02	K P Krishnamurthy	17.8	1000	17800
Er-Bn-Dp-03	Rajendra	11	1000	11000
Average				13266

Table 3.6 Rate of water discharge measured at furrow level – Banana crop

Code	Name of the farmer	Time (sec)	Qty of water (l)	Discharge rate of water (l/h)
Er-Bn-Fl-01	Chinnaswamy	5.5	32.2	21076
Er-Bn-Fl-02	Saniappa Gowder	2.2	22.0	36000
Er-Bn-Fl-03	Palaniswamy	4.7	52.0	39830
Average				32302

The results indicate that the drip irrigating farms had average water discharge rate of 13266 lph, which is about 41% of the flood method of irrigation. Significant amount of water saving is observed with the drip intervention as the size of furrow is very large and more water is wasted in flooding unnecessarily. Drip systems have the major advantage for saving of water due to injecting water directly to the root zone of the plant.

3.2.1.2 Hours of operation

This value is obtained from the primary survey data conducted for the individual farms. 20 drip adopted farmers and 20 flood adopted farmers were interviewed. The identified farmers have been asked to give details on hours of irrigation per day, days of irrigation per week and in different seasons such as monsoon, winter and summer. In Erode region the seasonal period is estimated as 3 months for monsoon, 4 months for winter and 5 months for summer. The total hours of irrigation is estimated for every crop in a year.

Sugarcane crop

Table 3.7 Hours of irrigation per acre per year – Sugarcane crop

Particulars	Drip method of irrigation			Flood method of irrigation		
	Rainy	Summer	Winter	Rainy	Summer	Winter
Hours/day (Average)	1.5	2.5	2.5	3	6	5
Days/week (Average)	0.5	4	3	0.5	2	2
Days/month (Average)	2	14	12	2	8	7
Months accounted/year	3	5	4	3	5	4
Total (hours/year)	**304**			**398**		

The result shows that for every acre of sugarcane plot, the total hours of operation for drip method of operation is 304 hours which is 94 hours shorter than flood method of irrigation. There is saving of about 24% in the hours of irrigation by the use of drip irrigation system.

Banana crop

Table 3.8 Hours of irrigation per acre per year – Banana crop

Particulars	Drip method of irrigation			Flood method of irrigation		
	Rainy	Summer	Winter	Rainy	Summer	Winter
Hours/day (Average)	0.5	1	1	3	5	4.5
Days/week (Average)	2	6.5	6	1	3	2
Days/month (Average)	8	26	24	4	10	8
Months accounted/year	3	5	4	3	5	4
Total (hours/year)	**238**			**430**		

The result shows that the total hours of operation for drip method of operation is 238 hours which is 192 hours shorter than flood method of irrigation. There is saving of about 45% in the hours of irrigation by the use of drip irrigation system.

3.2.1.3 Water saving potential

It is determined by multiplying average hours of operation per year with average water consumption per hour. The average hours of operation per year is taken from the primary data collected during the survey and the average water consumption per hour is taken from the technical assessment done on rate of water discharge at the delivery level.

Sugarcane crop

Table 3.9 Water saving potential – Sugarcane crop

Type of irrigation	Average hours of operation (h/ac/yr)	Average water consumption (l/h/ac)	Total qty of water consumed (l/ac/yr)	Qty of water saved (l/ac/yr)	Saving of water (%)
Flood	398	44493	17708214	-	-
Drip	304	31347	9529488	8178726	46

In sugarcane crop irrigation, there is a saving of about 8 million litres (46 %) of water in using drip method of irrigation against flood method of irrigation estimated for one acre of land in a year.

Banana crop

Table 3.10 Water saving potential – Banana crop

Type of irrigation	Average hours of operation (h/ac/yr)	Average water consumption (kg/ h/ac)	Total qty of water consumed (l/ac/yr)	Qty of water saved (l/ac/yr)	Saving of water (%)
Flood	430	32302	13889860	-	-
Drip	238	13266	3157308	10732552	77

The above results indicate that there is a saving of about 10.7 million litres or 77% of water in using drip method of irrigation over flood method of irrigation estimated for one acre of land in a year. It also indicates that the average water discharge is more by 19,479 litres per hour in case of flood irrigation system.

3.2.1.4 Electricity saving potential

The electricity consumption per acre per year is estimated by calculating average electricity consumption per acre per hour multiplied with average hours of operation per acre per year.

Sugarcane crop

Table 3.11 Electricity saving potential of electric pump – Sugarcane crop

Method of irrigation	Average electricity consumption (kW)	Average hours of operation (h/ac/yr)	Total electricity consumed (kWh/ac/yr)	Electricity units saved (kWh/ac/yr)	Saving of electricity (%)
Drip	4.4	304	1340	415	45
Flood	4.4	398	1755	-	-

Banana crop

Table 3.12 Electricity saving potential – Banana crop

Method of irrigation	Average electricity consumption (kW)	Average hours of operation (h/ac/yr)	Total electricity consumed (kWh/ac/yr)	Electricity units saved (kWh/ac/yr)	Saving of electricity (%)
Drip	4.4	238	1050	847	24
Flood	4.4	430	1897	-	-

3.2.2 Indore region

3.2.2.1 Average rate of water discharge at delivery side

For the analysis, 5 drip using and 5 flood irrigating systems were examined.

Table 3.13 Rate of water discharge measured at drip level – Chilli crop

Code	Name of the farmer	Time (sec)	Qty of water (l)	Total discharge (l/h)
In-Ch-Dr-01	Rakesh	8.0	58	26000
In-Ch-Dr-02	Mahesh	19.0	75.65	14334
In-Ch-Dr-03	Shyamlal	8.0	71	32000
In-Ch-Dr-04	Premlal	15.0	52	12488
In-Ch-Dr-05	Natulilal	12.0	64	19299
Average				20824

Table 3.14 Rate of water discharge measured at furrow level – Chilli crop

Code	Name of the farmer	Time (sec)	Qty of water (l)	Discharge rate (l/h)
In-Ch-Fl-01	Ramesh	11.8	67	20295
In-Ch-Fl-02	Siyaram	15.2	67	15770
In-Ch-Fl-03	Misri lal	12.0	70	21000
In-Ch-Fl-04	Revaram	8.7	60	25000
In-Ch-Fl-05	Ramu	14.0	78	20000
Average				**20413**

From the tests it is observed that the average discharge of water value for both drip and flood method of irrigation appeared same in case of chilli crop.

3.2.2.2 Hours of operation

The interviews were conducted on 23 farmers using drip and 20 farmers using flood form of irrigation. The average hours of operation for each set of farmer is calculated and tabulated below.

Table 3.15 Hours of irrigation per year – Chilli crop

Particulars	Drip method of irrigation			Flood method of irrigation		
	Rainy	Summer	Winter	Rainy	Summer	Winter
Hours/day (Average)	0.5	1.5	2.5	3	2	3.5
Days/week (Average)	0	0	4	0	0	4
Days/month (Average)	6	12	12	11	18	18
Months accounted/year	1	2	5	1	2	5
Total (h / yr)	**190**			**420**		

3.2.2.3 Water saving potential

About 4.6 million litres of water (53%) is conserved by a farmer by shifting from flood method of irrigation to drip method of irrigation, for growing chilli in the region of Indore.

Table 3.16 Water saving potential - Chilli crop

Type of irrigation	Average hours of operation (h/ac/yr)	Average water consumption (kg/h/ac)	Total qty of water consumed (l/ac/yr)	Qty of water saved (l/ac/yr)	Saving of water (%)
Drip	190	20824	3956560	4616900	53
Flood	420	20413	8573460	-	-

3.2.2.4 Electricity saving potential

An approximate 1104 units of electricity are conserved annually, by a farmer shifting from furrow to drip irrigation for one acre of land, for growing Chilli in the region of Indore.

Table 3.17 Electricity saving potential – Chilli crop

Method of irrigation	Average electricity consumption (kW)	Average hours of operation (h/ac /yr)	Total electricity consumed (kWh/ac/yr)	Electricity units saved (kWh/ac/yr)	Saving of electricity (%)
Drip	4.8	190	912	1104	54
Flood	4.8	420	2016	-	-

3.2.3 Jalgaon region

3.2.3.1 Average rate of water discharge at delivery side

The results of water flow test conducted on both crops – Cotton and Banana are given in Table 3.18 and 3.19. In cotton, the drip system containing about 2500 micro tubes would constitute as a group or batch. The spacing maintained in cotton is 2.5 ft x 2.5 ft.

Cotton crop

Table 3.18 Rate of water discharge measured at drip level – Cotton crop

Code	Name of the farmer	Discharge per micro tube (l/h)	No. of micro tubes	Discharge rate of water (l/h)
Jg-Ct-dr-01	Dilip Patil	6.69	2500	16713
Jg-Ct-dr-02	Pandurang Sonji Patil	6.10	1300	7930
Jg-Ct-dr-03	Hari Kundli Mali	13.30	697	9272
Jg-Ct-dr-04	Purushottam Patil	9.70	2880	27936
Jg-Ct-dr-05	Vinod Naik	5.10	2444	12464
Average				14863

Table 3.19 Rate of water discharge measured at furrow level – Cotton crop

Code	Name of the farmer	Time	Qty of water (l)	Discharge rate of water (l/h)
Jg-Ct-fl-01	Atmaram Mahajan	10	80	28982
Jg-Ct-fl-02	Suresh Patil	16	86	20018
Jg-Ct-fl-03	Prakash Patil	22	80	13253
Jg-Ct-fl-05	Mahrao Pankaj Naik	16	82	20751
Jg-Ct-fl-05	Mahrao Pankaj Naik	18	83	18007
Average				20202

From the results, the average rate of discharge of water is about 14860 lph in case of drip adopted farm which is about 75% of the water discharge rate observed in the furrow method.

Banana crop

Table 3.20 Rate of water discharge measured at drip level – Banana crop

Code	Name of the farmer	Discharge per micro tube (l/h)	No. of micro tubes	Total dicharge (l/h)
Jg-Bn-Dr-01	Vasant Dange	4.80	3000	14400
Jg-Bn-Dr-02	Kashinath Nana Patil	3.50	3500	12244
Jg-Bn-Dr-03	Vasanth Krishna Mahajan	2.80	2895	8106
Average				11583

Table 3.21 Rate of water discharge measured at furrow level – Banana crop

Code	Name of the farmer	Time (sec)	Qty of water (l)	Discharge rate (l/h)
Jg-Bn-fl-01	Yuvaraj Chowdary	23	80	12317
Jg-Bn-fl-02	Rajaram Omkar Patil	12	70	20840
Average				16578

From the results, the average rate of discharge of water is about 11,583 lph in case of drip adopted farm which is about 70% of the water discharge rate observed in the furrow method of irrigation.

3.2.3.1 Hours of operation

The interviews were conducted on 21 farmers using drip and 21 farmers using flood form of irrigation in case of cotton crop and 5 farmers using drip and 5 farmers using furrow method of irrigation who were growing Banana crop. The average hours of operation for each set of farmer is calculated and tabulated as below.

Table 3.22 Hours of irrigation per year – Cotton crop

Particulars	Drip method of irrigation			Flood method of irrigation		
	Rainy	Summer	Winter	Rainy	Summer	Winter
Hours/day (Average)	0.6	0	2	6.7	0	8
Days/week (Average)	4	0	4	2	0	2.75
Days/month (Average)	15	0	16	8	0	9
Months accounted/ year	1.5	0	3	1.5	0	3
Total (h/yr)	105			298		

The result shows that the total hours of operation for drip method of operation is 105 hours which is 193 hours shorter than flood method of irrigation.

Table 3.23 Hours of irrigation per year – Banana crop

Particulars	Drip method of irrigation			Flood method of irrigation		
	Rainy	Summer	Winter	Rainy	Summer	Winter
Hours/day (Average)	0.9	4.4	2	8.5	8.5	8
Days/week (Average)	4.5	7	5	2.5	3.6	2.5
Days/month (Average)	18	28	20	10	14.5	10
Months accounted/year	1.5	4	4	1.5	4	4
Total (h / yr)	690			935		

3.2.3.2 Water saving potential

In case of cotton crop 4.4 million litres of water (74%) is saved by adopting drip method of irrigation, in Indore region.

The water saving potential for banana crop was found to be 7.5 million litres (48%) by shifting from flood to drip method of irrigation.

Cotton crop

Table 3.24 Water saving potential – Cotton crop

Type of irrigation	Average hours of operation (h/ac/yr)	Average water consumption (kg/h/ac)	Total quantity of water consumed (l/ac/yr)	Qty of water saved (l/ac/yr)	Saving of water (%)
Drip	105	14863	1560615	4459581	74
Flood	298	20202	6020196	-	-

Banana crop

Table 3.25 Water saving potential – Banana crop

Type of irrigation	Average hours of operation (h/ac/yr)	Average water consumption (kg/h/ac)	Total quantity of water consumed (l/ac/yr)	Qty of water saved (l/ac/yr)	Saving of water (%)
Drip	690	11583	7992270	7508160	48
Flood	935	16578	15500430	-	-

3.2.3.3 Electricity saving potential

An approximate 1435 units of electricity are conserved annually, by a farmer shifting from furrow to drip irrigation for 1 acre of land, for growing cotton in the region of Jalgaon.

Cotton crop

Table 3.26 Electricity saving potential – Cotton crop

Method of irrigation	Average electricity consumption (kW)	Average hours of operation (h/ac/yr)	Total electricity consumed (kWh/ac/yr)	Electricity units saved (kWh/ac/yr)	Saving of electricity (%)
Drip	4.6	105	483	887.8	65
Flood	4.6	298	1370.8	-	-

Electricity saving potential in Banana crop

An approximate 1588 units of electricity are conserved annually, by a farmer shifting from furrow to drip irrigation for 1 acre of land, for growing banana in the region of Raver taluk of Jalgaon district.

The variety of banana grown in Jalgaon region is Sreemanthy and the yield of crop per acre is about 25 tonnes. The water and electricity saving potential is less as compared to the banana variety, Rasthali grown in Erode region which has the yield of about 13.2 tonnes per acre and is more water intensive than the former variety.

Table 3.27 Water saving potential – Banana crop

Method of irrigation	Average electricity consumption (kW)	Average hours of operation (h/ac/yr)	Total electricity consumed (kWh/ac/yr)	Electricity units saved (kWh/ac/yr)	Saving of electricity (%)
Drip	4.6	695	3197	1104	26
Flood	4.6	935	4301	-	-

3.2.4 Tumkur region

3.2.4.1 Average rate of water discharge at delivery side

A total of 10 groundnut growing farms including 5 drip adopted and 5 furrow adopted were examined during the evaluation.

This measurement is of particular importance in this region due to the common usage of electric pump between farmers and also distance of the field from the pump being significant. The farmers adopting drip system included within the study as part of the scheme had tanks erected beside the field for storage and release of water from the tank. The rate of discharge from this cylindrical tank onto the field was tested in the following method.

Process adopted was:

- Allowing the tank to fill to a measured level and the level noted.
- Allowing the release of water from the tank taking a time based measurement for the decrease in water level.
- Measuring the difference in height and the diameter of the tank.
- Calculating volume of water discharged in unit time.

The results of the tests are shown in Table 3.28 and 3.29.

Table 3.28 Rate of water discharge measured at drip level – Groundnut

Code	Name of the farmer	Discharge per micro tube (l/h)	No. of micro tubes	Discharge rate (l/h)
Te-Tu-Dr-01	Jaweregowda	3.7	3300	12167
Te-Tu-Dr-02	Sridevi	2.2	3300	7408
Te-Tu-Dr-03	Mudalgiriayappa	1.6	3300	5337
Te-Tu-Dr-04	Narasappa	3.0	3300	9836
Te-Tu-Dr-05	Basavaraju	1.8	3300	5829
Average				**8115**

Table 3.29 Rate of water discharge measured at furrow level – Groundnut

Code	Name of the farmer	Time (sec)	Qty of water (l)	Discharge rate (l/h)
Te-Tu-Fl-01	Jaweregowda	30	45.5	5461
Te-Tu-Fl-02	Mahalingappa	45	214.3	17141
Te-Tu-Fl-03	Siddganangaiah	30	43.6	5229
Te-Tu-Fl-04	Thimmegowda	45	160.2	12820
Te-Tu-Fl-05	Chandrashekar	25	26.9	3871
Average				**8904**

3.2.4.2 Hours of operation

As done in other study sites, in Tumkur as well the farmers were enquired as to understand the usage hours of the electric pump to irrigate the groundnut crop. 22 farmers using drip and 20 farmers using flood method of irrigation were interviewed.

Table 3.30 Hours of irrigation per year – Groundnut

Particulars	Drip method of irrigation			Flood method of irrigation		
	Rainy	Summer	Winter	Rainy	Summer	Winter
Hours/day (Average)	0	7.6	7.7	0	7.5	8.5
Days/week (Average)	0	0	4	0	0	4
Days/month (Average)	0	16	12	0	18.5	14.6
Months accounted/year	0	3	2	0	3	2
Total (h/yr)	**550**			**664**		

It is observed that the groundnut is grown in December and harvested in April. Therefore, there is no irrigation in the summer season. The hours of operation per day are same in both the irrigation systems. There is a saving of about 114 hours in a year for a farmer to cultivate groundnut in one acre.

Table 3.31 Water saving potential – Groundnut

Type of irrigation	Average hours of operation (h/ac/yr)	Average water consumption (l/h/ac)	Total qty of water consumed (l/ac/yr)	Qty of water saved (l/ac/yr)	Saving of water (%)
Drip	550	8115	4463250	1449006	25
Flood	664	8904	5912256	-	-

About 1.4 million litres of water is expected to be saved by a farmer by switching from flood method to drip method of irrigation for one acre annually.

Table 3.32 Electricity saving potential – Groundnut

Method of irrigation	Average electricity consumption (kW)	Average hours of operation (h/ac/yr)	Total electricity consumed (kWh/ac/yr)	Electricity units saved (kWh/ac/yr)	Saving of electricity (%)
Drip	4.7	550	2585	536	17
Flood	4.7	664	3120	-	-

Annually every acre of groundnut crop being irrigated by drip irrigation which was previously being flooded saves 536 units of electricity. This estimate is only for farmers who have been previously flooding the crop and doesn't include farmers previously adopting rain fed irrigation.

Chapter
4

Assessment of GHG Mitigation Potential

In India, agriculture constitutes an important share of the demand for energy. From the 2004-05 statistics, it is evident that the annual electricity consumption for agriculture is about 88555 GWh which is about 23% (All India Electricity Statistics - General Review 2006, CEA, Ministry of Power, GoI) of the overall electricity consumption in the country. According to the state wise sale of electricity sales for the agriculture sector, the consumption is observed as 34% in Madhya Pradesh, 20% in Maharashtra, 37% in Karnataka, and 23% in Tamil Nadu.

Any technology that reduces dependence on fossil fuels in agriculture would contribute to both national energy security and global GHG mitigation. This chapter estimates the potential GHG savings from the adoption of drip method of irrigation in the study sites.

The details of electricity consumption pattern are given in Annexure 5.2. However, sale of this electricity amounts to no more than 5-10% of the state electricity boards' revenues.

On the other hand, the agriculture sector in India uses 85% of the country's available fresh water. However, irrigation efficiency is only 20-50%. In other words, Indian agriculture wastes up to half of the country's fresh water supply.

Another survey done in 2001 indicates that there are about 19 million pump sets and about 12.8 million tube wells in India. The details of the statistics of pump sets and tube wells are shown in Annexure 5.1.

Significant energy losses are associated with the distribution of electricity and in the poor selection, installation, maintenance and operation of the electrical motor pump system. The third main factor is the flood method of irrigation which accounts for both water and electricity losses.

In Chapter 3, the intervention of KB Drip technology in the irrigation sector has shown significant reduction in water as well as electricity in the study regions. Hence, any technology that reduces dependence on fossil fuels in agriculture would contribute to both national energy security and global GHG mitigation. This chapter estimates the potential GHG savings from the adoption of drip method of irrigation in the study sites.

4.1 CO_2 Mitigation Potential

The electricity required for all irrigation based pumps in the country is provided by the regional electrical grids. The Indian electricity system is divided into five regional grids, viz. Northern, Eastern, Western, Southern, and North-Eastern. Each grid covers several states. As the regional grids are interconnected, there is inter-state and inter-regional exchange. A small power exchange also takes place with the neighbouring countries like Bhutan and Nepal. For each of the five regions, the main emission factors are calculated in accordance with the relevant CDM methodologies.

As a result of the impressive growth attained by the Indian Power Sector, the installed capacity has grown from mere 1,713 MW in 1950 to 132,329 MW as of

31.03.2007, consisting of 86,015 MW thermal, 34,654 MW hydro and 3,900 MW nuclear. Region-wise details of installed capacity are shown in Annexure 4.1.

The states covered under regional grids are given in the Annexure 4.1.

The prevailing baseline emissions based on the data for the Fiscal Year 2005-06 are shown in Table 4.1.

The calculation to arrive at the emission factor of the regional grids, the methodology defined by the UNFCCC guidelines in ACM0002 (version 6) includes the estimation of the operating margin and the build margin of all the electric plants feeding the grids. The average of the combined and build margin emission factor gives the overall emission factor of the grid. Central Electricity Authority (CEA), Ministry of Power, and Government of India in cooperation with GTZ CDM – India has compiled a database for all grid powered power stations in India.

Table 4.1 CO_2 emission factors of regional grids

Region	CO_2 emission factor (Combined margin)
North	0.80
East	1.05
South	0.86
West	0.81
North-East	0.42
India	0.85

Different Types of Emission Factors

The CDM methodologies which have been approved to date by the CDM Executive Board distinguish a range of different emission factors. In the Indian context, the following four are most relevant, and were therefore calculated for each regional grid based on the underlying station data:

• **Weighted average:**
The weighted average emission factor describes the average CO_2 emitted per unit of electricity generated in the grid. It is calculated by dividing the absolute CO_2 emissions of all power stations in the region by the region's total net generation. Net generation from so-called low-cost/must-run sources (hydro and nuclear) is included in the denominator.

• **Simple operating margin (OM):**
The operating margin describes the average CO_2 intensity of the existing stations in the grid which are most likely to reduce their output if a CDM project supplies electricity to the grid (or reduces consumption of grid electricity). The simple operating margin is obtained by dividing the region's total CO_2 emissions by the net generation of the stations serving the region excluding low-cost/must-run sources. In other words, the total emissions are divided by the total net generation of all thermal power stations. Hydro and nuclear qualify as low-cost/must-run sources, and their net generation is therefore excluded from the denominator.

• **Build margin (BM):**
The build margin reflects the average CO_2 intensity of newly built power stations that will be (partially) replaced by a CDM project. In accordance with ACM0002, the build margin is calculated in this database as the average emissions intensity of the 20% most recent capacity additions in the grid based on net generation. Depending on the region, the build margin covers units commissioned in the last five to ten years.

• **Combined margin (CM):**
The combined margin is a weighted average of the simple operating margin and the build margin. By default, both margins have equal weights (50%). However, CDM project developers may choose to argue for different weights. In particular, for intermittent and non dispatchable generation types such as wind and solar photovoltaic, ACM0002 allows to weigh the operating margin and build margin at 75% and 25%, respectively (see ACM0002, Version 06). However, the combined margins shown in the database are calculated based on equal weights.

The data base can be directly accessed for the CO_2 emission factor calculations. For the calculation of CO_2 emission potential, combined margin of the weighted average of the simple operating margin and build margin at 50:50 ratio can be used. The different types of emission factors are explained in the box on previous page.

The CO_2 emission reduction potential based on electricity savings with the intervention of drip method of irrigation on various crops cultivated in study regions are stated as below. The estimation of CO_2 reduction covers the data of past 3 years of drip usage.

4.1.1 Erode region

Sugarcane

It is observed from Table 4.2 that the average electricity unit savings is 415 kWh per acre with the use of drip systems over flood irrigation systems annually. The corresponding reduction in emissions needs an estimation of energy mix feeding the Tamil Nadu grid which is the grid feeding electricity to the irrigation pump sets in the region.

Table 4.2 CO_2 Emission reductions - Sugarcane

Particulars	2004-05	2005-06	2006-07
Electricity saving per acre per annum (kWh)	415	415	415
kg of KB Drip sold and implemented for the Sugarcane crop	288	3792	8928
Number of kg of drip system under operation and abating CO_2 emissions	288	4080	13008
Acres of land under Sugarcane	12	170	542
Total units of Electricity saved annually with KB Drip (Electricity saving per acre x total no of acres)	4980	70550	224930
Factor to account for conservativeness (10%)	4482	63495	202437
Total Emission abated (kg CO_2 / year)	3855	54606	174096
Tonnes of CO_2 saving per annum	3.8	54.6	174.0

From the database available with CEA, the emission factor for southern grid is estimated at 0.86 kg CO_2 per unit of electricity. This would mean that every unit of electricity used from the western grid contributes 860 gm of CO_2 emissions. With this figure and the calculated value of 415 from Table 4.2, it can be shown that every acre of sugarcane previously being flooded and currently being irrigated by drip can reduce 357 (0.86 x 415) kg of CO_2 annually.

It was observed that one acre of sugarcane required an average of 24 kg of KB Drip of lateral thickness of 125 micron with crop spacing of 3 ft x 3 ft.

Banana crop

It is understood from Table 4.3 that the average quantity of electrical units is 847 kWh per acre of banana crop with drip method of irrigation against the flood method of irrigation. Electricity supply being supplied from the same grid, the emission factor is considered as 0.86 kg of CO_2 per kWh. Having considered that the electricity saving per acre is 847 kWh, the quantity of CO_2 emission reduction is 728 (0.86 x 847) kg per acre annually.

The average value of KB Drip required for one acre banana crop is 24 kg of lateral thickness of 250 micron with crop spacing of 6.5 ft x 6.5 ft. The total quantity of CO_2 emission reductions per year is calculated as below.

Table 4.3 CO_2 Emission reductions - Banana crop

Particulars	2004-05	2005-06	2006-07
Electricity saving per acre per annum (kWh)	847	847	847
kg of KB Drip sold and implemented for the banana crop	1728	1464	3024
Number of kg of drip system under operation and abating CO_2 emissions	1728	3192	6216
Acres of land under banana	72	133	259
Total units of electricity saved annually with KB Drip	60984	112651	219373
Factor to account for conservativeness (10%)	54885.6	101385.9	197435.7
Total emission abated (kg CO_2/year)	47202	87192	169795
Tonnes of CO_2 abated per annum	47.2	87.2	169.8

4.1.2 Indore region

The 1104 units of electricity being saved by the farmer adopting drip form of irrigation would have otherwise been used by the farmer. Hence, the emissions correspondingly reduced by these units of electricity saved needs an estimation of the energy mix feeding from the Madhya Pradesh grid, which is the grid feeding electricity to the irrigation pump sets in the region. Since exchange of power between states within the western region is common, it is proposed to include the western grid as the basis for calculation of energy mix (and hence the baseline emission) that is feeding the western grid.

From these calculations the emission factor for the western grid is estimated at 0.810 kg CO_2 per unit of electricity. This would mean that every unit of electricity used from the western grid contributes 830 gm of CO_2 emissions. With this figure and the calculated value of 1013 from Table 4.4, it can be shown that every acre of chilli previously being flooded and currently being irrigated by drip can reduce 894.2 (0.810*1104) kg of CO_2 annually.

When interviewing the 23 farmers adopting drip irrigation, it was found that 1 acre of chilli required an average of 24 kg of KB Drip of lateral thickness of 125 micron with crop spacing of 2 ft x 2 ft. A conservative figure of 20 kg of drip per acre of chilli is considered for the calculations.

Table 4.4 CO_2 Emission reductions – Chilli crop

Particulars	2002-2003	2003-2004
Electricity saving per acre per annum (kWh)	1104	1104
kg of KB Drip sold and implemented for the chilli crop	2000	2500
Number of kg of drip system under operation and abating CO_2 emissions	2000	4500
Acres of land under chilli	100	225
Total units of electricity saved annually with KB Drip	110400	248400
A factor to account for conservativeness (10%)	99360	223560
Total emission abated (kg CO_2/year)	80481	181083
Tonnes of CO_2 abated per annum	80.4	181.1

It is hence seen that a semi water intensive crop like chilli, when cultivated using the drip form of water distribution has the capability to, on an average, reduce 1104 units of electricity and in return the farmer tends to benefit from a minimum 20% increase in crop yield. Due to the tariff structure for irrigational energy requirements based on a hp basis this energy savings is not appreciated by the farmer as direct benefit. It however, saves the overall consumption of energy in the agricultural sector for the government. This 1,156 units of energy by this farmer is reduced from the western grid where the predominate source of energy production is thermal energy. With detailed calculations it has been estimated that 1 unit of electricity from this grid is at the cost of 810 gm of CO_2 released by the plants supplying energy to the grid. Hence, 1 farmer with 1 acre of chilli crop shifting from drip irrigation to flood irrigation has the potential to abate 894 kg of CO_2. On a conservative estimate 20 kg of Drip system is required for 1 acre of chilli crop. Hence 20 kg of drip system sold abates 965 kg of CO_2 annually.

4.1.3 Jalgaon region

Cotton crop

With the use of drip irrigation, the farmer is saving about 888 units of electricity per acre per year which would have otherwise been used. Hence the emissions correspondingly reduced by these units of electricity saved needs an estimation of the energy mix feeding the Maharashtra grid which is supplying electricity to the irrigation pump sets in the region.

From the latest listing of emission factors in the Central Electricity Authority (CEA) website, the emission factor for the western grid is estimated at 0.81 kg CO_2 per unit of electricity. This would mean that every unit of electricity used from the western grid contributes 810 gm of CO_2 emissions. This value is based on data collected in fiscal year 2005–06. The calculations are based on generation, fuel consumption and fuel quality data from the power stations. It can be shown that every acre of cotton previously being flooded and currently being irrigated by drip can reduce 719 (0.81 x 888) kg of CO_2 annually.

The average value of KB Drip required for one acre cotton crop is 20 kg of lateral thickness of 125 micron with crop spacing of 4 ft x 3 ft. The total quantity of CO_2 emission reductions per year is calculated as shown in Table 4.5.

Table 4.5 CO_2 Emission reduction calculations - Cotton crop

Particulars	2004-05	2005-06	2006-07	2007 (up to June)
Electricity saving per acre per annum (kWh)	888	888	888	888
kg of KB Drip sold and implemented for the cotton crop	1900	2000	2200	2400
Number of kg of drip system under operation and abating CO_2 emissions	1900	3900	6100	8500
Acres of land under cotton	95	195	305	425
Total units of electricity saved annually with KB Drip	84360	173160	270840	377400
A Factor to account for conservativeness*(10%)	75924	155844	243756	339660
Total emission abated (kg CO_2/year)	61498	126233	197442	275125
Tonnes of CO_2 abated per annum	61.5	126	197	275.1

Banana crop

The emission reduction calculation for banana crop in Jalgaon district is calculated based on the emission factor of 0.81 kg CO_2 and average quantity of KB Drip per acre as 20 kg of lateral thickness of 125 micron with crop spacing of 5 ft x 5 ft. The electricity savings from drip intervention is estimated as 1104 units per acre per year which is indicated in Table 4.6. Therefore, the saving in CO_2 emissions by the drip intervention is 894 (1104 x 0.81) kg per acre per year. The year wise estimate of CO_2 emission reductions in Jalgaon region in the last three years is given in Table 4.6.

Table 4.6 CO_2 Emission reductions - Banana crop

Particulars	2004-05	2005-06	2006-07
Electricity saving per acre per annum (kWh)	1104	1104	1104
kg of KB Drip sold and implemented for the banana crop	600	200	400
Number of kg of drip system under operation and abating CO_2 emissions	600	800	1200
Acres of land under banana	30	40	60
Total units of electricity saved annually with KB Drip	33120	44160	66240
A factor to account for conservativeness (10%)	29808	39744	59616
Total emission abated (kg CO_2/year)	24144	32192	48289
Tonnes of CO_2 abated per annum	24.1	32.2	48.3

4.1.4 Tumkur region

The emission factor for the southern grid is taken from the Central Electricity Authority website where it is estimated at 0.86 kg CO_2 per unit of electricity. This would mean that every unit of electricity used from the southern grid contributes 860 gm of CO_2 emissions. With this figure and the calculated value of 536 units from table 4.7, it is estimated that every acre of groundnut previously being flooded and currently being irrigated by drip in the region can abate 460 kg of CO_2 or 0.46 tonnes of CO_2 in every year of operation.

To quantify the emission reductions in volumes of the project, when interviewing the 23 farmers adopting drip irrigation, it was found that 1 acre of groundnut required an average of 28 kg of KB Drip of lateral thickness of 125 micron with crop spacing of 1.5 ft x 1 ft. A figure of 28 kg of drip per acre of groundnut is considered for the calculations.

Table 4.7 CO_2 Emission reductions – Groundnut

Particulars	2004-05	2005-06	2006-07
Electricity saving per acre per annum (kWh)	536	536	536
kg of KB Drip sold and implemented for the groundnut crop	513	216	446
Number of kg of drip system under operation and abating CO_2 emissions	513	729	1175
Acres of land under groundnut	18	26	42
Total units of electricity saved annually	9820	13955	22493
A factor to account for conservativeness (10%)	8838	12560	20244
Total emission abated (kg CO_2/year)	7159	10173	16397
Tonnes of CO_2 abated per annum	7.1	10.1	16.4

The average increase in yield of the groundnut crop is about 25% and the average energy savings is about 18%. Annually, 616 units of electricity are saved correspondingly.

Due to the hp based tariff system and unsystematic practises of agriculture by large percentages of farmer in the region the energy savings are modest. The true potential of the drip system to save energy is in a way restricted in this region due to more of an institutional implementation of the drip system. The other benefits due to increase in yield are evident already and have contributed to the economic betterment of the beneficiaries in the study region and given the farmers have an indication of the various benefits of implementing the drip system for their crops.

Conclusion

The survey results showed that there is an increase in yield with the adoption of KB Drip. About 76% (Table 5.1) increase in yield was found in the chilli crop and 56% increase in yield was found in cotton crop.

Table 5.1 Details of increase in yield, drip vs flood method

Place	Crop	Yield (Tonnes/acre)		% increase
		Drip	Flood	
Erode	Sugarcane	57.2	48.6	18
	Banana *(Rasthali)*	13.2	9.5	39
Indore Jalgaon	Chilli	1.9	1.1	76
	Cotton	1.4	0.9	56
	Banana *(Sreemanthy)*	25.8	24.5	5
Tumkur	Groundnut	0.68	0.5	36

The farmers said that the benefit from adoption of KB Drip was that there was saving in labour cost, water saving, higher yield, weed growth was under control and less consumption of electricity.

They said that:

a) An additional crop can be grown when a farmer adopts the drip method of irrigation.
b) No extra attention is needed in case of KB Drip. Water supply to the plant is quite automatic and mechanical.
c) Cost of drip (KB) is less compared to other drip systems, in addition a 1 year warranty is provided on KB increasing the credibility of the product.
d) Storage is easy in case of KB Drip. (Can be stored in urea bags).
e) Installation cost is much less compared to other drip systems.
f) Transportation of KB Drips is much more convenient.

Some of the problems mentioned by them were:

- Mud/nutrients at times block the holes of the drip system. The main reason however is non-installation of the filter as recommended by IDEI.
- Due to the light weight of the system, heavy winds do de-align the drip lines, this is to an extent controlled by tying the other end of the drip line.
- The efficiencies of the pumps in the four regions profiled ranged from 20% in Indore to a pump with efficiency of 47% in Tumkur. The pumps in Tumkur were submersible type, used to lift water from bore wells. In the region of Indore mono-block pumps are used to lift the water from open wells. In the regions of Erode and Jalgaon both mono-block and submersible pumps are used.

The performance tests indicated that about 60% of them were functioning below the specification. The low efficiency results in higher consumption of electricity and duration of irrigation which results in loss to both the farmer and the government. Following are some of the key observations made during the performance tests which are responsible for the lowered efficiency:

1) Mismatch of capacity and the load
2) Operational drawbacks
   - The fluctuations in the supply voltage cause damage to the pump parts as there is no voltage regulator connected. This also results in lower performance.
   - Inappropriate handling of pumps such as running of pumps under 2 phase electricity supply (in Erode), providing more winding to have lower current flow (in Indore) etc.
   - The silt present in the ground water often creates clogging in the suction pipes resulting in reduced discharge of water.
3) Factors due to improper usage and lack of knowledge

There is substantial water savings in the usage of KB Drip vis-à-vis flood irrigation. Water saving was found to be 77% (Table 5.2) in banana (Rastahli variety) crop of Erode district and 74% in case of cotton in Jalgaon district.

Table 5.2 Water saving potential, drip vs flood method of irrigation

Type of irrigation	Average hours of operation	Average water consumption	Total quantity of water consumed	Qty of water saved	Saving of water
	(h/ac/yr)	(l/h/ac)	(l/ac/yr)	(l/ac/yr)	(%)
Erode					
Sugarcane					
Drip	304	31347	9529488	8178726	46
Flood	398	44493	17708214	-	-
Banana					
Drip	238	13266	3157308	10732552	77
Flood	430	32302	13889860	-	-
Indore					
Chilli					
Drip	190	20824	3956560	4616900	53
Flood	420	20413	8573460	-	-
Jalgaon					
Banana					
Drip	690	11583	7992270	7508160	48
Flood	935	16578	15500430	-	-
Cotton					
Drip	105	14863	1560615	4459581	74
Flood	298	20202	6020196	-	-

Type of irrigation	Average hours of operation	Average water consumption	Total quantity of water consumed	Qty of water saved	Saving of water
	(h/ac/yr)	(l/h/ac)	(l/ac/yr)	(l/ac/yr)	(%)
Tumkur					
Groundnut					
Drip	550	8115	4463250	1449006	25
Flood	664	8904	5912256	-	-

There is substantial electricity savings with the usage of KB Drip vis-à-vis flood method of irrigation. The electricity savings ranged from 17-65% (Table 5.3) for the various crops in the study area.

Table 5.3 Electricity savings, drip vs flood method of irrigation

Method of irrigation	Average electricity consumption	Average hours of operation	Total electricity consumed	Electricity units saved	Saving of electricity (%)
	(kWh/ac)	(h/ac/yr)	(kWh/ac/yr)	(kWh/ac/yr)	
Erode					
Sugarcane					
Drip	4.4	304	1340	415	45
Flood	4.4	398	1755	-	-
Banana					
Drip	4.4	238	1050	847	24
Flood	4.4	430	1897	-	-
Indore					
Chilli					
Drip	4.8	190	912	1104	54
Flood	4.8	420	2016	-	-
Jalgaon					
Banana					
Drip	4.6	695	3179	1104	26
Flood	4.6	935	4301	-	-
Cotton					
Drip	4.6	105	483	887	65
Flood	4.6	298	1370	-	-
Tumkur					
Groundnut					
Drip	4.7	550	2585	536	17
Flood	4.7	664	3120	-	-

CEA, the database indicates that for every unit of electricity saved, the emission factor for the southern grid is estimated at 0.86 kg CO_2 and every unit of electricity saved for the western grid would abate 0.81 kg of CO_2.

The annual CO_2 emission abatement for every acre of KB Drip adoption for sugarcane crop would be 357 kg/acre/year (Table 5.4). The details for the other crops are given in table 5.4.

Table 5.4 CO_2 Emission reduction

Method of irrigation	Electricity units saved (kWh/ac/yr)	Emission factor (kg CO_2/kWh)	kg CO_2 emission abated/acre/year
Erode			
Sugarcane			
Drip	415	0.86	357
Banana			
Drip	847	0.86	728
Indore			
Chilli			
Drip	1104	0.81	894
Jalgaon			
Banana			
Drip	1104	0.81	894
Cotton			
Drip	887	0.81	718
Tumkur			
Groundnut			
Drip	536	0.86	461

There is tremendous potential to introduce energy saving technology like the KB Drip. The number of pump sets installed in India was 12.82 million in the year 2001 (Annexure 5.1) and it is ever increasing. The electricity consumption for agriculture purpose was 129700 GWh in the year 2004-2005. (Annexure 5.2).

Annexure

Villages covered under the study

Sl.No.	Village	Taluka	District	Distance from headquarters (km)
	Tamil Nadu			
1	Veralupatti	Aravalukuchi	Karuru	36
2	Pallanatham	Vedasandur	Dindigul	40
3	Soladasanapatti	Aravalukuchi	Karuru	40
4	Sethamangalam	Aravalukuchi	Karuru	15
5	Rakiavalasu	Erode	Erode	20
6	Kollagoil	Erode	Erode	25
7	Karavalasu	Erode	Erode	20
8	Anjur	Erode	Erode	10
9	Papam Palyam	Tirichigodu	Namakkal	35
10	Lakshmipuram	Erode	Erode	12
11	Vattur	Tirichigodu	Namakal	70
12	M Hanumana halli	Erode	Erode	18
13	Sanyan patti	Sagagiri	Salem	18
14	Veralupathi	Aravalukuchi	Karur	20
15	Ammanapati	Aravalukuchi	Karur	22
16	Kamakapatti	Aravalukuchi	Karur	86
17	Jangal Patti	Aravalukuchi	Karur	82
18	Kurikaranvalasu	Aravalukuchi	Karur	90
19	Sanyasipatti	Sagagiri	Salem	92
20	Kovil Palyam	Erode	Erode	78
21	M Hanuman Palli	Erode	Erode	78
22	T Pudupalyam	Thirchanagodu	Namakkal	92
23	Vattur	Thirchanagodu	Namakkal	38
24	Saniyasi Patti	Sagagiri	Salem	44
25	Palamangalam	Erode	Erode	40
26	Kanda Swami Palyam	Erode	Erode	32
27	Sivagiri	Erode	Erode	110
28	Pappam Palyam	Tirichigodu	Namakkal	36
29	Putur	Bhavani	Erode	40
30	P K Putur	Bhavani	Erode	40
31	Velithirupur	Bhavani	Erode	15
32	Channambapatti	Bhavani	Erode	20

Sl.No.	Village	Taluka	District	Distance from headquarters (km)
33	Sanampatti	Bhavani	Erode	25
34	Kollagoil	Erode	Erode	20
	Madhya Pradesh			
35	Bhangardha	Badhwa	Khargaoun	70
36	Dhangaoun	Khandwa	Khandwa	75
37	Khangada	Badhwa	Khargoun	75
38	Jamli	Khargoun	Khargaoun	90
	Maharashtra			
39	Ambilhole	Jamner	Jalgaon	63
40	Bhagdara	Jamner	Jalgaon	50
41	Gondakhal	Jamner	Jalgaon	62
42	Jamner	Jamner	Jalgaon	48
43	Kekathibhora	Jamner	Jalgoan	41
44	Karmad	Jamner	Jalgaon	33
45	Malkeda	Jamner	Jalgaon	69
46	Nagan Chowki	Jamner	Jalgaon	58
47	Pahur	Jamner	Jalgaon	54
48	Palasakheda	Jamner	Jalgaon	45
49	Paldhi	Jamner	Jalgaon	49
50	Samrod	Jamner	Jalgaon	60
51	Sonala	Jamner	Jalgaon	66
52	Sunasgaon	Jamner	Jalgaon	48
53	Shendurni	Jamner	Jalgaon	64
54	Raipur	Raver	Jalgaon	90
	Karnataka			
55	Ajanahalli	Kortagere	Tumkur	34
56	Kabigere	Kortagere	Tumkur	33
57	Golarahalli	Kortegere	Tumkur	33
58	Chikarrasanahalli	Kortegere	Tumkur	35
59	MaratiPalya	Kortegere	Tumkur	34
60	Chikkanhalli	Kortegere	Tumkur	32
61	Tovankere	Kortegere	Tumkur	36

Location of Study Area

Annex **1.3**

Questionnaire for feedback from farmers on the device of drip irrigation

Project: "Socio-economic-techno-environmental assessment of IDEI products (Low cost KB Drip)

The Energy and Resources Institute
No 7117, 4th Main, 2nd Cross
Domlur 2nd stage, Bangalore – 560 071

A. (General Information)

1. Name of the person: ______________________________

2. Details of location:

Village	Taluka/Block	District	State

3. Family size:

Men	
Women	
Children	

4. Primary occupation:
   Agriculture ☐
   Non-agriculture ☐
   If Non Agriculture, specify ____________________

5. Secondary occupation:
   Agriculture ☐
   Non-agriculture ☐
   If Non-agriculture, specify ____________________

B. (Details of Land)

Land details	Area (acre)	Remarks
Total land owned		
Land under cultivation		
Land under irrigation		
Under drip		
Under flood		
Any other , specify		

C. (Details of the System)

6. Date of installation ____________________________

7. Type of the drip irrigation________________________

8. How many kg of pipe installed per acre__________________________

9. Cost of pipe per kg_____________________

10. Cost of drip irrigation installation:
KB Drip system ______________ per acre
System cost ______________ per acre
(including laterals etc.)

11. Total cost of repair:
Per month ____________________
Per annum ____________________

12. Type of problems occurred:
(a) ______________
(b) ______________
(c) ______________

13. Number of times of occurrences of the above problem:____________per annum

14. Repaired by local technicians: Yes ☐ No ☐

15. Is spare part available locally: Yes ☐ No ☐
If no, where is it available __________

D. (Service Details)

16. Make of the system____________________

17. Name the dealer supplied_______________________

18. Location of the dealer ___________________________

19 Warranty period_____________________

20. How is after sales service of the above product__________________

E. (Subsidy)

21. Whether subsidy is available for the product: Yes ☐ No ☐
if yes how much Rs. ________per acre

G. (Details of Cropping Pattern on Irrigated Land)

22. Whether shift from dry land to drip irrigated land: Yes ☐ No ☐

23. Whether shift from flood to drip irrigated land: Yes ☐ No ☐

Production Details- Drip Irrigation

Sl. No.	Name of the crop	Acreage	Production/ acre	Crop residue/acre	Price/unit
Kharif					
Rabi					
Summer					

H. Operation of drip for the particular crop

Cotton ☐ Sugarcane ☐ Vegetable ☐ Specify-

24. Number of hrs of operation per day: Rainy_____ Summer______ Winter______

25. Number of days operated per week: Rainy_____ Summer______ Winter_____

26. Number of days operated per month: Rainy_____ Summer______ Winter_____

27. Total days of operation per season:

Rainy…………Summer…………Winter…………..

I. (Details of cropping pattern on previously non-irrigated land)

Sl. No.	Name of the crop	Acreage	Production/acre	Crop residue/acre	Price/unit
Kharif					
Rabi					
Summer					

J. (Benefits)

28. What are the benefits received after implementation of drip irrigation system?
    (a) ______________________
    (b) ______________________
    (c) ______________________

29. How much water saving has been achieved after drip irrigation?_________%

30. Is there any increase in the area under irrigation after installation of drip system? If yes, how much?

31. What is the pay back period, has the return on investment been received?

32. Other perceptions (probe)________

Questionnaire for feedback from farmers on the device of flood irrigation

Project: "Socio-economic-techno-environmental assessment of IDEI products (Low cost KB Drip)

The Energy and Resources Institute
No 7117, 4th Main, 2nd Cross
Domlur 2nd stage, Bangalore – 560 071

A. (General Information)

1. Name of the person: ____

2. Details of location:

Village	Taluka/Block	District	State

3. Family size:

Men	
Women	
Children	

4. Primary occupation:
   Agriculture ☐
   Non-agriculture ☐
   If Non Agriculture, specify ____________________________

5. Secondary occupation:
   Agriculture ☐
   Non-agriculture ☐
   If Non-agriculture, specify ________________________________

B. (Details of Land)

Land details	Area (acre)	Remarks
Total land owned		
Land under cultivation		
Land under irrigation		
Under drip		
Under flood		
Any other , specify		

C. (Subsidy)

6. Whether subsidy is available for the product (pumpset): Yes ☐ No ☐
If yes how much Rs. ________per acre

D. (Details of Crop with Flood)

Sl. No.	Name of the crop	Acreage	Production/ acre/year	Production of crop residues/ acre/crop	Price/unit
Kharif					
Rabi					
Summer					

E. Details of Operation for Irrigation under Flood for the Particular Crop
Cotton ☐ Sugarcane ☐ Vegetable ☐ Specify-

7. Number of hrs of operation per day: Rainy______Summer______ Winter______

8. Number of days operated per week: Rainy______Summer_____ Winter______

9. Number of days operated per month: Rainy______Summer______ Winter_____

10. Total days of operation per season:
Rainy…………Summer…………Winter…………..

F. (Details of Cropping Pattern Prior to Flood)
11. Whether shift from dry land to flood irrigated land: Yes ☐ No ☐

Table 3-Details of crops grown prior to flood

Sl. No.	Name of the crop	Acreage	Production/ acre/year	Production of crop residues/ acre/crop	Price/unit
Kharif					
Rabi					
Summer					

G. (Benefits)

12. What are the benefits received after implementation of flood irrigation system?
    (a) ____________________
    (b) ____________________
    (c) ____________________

13. Is there any increase in the area under irrigation after installation of flood system? If yes, how much?

14. What is the pay back period, has the return on investment been received?

15. Other perceptions (probe)

Checklist for technical assessment

Sl. No.						
1	Code					
2	Name					
3	Address					

Sl. No.						
4	**Details of plot**					
	Category	**Unit**	**Value**			
a	Plot area	ft				
b	Area	acre				
c	Number of plants	Nos				
d	Number of plots	Nos				
e	Plants per plot	Nos				
5	**Number of pumps**					
	Pump 1			Pump 2		
	Category	**Unit**	**Value**	**Category**	**Unit**	**Value**
a	Type			Type		
b	Name			Name		
c	Rating	hp		Rating	hp	
d	Age	Year		Age	Year	
	Details of well			Details of well		
e	Type			Type		
f	Distance	ft		Distance	ft	
g	Suction	ft		Suction	ft	
h	Delivery	ft		Delivery	ft	
i	Total depth	ft		Total depth	ft	
6	**3 phase electricity metre reading**					
	Phase	kW				
	R					
	Y					
	B					
	Avearge					
7	**Water discharge calculation**					
	Water discharge (at source)					
	Trial	Time (min)	Qty of water (l)	Discharge rate (l/h)		
	1					
	2					
	3					
	Average					
	Water discharge (at delivery)					
	Trial					
	1					
	2					
	3					
	Average					

Sl. No.						
	Water discharge (in drip method of irrigation)					
	Trial	Time (min)	Qty of water (l)	Discharge rate (l/h)		
	1					
	2					
	3					
	Average					
8	**Efficiency of pump**					
	Energy input	kWh				
	Energy output	kWh				
	Efficiency	%				

Electric pumps used in technical evaluation

Sl. No.	Name of the owner of pump	Village	District	State	Horse Power (BHP)	Make of the system	Age of the system (Yr)
1	Palaniswamy	Sirigiri	Erode	Tamil Nadu	5	Texmo	4
2	Murugeshan	Sangetha palyam	Salem	Tamil Nadu	7.5	Singari	7
3	Ramaraju	Soladasanapetti	Karur	Tamil Nadu	5	Texmo	2
4	Subramanian V S	Sirigiri	Erode	Tamil Nadu	5	Texmo	5
5	Mahalingam	Sirigiri	Erode	Tamil Nadu	5	RAE	20
6	Balakrishnan	Jangalpetti	Karur	Tamil Nadu	5	Suguna	25
7	Ramaraju	Soladasanapetti	Karur	Tamil Nadu	5	Decon	2
8	Subramanian V S	Sirigiri	Erode	Tamil Nadu	5	Texmo	5
9	Palaniswamy	Sirigiri	Erode	Tamil Nadu	5	Texmo	4
10	Chinnaswamy	Chennampatti	Erode	Tamil Nadu	5	Texmo	32
11	Saniappa Gowder	Chennampatti	Erode	Tamil Nadu	7.5	Texmo	4
12	Palaniswamy	Chennampatti	Erode	Tamil Nadu	7.5	Texmo	3
13	Gopal	Jarathal	Erode	Tamil Nadu	5	Suguna	5
14	K P Krishnamurthy	Kollagoil	Erode	Tamil Nadu	5	Texmo	10
15	Rajendra	Chennampatti	Erode	Tamil Nadu	5	Suguna	2
16	Dilip patil	Malkheda	Jalgaon	Maharashtra	5	Texmo	35
17	Pandurang Sonji Patil	Palaskheda	Jalgaon	Maharashtra	7.5	Texmo	
18	Hari kundli mali	Shendurni	Jalgaon	Maharashtra	5	Texmo	12
19	Purushottam patil	Jamner	Jalgaon	Maharashtra	7.5	Lubi	4
20	Vinod Naik	Malkheda	Jalgaon	Maharashtra	3	Megha	2
21	Atmaram Mahajan	Jamner	Jalgaon	Maharashtra	5	Texmo	35
22	Suresh Patil	Jamner	Jalgaon	Maharashtra	5	RBC	8
23	Prakash patil	Palaskheda	Jalgaon	Maharashtra	5	Everest	15
24	Chagan shyamarao Zalte	Jamner	Jalgaon	Maharashtra	5	Texmo	10
25	Mahrao Pankaj Naik	Malkheda	Jalgaon	Maharashtra	5	Texmo	8
26	Vasant Dange	Samrod	Jalgaon	Maharashtra	5	Texmo	22
27	Kashinath Patil	Palaskheda	Jalgaon	Maharashtra	3	CRI	10
28	Vasanth Krishna Mahajan	Jamner	Jalgaon	Maharashtra	5	Texmo	4
29	Yuvaraj Chowdary	Jamner	Jalgaon	Maharashtra	7.5	Texmo	35
30	Rajaram Omkar Patil	Samrod	Jalgaon	Maharashtra	7.5	ACI	10
31	Jaweregowda	Kabbigere	Korategere	Karnataka	7.5		2
32	Sridevi	Kabbigere	Korategere	Karnataka	7.5		2

Sl. No.	Name of the owner of pump	Village	District	State	Horse Power (BHP)	Make of the system	Age of the system (Yr)
33	Mudalgiriayappa	Kabbigere	Korategere	Karnataka	4		3
34	Narasappa	Kabbigere	Korategere	Karnataka	4		3
35	Basavaraju	Chikkarasanahalli	Korategere	Karnataka	3		3
36	Jaweregowda	Kabigere	Korategere	Karnataka	7.5	Silver	3
37	Mahalingappa	Anjenahalli	Korategere	Karnataka	5		3
38	Siddganangaiah	Surenhalli	Korategere	Karnataka	7.5		6
39	Thimmegowda	Chikkannahalli	Korategere	Karnataka	6		5
40	Chandrashekar	Kabigere	Korategere	Karnataka	5		10
41	Rakesh Dhulichand Challatra	Bangardha	Kargaoun	MP	5		
42	Mahesh				5		
43	Shyamlal				5		
44	Premlal				5		
45	Natulilal				3		
46	Ramesh				3		
47	Siyaram				5		
48	Misri lal				5		
49	Revaram				3		
50	Ramu				3		

Performance results of electric pumps

Sl. No.	Pump code	Name of the owner	Power input (kW)	Water discharge (l/h)	Head (m)	Power output (kW)	Efficiency (%)
Tamil Nadu							
1	Er-Sg-Fl-01	Palaniswamy	4.0	38317	18	1.90	47
2	Er-Sg-Fl-02	Murugeshan	5.5	53471	21	3.10	57
3	Er-Sg-Fl-03	Ramaraju	5.7	27200	18	1.36	24
4	Er-Sg-Fl-04	Subramanian V S	3.7	45638	18	2.27	61
5	Er-Sg-Dp-01	Mahalingam	1.9	22700	21	1.28	44
6	Er-Sg-Dp-02	Balakrishnan	3.7	31340	12	1.04	28
7	Er-Sg-Dp-03	Ramaraju	5.7	27200	18	1.36	24
8	Er-Sg-Dp-04	Subramanian V S	3.7	45638	18	2.27	61
9	Er-Sg-Dp-05	Palaniswamy	4.0	38317	18	1.90	47
10	Er-Bn-Fl-01	Chinnaswamy	2.4	21075	21	1.22	51
11	Er-Bn-Fl-02	Saniappa Gowder	5.9	36678	23	2.28	39
12	Er-Bn-Fl-03	Palaniswamy	5.9	40484	12	1.35	23
13	Er-Bn-Dp-01	Gopal	4.9	21270	11	0.62	14
14	Er-Bn-Dp-02	K P Krishnamurthy	3.2	33430	17	1.51	48
15	Er-Bn-Dp-03	Rajendra	5.9	24090	20	1.30	22
		Average	4.4	33790			39
Maharashtra							
16	Jg-Ct-dr-01	Dilip patil	3.1	22170	11	0.64	21
17	Jg-Ct-dr-02	Pandurang Sonji Patil	5.4	5631	134	2.06	38
18	Jg-Ct-dr-03	Hari kundli mali	2.2	17868	15	0.71	33
19	Jg-Ct-dr-04	Purushottam patil	5.2	51438	3	0.38	7
20	Jg-Ct-dr-05	Vinod Naik	5.0	23943	18	1.19	24
21	Jg-Ct-fl-01	Atmaram Mahajan	2.8	29132	15	1.21	44
22	Jg-Ct-fl-02	Suresh Patil	3.6	25712	14	0.96	27
23	Jg-Ct-fl-03	Prakash patil	2.4	21416	5	0.27	11
24	Jg-Ct-fl-04	Chagan shyamarao Zalte	4.1	25732	16	1.11	27
25	Jg-Ct-fl-05	Mahrao Pankaj Naik	4.6	15279	11	0.44	10
26	Jg-Bn-Dr-01	Vasant Dange	3.4	13258	30	1.10	32
27	Jg-Bn-Dr-02	Kashinath Patil	3.4	18048	15	0.75	22
28	Jg-Bn-Dr-03	Vasanth Krishna Mahajan	7.9	10342	137	3.87	49
29	Jg-Bn-fl-01	Yuvaraj Chowdary	8.8	10833	107	3.15	36

Sl. No.	Pump code	Name of the owner	Power input (kW)	Water discharge (l/h)	Head (m)	Power output (kW)	Efficiency (%)
30	Jg-Bn-fl-02	Rajaram Omkar Patil	7.3	20840	13	0.73	10
		Average	4.6	20776			26
Karnataka							
31	Tu-Gn-Fl-01	Jaweregowda	5.0	10463	67	1.91	38
32	Tu-Gn-Fl-02	Mahalingappa	5.1	17228	49	2.29	45
33	Tu-Gn-Fl-03	Siddganangaiah	4.4	5263	95	1.36	31
34	Tu-Gn-Fl-04	Thimmegowda	3.3	17840	36	1.77	55
35	Tu-Gn-Fl-05	Chandrashekar	5.0	4129	58	0.65	13
36	Tu-Gn-Dr-01	Jaweregowda	5.8	16156	61	2.67	46
37	Tu-Gn-Dr-02	Sridevi	3.6	16157	61	2.67	75
38	Tu-Gn-Dr-03	Mudalgiriayappa	6.0	9600	76	1.99	33
39	Tu-Gn-Dr-04	Narasappa	3.8	9600	76	1.99	53
40	Tu-Gn-Dr-05	Basavaraju	4.4	5829	80	1.27	29
41	Tu-Gn-Dr-06	Rajanna	8.1	22033	110	6.60	81
42	Tu-Gn-Dr-07	Gangananna	2.5	7496	85	1.73	69
		Average	4.7	11816	47		
Madhya Pradesh							
43	In-Ch-Fl-01	Ramesh	5.0	26195	11	0.78	16
44	In-Ch-Fl-02	Siyaram	7.0	17793	14	0.68	10
45	In-Ch-Fl-03	Misrilal	4.4	29556	11	0.89	20
46	In-Ch-Fl-04	Revaram	3.3	28983	13	1.03	32
47	In-Ch-Fl-05	Ramu	5.0	20823	11	0.62	12
48	In-Ch-Dr-01	Rakesh	5.8	26562	11	0.80	14
49	In-Ch-Dr-02	Mahesh	3.6	22858	12	0.75	21
50	In-Ch-Dr-03	Shyamlal	6.0	42638	11	1.28	21
51	In-Ch-Dr-04	Premlal	3.8	32380	13	1.15	30
52	In-Ch-Dr-05	Natulilal	4.4	33705	11	1.01	23
		Average	4.8	28149	20		

Details of hours of irrigation in Erode region

Month	Season	Sugarcane (hours, days per week)		Banana (hours, days per week)	
		Drip	Flood	Drip	Flood
January	Summer	1, 6.5 days a week	6 hours, thrice a week	1 hour, 6 days a week	6 hours, 3 days a week
February	Summer	1 hour, 6.5 days a week	6 hours, thrice a week	1 hour, 6 days a week	6 hours, 3 days a week
March	Summer	1 hour, 6.5 days a week	6 hours, thrice a week	1 hour, 6 days a week	6 hours, 3 days a week
April	Summer	1 hour, 6.5 days a week	6 hours, thrice a week	1 hour, 6 days a week	6 hours, 3 days a week
May	Summer	1 hour, 6.5 days a week	6 hours, thrice a week	1 hour, 6 days a week	6 hours, 3 days a week
June	Rainy	½ hour, twice a week	15 days, once a week	½ hour, twice a week	3 hours, 7 days once
July	Rainy	½ hour, twice a week	15 days, once a week	½ hour, twice a week	3 hours, 7 days once
August	Rainy	½ hour, twice a week	15 days, once a week	½ hour, twice a week	3 hours, 7 days once
September	Winter	1 hour, 6 days a week	4.5 hours, twice a week	1 hour, 5 days a week	5 hours, 2 days a week
October	Winter	1 hour, 6 days a week	4.5 hours, twice a week	1 hour, 5 days a week	5 hours, 2 days a week
November	Winter	1 hour, 6 days a week	4.5 hours, twice a week	1 hour, 5 days a week	5 hours, 2 days a week
December	Winter	1 hour, 6 days a week	4.5 hours, twice a week	1 hour, 5 days a week	5 hours, 2 days a week

Region-wise installed capacity as of 31-03-2007

Region	Hydro	Thermal				Nuclear	Renewable	Total
		Coal	Gas	Diesel	Total			
Northern	13,000.38	18,027.50	3,323.19	14.99	21,365.68	1,180.00	813.37	36,359.43
Western	6,918.83	22,441.50	5,820.72	17.48	28,279.70	1,840.00	1,874.76	38,913.29
Southern	11,011.71	16,172.50	3,586.30	939.32	20,698.12	880	4,971.55	37,561.38
Eastern	2,496.53	14,149.88	190	17.2	14,357.08	0	46.76	16900.37
N. Eastern	1221.07	330	771.5	142.74	1,244.24	0	48.91	2,514.22
Islands	5.25	0.00	0.00	70.02	70.02	0	5.25	80.52
All India	**34,653.77**	**71,121.38**	**13,691.71**	**1,201.75**	**86,014.84**	**3,900.00**	**7,760.60**	**132,329.21**

Geographical scope of the five regional electricity grids

Northern	Western	Southern	Eastern	North-Eastern
Chandigarh	Chhattisgarh	Andhra Pradesh	Bihar	Arunachal Pradesh
Delhi	Gujarat	Karnataka	Jharkhand	Assam
Haryana	Daman & Diu	Kerala	Orissa	Manipur
Himachal Pradesh	Dadar & Nagar	Tamil Nadu	West Bengal	Meghalaya
Jammu & Kashmir	Haveli	Pondicherry	Sikkim	Mizoram
Punjab	Madhya Pradesh	Lakshadweep	Andaman- Nicobar	Nagaland
Rajasthan	Maharashtra		Nicobar	Tripura
Uttar Pradesh	Goa			
Uttaranchal				

State-wise number of energised pumpsets/tubewells in India

(As of 31st March,1998 and 2001)

States	Estimated pumpsets potential# ('000)	As of 31st March	
		1998	2001
Andhra Pradesh	1981	1824689	1924543
Arunachal Pradesh	1.2	-	-
Assam	254	3675	3675
Bihar	1352.2	270277	274911
Gujarat	779.8	617495	694163
Goa	7.8	6454	6867
Haryana	470.8	409404	420472
Himachal Pradesh	14.2	5098	6167
Jammu & Kashmir	67.2	5621	5621
Karnataka	1357	1082150	1263859
Kerala	435.6	329355	392295
Madhya Pradesh	2773.6	1229016	1236737
Chhattisgarh	-	-	73984
Maharashtra	2449.8	2151191	2327716
Manipur	37.6	45	45
Meghalaya	14.2	65	65
Mizoram	-	-	-
Nagaland	10	176	176
Orissa	1214	72047	74625
Punjab	751	735162	777854
Rajasthan	630.6	565068	639131
Sikkim	5	-	-
Tamil Nadu	1662.6	1609242	1723778
Tripura	14.8	1764	2094
Uttar Pradesh	2610	790157	808238
Uttaranchal	-	-	17524
West Bengal	650	104383	110793
Total (States)	19544	11812534	12785330
Total (UTs)	50	36872	38150
India	19594	11849406	12823480

Note# : Effected from Oct. 95.
Source : Compendium of Power Statistics 2001 & 2002, Madhya Pradesh State Electricity Board

Region/State-wise forecast of electrical energy consumption

(Utilities only) for irrigation category in India)

(2004-2005)	
States/UTs	Estimated Consumption (GWh)
Haryana	5753.64
Himachal Pradesh	11.51
Jammu & Kashmir	226.3
Punjab	7338.1
Rajasthan	8147.21
Uttar Pradesh	12366.01
Uttaranchal	1240.1
Chandigarh	3.01
Delhi	64.1
Sub-Total (NR)	35150.28
Gujarat	15316.12
Madhya Pradesh	10027.5
Chhattisgarh	1795.9
Maharashtra	21224.96
Goa	20.98
Dadra & Nagar Haveli	0.58
Daman & Diu	1.58
Sub-Total (WR)	48387.62
Andhra Pradesh	15409.6
Karnataka	16432.41
Kerala	572.95

(2004-2005)	
States/UTs	Estimated Consumption (GWh)
Tamil Nadu	8795.82
Lakshadweep	0
Pondicherry	120.25
Sub-Total (SR)	41331.03
Bihar	1527.54
Jharkhand	87.36
Orissa	614.47
West Bengal	2418.34
Andaman & Nicobar Islands	0
Sikkim	0
Sub-Total (ER)	4647.71
Assam	64.96
Manipur	0
Meghalaya	1.5
Nagaland	0
Tripura	116.48
Arunachal Pradesh	0
Mizoram	0
Sub-Total (NER)	183
India	129700

Source : Rajya Sabha Unstarred Question No. 3125, dated 15.05.2006.

Erode, Tamil Nadu

Photo-1: Banana crop grown by using KB Drip in Erode, Tamil Nadu

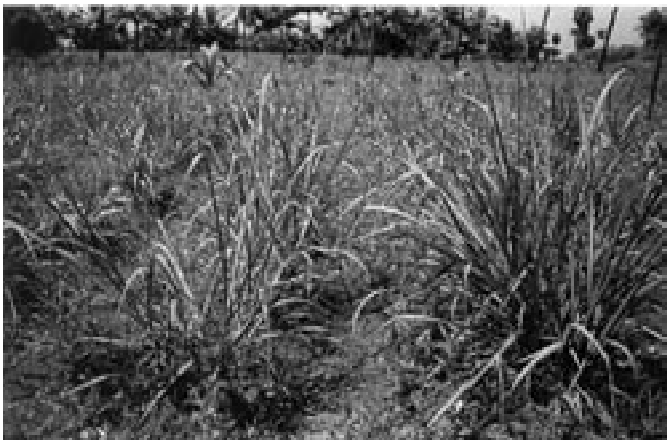


Photo-2: Sugar cane crop grown by using KB Drip in Erode, Tamil Nadu

Photo-3: Discussions with drip dealer in Erode, Tamil Nadu

Photo-4: Discussion with farmers in Erode, Tamil Nadu

Photo-5: Measurement of Input power during technical evaluation in Erode, Tamil Nadu

Photo-6: Technical evaluation of water discharge at source in Erode, Tamil Nadu

Tumkur, Karnataka

Photo 1. Measurement of Water discharge from drip mains in Tumkur, Karnataka

Photo 2. Measurement of Water discharge by flood method at Tumkur, Karnataka

Photo 3. Water measurement during technical evaluation of drip system in Tumkur, Karnataka

Photo 4. Technical evaluation of drip system in Tumkur, Karantaka

Photo 5. Electric input measurement carried in Tumkur, Karnataka

Photo 6. Focus group discussion with farmers in Tumkur, Karnataka

Indore, Madhya Pradesh

Photo 1. Chilly crop grown under drip system in Indore, Madhya Pradesh

Photo 2. Technical evaluation of water discharge of drip system in Indore, Madhya Pradesh

Photo 3. Wetting measurement at root zone under drip system in Indore, Madhya Pradesh

Photo 4. Technical evaluation of water discharge from open well to drip system in Indore, Madhya Pradesh

Photo 5. Focus group discussion with the Chilly growing farmers under drip system in Indore, Madhya Pradesh

Photo 6. Discussion with farmers growing chilly under drip system in Indore, Madhya Pradesh

Jalgaon, Maharashtra

Photo 1. Cotton crop grown under drip system in Jamner, Maharashtra

Photo 2. Banana plot in Jamner, Maharashtra

Photo 3. Technical Evaluation for drip system in Jamaner, Maharashtra

Photo 4. Technical evaluation of water disharge from open well to drip system in Jamaner, Maharashtra

Photo 5. discussion with the Cotton growning farmers under drip system in Jamaner, Maharashtra

Photo 6. Discussion with dealers of drip system in Jamaner, Maharashtra

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