



REPORT OF TASK FORCE ON MICROIRRIGATION

N. Chandrababu Naidu
Chairman



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N. Chandrababu Naidu,
Chairman

H.P. Singh
Member Secretary

Government of India, Ministry of Agriculture,
Department of Agriculture & Cooperation, New Delhi.

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PREFACE

Indian Agriculture, accounting for 25 per cent of the nation's Gross Domestic Product (GDP), 15 per cent of exports and 60 per cent of the employment, continues to be the mainstay of the economy. Having achieved laudable success in agricultural production in the last 50 years, India has transformed herself from a food deficit to a food surplus country. But, there are many challenges which Indian agriculture is facing in the fast changing scenarios. Relating to the natural resources and production base, water has emerged as the most crucial factor for sustaining the agricultural sector.

India accounts for 16 per cent of the world's human population and nearly 30 per cent of the cattle with only 2.4 per cent of the land and 4 per cent of the water resources. Even if the full irrigation potential is exploited, about 50 per cent of the country's cultivated area will remain unirrigated, particularly with current level of irrigation efficiency. The share of water for agriculture would reduce further with increasing demand from other sectors. But the demand for water for agricultural purposes is estimated to increase to produce increasing quantities of food, horticultural produce and raw material for the industry. Efficient management of water is, therefore, key to future growth of Indian agriculture.

Past interventions for development of irrigation, often due to misplaced and inappropriate policies, have led to indiscriminate use of water and have only helped to create a system, which could cater to the needs of sub-optimal production. Besides, serious agro-ecological and sustainability problems have emerged due to the lack of appropriate technologies, poor technology transfer mechanisms and inadequate institutional support systems. While the water table rise and water logging along with secondary salinization is the problem in canal command areas, receding water table along with ground water pollution in many States are the daunting problems in tube well irrigated areas. The water use efficiency (WUE) in Indian agriculture, at about 30-40 per cent, is one of the lowest in the world, against 55 per cent in China. This requires paradigm shift in conservation and in agriculture policies, which should lead to saving of water, fertilizer and energy resulting in crop diversification and equitable distribution of resources.



The Government of India has played a catalytic role in promotion of efficient management of water through the use of modern methods of irrigation, leading to a coverage of 0.5 million ha under drip and 0.7 million ha under sprinkler irrigation. Recognizing the need for efficient use of water and the necessity for increasing the water use efficiency, the Government of India constituted the Task Force on Microirrigation to seek guidance on improved technologies, appropriate policy interventions and strategic institutional supports.

The Task Force had wide consultations and in-depth deliberations, including 4 meetings, State level consultations, and suggestions from the public through the electronic media, before coming out with its recommendations, which hopefully are both practical and implementable. Recognising the vast potential of coverage under microirrigation to the tune of 69 million ha and its role in enhancing productivity, diversification and sustainability, the Task Force underscored the need for synergistic blend of technology and policy, particularly, reduction in taxes levied on microirrigation systems, easy availability of credit through financial institutions and building of a strong institutional support for overseeing the development of sector. The Task Force sees that a target of 3.00 M.ha under microirrigation (2 M.ha) under drip and 1 M.ha under sprinkler) is a distinct possibility during the Tenth Five Year Plan period with the hope to cover the potential area by the year 2030.

I, as the Chairman of the Task Force would like to thank all the Members for their active participation. I am also thankful to all the States for their cooperation. I am grateful to Shri R.C.A. Jain, Secretary (A&C), Department of Agriculture & Cooperation for providing the support of the Department and also for providing inputs for the report. My thanks are also due to Dr. H.P. Singh, Member Secretary, for his commitment and hard work in convening the meetings, preparing draft reports and providing technical support.

I am sure, the Government would give serious consideration to operationalize the recommendations, which will go a long way in the furtherance of the Indian Agriculture and livelihood security.

(N. CHANDRABABU NAIDU)





ACRONYMS

A&C	- Agriculture and Cooperation	GNP	- Gross National Product
AFC	- Agricultural Finance Corporation	GoAP	- Government of Andhra Pradesh
AP	- Andhra Pradesh	Gol	- Government of India
APMIP	- Andhra Pradesh Micro Irrigation Project	gph	- Gallons per Hour
ASAE	- American Society of Agricultural Engineers	ha	- Hectare
B	- Boron	HDPE	- High Density Polyethylene
BCM	- Billion Cubic Meter	HP	- Horse Power
BCR	- Benefit Cost Ratio	HR	- Hour
BIS	- Bureau of Indian Standards	HYV	- High Yielding Varieties
CBIP	- Central Board of Irrigation and Power	ICAR	- Indian Council of Agricultural Research
CIPET	- Central Institute of Plasticulture Engineering Technology	ID	- Internal Diameter
CVD	- Countervailing Duty	IDE	- International Development Enterprises
DAC	- Department of Agriculture and Cooperation	INCID	- Indian National Committee on Irrigation and Drainage
DCPC	- Department of Chemicals and Petrochemicals	IPCL	- Indian Petrochemicals Corporation Ltd
DI	- Drip Irrigation	ISO	- International Organisation for Standardisation
DIS	- Drip Irrigation Systems	JISL	- Jain Irrigation Systems Ltd
DIT	- Drip Irrigation Technology	kg/ha	- Kilograms per Hectare
DPAP	- Drought Prone Area Programme	km ³	- Cubic Kilo Meter
dS/m	- deci Simon per meter (unit of Electrical Conductivity)	kW	- Kilowatt
EC	- Electrical Conductivity	kWhr	- Kilowatt Hour
FAD	- Food and Agriculture Division	LDPE	- Low Density Polyethylene
GDP	- Gross Domestic Product	LEPA	- Low Energy Precision Application
GI	- Galvanised Iron	LLDPE	- Linear Low Density Polyethylene
		lph	- Litres per Hour



lps	- litres per second	R&D	- Research and Development
M ha m	- Million Hectare meter	RBI	- Reserve Bank of India
M	- Million	RIDF	- Rural Infrastructure Development Fund
m/sec	- Meter per Second	Rs.	- Rupees
m ³	- Cubic Meter	SAD	- Special Additional Duty
M ha	- Million Hectare	SAU	- State Agricultural University
MI	- Microirrigation	SBI	- State Bank of India
MIS	- Microirrigation Systems	SC	- Scheduled Castes
MITs	- Microirrigation Technologies	SDF	- Sugar Development Fund
mm	- millimeter	SFDA	- Small Farmers Development Agency
MoA&C	- Ministry of Agriculture and Cooperation	SI	- Sprinkler Irrigation
MT	- Metric Tonne	SIT	- Sprinkler Irrigation Technology
NABARD	- National Bank for Agricultural and Rural Development	sq. m.	- Square meter
NCPA	- National Committee on use of Plastics in Agriculture	ST	- Scheduled Tribes
NCPAH	- National Committee on Plasticulture Applications in Horticulture	t/ha	- Tonnes per Hectare
NCPF	- National Council for Precision Farming	TERI	- Tata Energy Research Institute
NCDC	- National Cooperative Development Corporation	TF	- Task Force
NGO	- Non Governmental Organisation	TFM	- Task Force on Microirrigation
NPW	- Net Present Worth	TOR	- Terms of Reference
NRC	- National Research Centre	UV	- Ultra-Violet
O&M	- Operation and Maintenance	VAT	- Value Added Tax
PDC	- Plasticulture Development Centre	W	- Watt
PFDC	- Precision Farming Development Centre	WALMI	- Water and Land Management Institute
PP	- Poly Propylene	WDF	- Watershed Development Fund
PVC	- Poly Vinyl Chloride	WUA	- Water Users Association
Q/ha	- Quintals per Hectare	WUE	- Water Use Efficiency
QRC	- Quick Release Coupler	%	- Percent





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EXECUTIVE SUMMARY

BACKGROUND

1. Agriculture, a way of life in India, has shaped the thought, outlook and culture of the people for centuries. The agro-climatic condition of the country is suitable for growing a variety of crops, which are found in most parts of the world. Agriculture will continue to be the engine of country's growth and development. Besides being the backbone of the national and household food and livelihood securities of over 650 million people, agriculture sector accounts for 25 per cent of the nation's Gross Domestic Product (GDP), 15 per cent of the export and employs about 60 per cent of the workforce.
2. Resource-wise, the country accounts for 16 per cent of the world's human population and nearly 30 per cent of the cattle with only 2.4 per cent of the land and 4 per cent of the water resources. The total surface water availability of the country is estimated to be 1953 Billion Cubic Metres (BCM) of which only about 690 BCM is utilizable. Similarly, the replenishable ground water availability is to the tune of 432 BCM of which only 342 BCM is utilizable. Even if the full potential is exploited, about 50 per cent of the cultivated area will remain under rainfed agriculture. Water is the life-blood of agriculture and it consumes over 80 per cent of the fresh water resources. Judicious exploitation and management of water, therefore, holds the key for the future growth of Indian agriculture.
3. As widely recognized, the Green Revolution was ushered in and nurtured by the integrated seed-water (irrigation)–fertilizer technology. In congruence with the spread of the HYV seeds, irrigation percentage in the country increased from less than 20% in 1950-51 to nearly 40% now, the net irrigated area climbing to over 82 million hectares in 2002. However, the rate of growth of irrigated area had considerably decelerated in recent years, partly due to the exhaustion of easily irrigable areas and the depletion and degradation of water resources.
4. The requirement of water by different sectors by 2025 is estimated to be 105 M ha m, but the share of water for agriculture is expected to get reduced from the present level of 84 per cent to 69 per cent by 2025. On the other hand, the demand for water for agricultural purposes is estimated to increase from 470 BCM in 1985 to



740 BCM in 2025. During the same period, the demand for non-agricultural use of water will multiply four-fold, from 70 BCM to 280 BCM.

5. Misplaced and inappropriate policies leading to indiscriminate use of water, lack of appropriate technologies, poor technology transfer mechanisms and inadequate and defective institutional support systems have led to serious agro-ecological and sustainability problems in irrigated areas. While the water table rise and water logging to the extent of 8.5 M ha is the problem in canal command areas along with secondary salinization, receding water table at a rate of as high as one meter annually along with underground water pollution in many states are the daunting problems in tubewell irrigated areas. The water use efficiency (WUE) in Indian agriculture, at about 30-40 per cent, is one of the lowest in the world, against 55 per cent in China.
6. The vulnerability of Indian agriculture is bound to be severe lest the present trend of water use and management is changed. The International Water Management Institute forecasts that by 2025, 33 per cent of India's population will live under absolute water scarcity condition. The per capita water availability, in terms of average utilizable water resources in the country, has dropped drastically from 6008 m³ in 1947 to 1250 m³ now and is expected to dwindle to 760 m³ by 2025. The International Conference on Water and the Environment, Dublin and the United Nations Conference on Environment, the Earth Summit, Rio De Janeiro, both held in 1992, the Millennium Summit, 2000, and the Earth Summit Ten Years Later, 2002, had drawn world's attention to this crisis.
7. Rainfed lands are not only low in productivity and sustainability and are more prone to risks, as compared to those in irrigated areas, but are also the location for (proportionately) greater concentrations of poor and hungry persons. This can be obviated to some extent by expanding irrigated areas through improving water management and water use patterns. **Presently, the problem facing the country is not the development of water resources, but the management of the developed water resources in a sustainable manner.** By adopting efficient water management practices, the bulk of India's agricultural lands could be rendered as irrigated. Microirrigation is one such practice.
8. Microirrigation which allows application of water to root zone of the crops through specially designed equipment known as emitters, has already been adopted by



some countries for transforming their agriculture. India introduced this technology on a commercial scale in the Eighth Plan and during the past decade about 1.20 M ha could be covered under microirrigation, mostly under horticultural crops. However, the coverage so far has been minuscule in the face of the fact that almost 69 M ha could be covered through this improved system.

CONSTITUTION OF THE TASK FORCE

9. Should the national policies and governance systems perpetuate the ills of faulty water management and condemn the people inhabiting the vast rainfed areas to remain and die poor? Obviously, the above trend and inefficiency of water use in agriculture, which is destructive and self-defeating, must not only be curbed but also reversed to sustainably meet the future needs and aspirations of our people.
10. Recognizing the urgent need for increasing the water use efficiency, the Union Finance Minister in his budget speech of 2003 - 2004 announced the decision of the Government to go into all aspects of water management and irrigation by constituting a Task Force, which reads as follows:

“Water management and irrigation

The recent drought again brings into sharp focus the need for conserving our water resources. A number of initiatives have already been taken to conserve land and water resources. States are also encouraged to promote drip and sprinkler irrigation through supply of equipment at subsidized rates. But these efforts have to be intensified. Therefore, a bipartisan Task Force, headed by the Chief Minister of Andhra Pradesh, and with a Minister of Agriculture from another State, as one of the members, will be constituted to recommend measures needed to be adopted firstly, to expand the coverage of such irrigation, thereafter to also suggest safeguards so that the intended benefits actually reach the target groups.”

11. In pursuance of the above announcement, the Ministry of Finance constituted a Task Force on Microirrigation (TFM) under the Chairmanship of Shri N. Chandrababu Naidu, Chief Minister of Andhra Pradesh with the following Terms of Reference (Annexure-I):
 - i. To suggest strategies to expand coverage of area under microirrigation in the country.



- ii. To suggest institutional mechanism needed for promoting microirrigation including quality assurance, regionally differentiated technologies and interventions.
 - iii. To suggest technological support for regions and crop specific interventions on microirrigation.
 - iv. To suggest measures so that the intended benefits reach the target groups.
 - v. The Task Force will submit its Report within six months time.
12. The TFM held meetings on 21.08.2003, 25.09.2003, 24.11.2003, and 15.12.2003, besides field visit in Jalgaon, Maharashtra. Visit was also undertaken by the Chairman and Member Secretary of TFM to Israel to see the progress in microirrigation and to have interaction with the leading industry representatives there. A web page was also launched (<http://agricoop.nic.in>) on 1st of August, 2003 for seeking suggestions of the public. Letters were also sent to the State Governments to get their suggestions. State level consultations were held in the states of Gujarat, Haryana, Punjab, Tamil Nadu and Uttar Pradesh. The deliberations during the meetings, responses received through the Internet as well as through mail provided valuable inputs for firming up the recommendations of the TFM.

FINDINGS

13. The Task Force recognized that agriculture and allied sectors including horticulture will continue to be a prime mover for the growth and prosperity of the nation. However, there are a number of challenges, which are confronting the growth of the sector. By 2010, agricultural production, including horticulture production will have to be doubled, mostly through yield enhancement and increase in cropping intensity, coupled with sustainability. In the quest for improving productivity, water would be the most critical input.
14. The irrigation sector, mostly due to the overwhelmingly high prevalence of surface irrigation will have to address the challenges of low WUE in face of the depleting water resources. The efficacy of development and need-based adoption of microirrigation system to meet the challenges should be examined. As witnessed in developed and selected developing countries, including those in India, microirrigation, comprising drip, minisprinkler and sprinkler, must become a pivotal



element of integrated water use system with many agro - ecological, socio-economic and environmental advantages. Microirrigation has emerged as a tool for effective management of resources which saves water, fertilizers and also electricity and is one of the interventions in high value agriculture leading to diversification. In short, it is a versatile solution provider - distributing the benefits completely, evenly and equitably unlike other irrigation systems.

15. The microirrigation system has to be seen as a holistic approach to address:

Poverty alleviation: essentially through increasing income, converting vast rainfed areas into irrigated areas which are endowed with greater productivity and stability and through the creation of additional employment opportunities, especially by involving the private sector.

Horticulture-led diversification of agriculture: leading to the promotion of high value commodities with tremendous prospects for capturing new markets, particularly under the WTO regime. The system also permits commercialization of protected horticulture with tremendous economic returns.

Enhanced productivity: through the increase in yield improved quality of the product and reduced labour and input costs – resulting in greater competitiveness in the liberalized world market. **“More crop per drop” must be the driving force.**

Environmental protection and ecological security: by promoting precision farming where the correct quantity, correct time and correct place of application of the irrigation water is assured. There is a significant reduction in accumulation of salt in the root zone in the associated problems of water table rise and water logging, in salinisation and in the fall of the water table in tubewell command areas.

Promotion of equity: by adopting microirrigation technology in varying settings as it is non-specific to location, topography, commodity and the quality of land. Its adoption in waste lands and in hill and mountainous regions will greatly improve the socio-economic condition of the people in such hitherto un-reached areas.



Reduced biotic and abiotic stresses: through need-based and precise application of water, as several diseases and pests are commonly associated with excess water. Sprinkler irrigation is proving a tremendous success in Rajasthan and Madhya Pradesh as the system is having significant impact on reducing the further degeneration of the land and in mitigation of the abiotic stresses, particularly high temperature and drought.

16. Though the hectareage under drip irrigation in the country rose from a meager 1500 hectares in 1980s to nearly 5 lakhs hectares in 2002, yet the technology adoption is confined only to 12 States and the area is negligibly small in most of the Eastern and Northeastern States. Maharashtra is the single most progressive State in terms of the area under drip with a hectareage of 2 lakhs contributing to almost 46 per cent of the drip area in the country. Karnataka, Tamil Nadu and Andhra Pradesh follow this with percentages of about 21, 14 and 12, respectively and Gujarat is the distant 5th one with a meager percentage of 2.5. Andhra Pradesh has now given major focus on microirrigation under the Andhra Pradesh Microirrigation Project (APMIP) and has planned to cover about 2.5 lakh ha in the next two years.
17. Presently, this technology is in vogue only for a very few crops. Among the horticultural crops, drip technology is adopted mostly, in coconut with a penetration of 19%. This is followed by banana (11%), grapes (10%), mango (9.4%), citrus (7.9%) and pomegranate (6.2%). All other crops individually contribute to less than 5 per cent of the area under drip. There is need to expand the technology to many other fruits, vegetables and cash crops.
18. The sprinkler irrigation has got many of the advantages of the drip system. But, an added advantage is that it is more economical for use in canal command areas because of cereal dominated cropping pattern and convincingly it has been demonstrated in gravity fed irrigation projects in Madhya Pradesh and Haryana. Secondly, this system is most suited for frost protection on the one hand and cooling of crops on the other and could be used most advantageously in oilseeds and pulses to improve the productivity and increase production for substituting imports.



19. Development of microirrigation suffers from the following constraints:

- Lack of credit facilities
- Poor institutional support system.
- Lack of skilled human resources, availability of appropriate material and technical know-how.
- Generally perceived as a technology-driven movement, hence receives resistance from certain quarters.
- The initial cost of establishing MIS is high, hence generally out of the reach of resource-poor farmers.
- Not integrated with total water management system, hence generally viewed in isolation.
- Lack of information on temporal and spatial variation in soil moisture and on the optimal fraction of soil to be wetted.
- Lack of availability of low cost soluble fertilizers and other agro chemicals.

STRATEGIES AND APPROACH

20. Viewed as an integral part of comprehensive water management strategy with the focus on enhancing water use efficiency, reaching water to the un-reached areas must be the guiding principle of the promotion of microirrigation. The approach must be to produce more and more from less and less water. This concept should be streamlined in the national policy on water development and management. The investment and funding arrangement should consider microirrigation as an important infra-structural development and must increasingly occupy the centre - stage in the development and management of water resources in the country towards poverty alleviation, food security and environmental sustainability.

21. Some strategic considerations for successful adoption of microirrigation are as follows:

- For the large scale adoption of the technology, specially by small farmers, financial assistance could be required in the take-off phase, at least for two plan periods.



- Appropriate mechanisms and institutions for managing the financial and technical support should be in place.
- High quality of all the hardware components of the system is a fundamental requirement for the success of microirrigation. The manufacturers, retailers, and other members of the chain of delivery should be fully aware of the quality needs and the people down the line should be trained.
- The design of the microirrigation system and its various components such as filters, emitters, etc. should be easy and simple so that even the traditional farmers may successfully operate and maintain them.
- The private sector should be a partner in the development and diffusion of microirrigation technologies and should work in partnership with the public sector and the NGOs.
- As a part of the integrated water use system, the interactive forces involving land, water, crop, livestock, fisheries, should be integrated with due consideration to equity, pricing and sustainable conservation of the natural resources.

RECOMMENDATIONS

Expand Coverage

22. For its promotion, microirrigation should be viewed as a total plant support system starting with planting material to post harvest management and marketing. Therefore, microirrigation will have to be promoted in a holistic manner involving appropriate cultivars, good agronomic practices, post harvest handling, processing and marketing leading to an end-to-end approach. Water source development and recharge of wells through Watershed Management should also form a part of the package.
23. With an area of 0.50 M ha under drip and 0.70 M ha under sprinkler irrigation, the coverage has hardly touched the fringe of the existing potential of about 69 M ha. Therefore, attempts should be made to cover the area under microirrigation in a phased manner over the plan period. The strategy should, therefore, be to increase the coverage through the congruence of investment, institutional support, technological interventions, fiscal incentives as well as concession on taxes.



Investments

24. The Task Force emphasized that assistance for microirrigation should be viewed as an investment for infrastructure support, as in the case of irrigation projects. This analogy holds good ground considering the fact that microirrigation helps save and conserve water resources, expand irrigated area and add to the productivity and GDP. Thus, it recommended that microirrigation should be made compulsory in the command areas of new irrigation projects. There is need to introduce a policy of “no lift without drip’ to ensure benefits to large number of farmers with the same amount of water.
25. Considering the past trends and the available infrastructure facility with the industry, the aim should be to cover an area of about 3.0 M ha (2 M ha drip and 1 M ha under sprinkler) under microirrigation in the country during the Tenth Plan and another 14 M ha during the Eleventh Plan. This would require an investment to the tune of Rs.10,500.00 crores during the Tenth Plan and another Rs. 51,000.00 crores during the Eleventh Plan.
26. The Task Force underscored that investments of this magnitude will be possible only through proper sourcing of funds and recommended that multi-pronged strategy should be adopted for generating the resources by way of i) imposing an import cess of 5% on the import of items like pulses, oilseeds, oils and horticultural produce, (ii) by ensuring that 10% of the funds on irrigation projects be used for development of microirrigation in the country, and iii) making available credit to farmers at 6% interest rate. There is also scope to explore the possibilities of international funding through World Bank and other financial institutions.
27. The total expenditure involved for covering 3 M ha during the X Plan could be shared by Government of India, State Government and the farmers. The Central Government’s share could be 40% of the cost i.e. Rs. 4200.00 crores, which could be raised through budget provision, World Bank funding or import cess. The State Government’s share could be 10% viz Rs. 1050.00 crores, which could be raised by availing Rural Infrastructure Development Fund (RIDF) of NABARD. The balance 50% share amounting to Rs. 5250.00 crores will have to be borne by the beneficiaries for which they may seek institutional financing.



28. The Task Force noted that imports of horticultural products, oilseeds and pulses during 2002-03 have been to the tune of 6.6 million tonnes valued at Rs. 13761.16 crores. Import cess of 5% on these items would generate annual revenue to the tune of Rs. 688.00 crores. Similarly, about Rs. 10,000.00 crores are being spent annually on major and medium irrigation projects in the country. Ten per cent of this, Rs. 1000.00 crores, could be available from the irrigation sector projects. Apart from this, there are other beneficiaries of microirrigation such as the power and fertilizer sectors, which could be involved in raising resources for promoting microirrigation.
29. The Government of India has announced financial assistance for reviving some of the ailing sugar factories. Part of this assistance should be earmarked for promoting microirrigation for sugarcane crop and the industries availing the revival package should bring at least 50 per cent of the sugarcane area under microirrigation.
30. Out of the 3.0 M ha, about 0.5 M ha should be earmarked for wastelands, hilly areas, saline lands, etc. Besides, microirrigation should be made an integral part of watershed management and water harvesting programmes.
31. The Task Force observed that in the current context, microirrigation may not come directly under the definition of infrastructure. However, the concept of infrastructure has also become broad-based. The concepts such as Build-Operate-Transfer (BOT), and Build-Operate-Lease-Transfer (BOLT) which were once non-existent, have come into being. In the case of grant of assistance for installing microirrigation systems, the Government is providing only one time grant as start-up assistance. Thereafter, the system is owned and operated by the farmers. The assistance which helps save the resources like water, fertilize and electricity is indirectly helping to generate additional resources out of the savings. Considering this analogy, microirrigation need to be accepted as an infrastructure and they should be given the same status as irrigation projects.

Fiscal incentives

32. The assistance for microirrigation during the initial period of the Eighth Plan was 50% of the cost of the system to all category of farmers. This was enhanced to 90% of the cost to Small, Marginal, SC, ST and Women farmers and 70 per cent of the cost to other category farmers during 1996-97. Subsequently, during the Ninth



Plan (2000-01), the assistance was again scaled down to 50% of the cost to Small, Marginal, SC, ST and Women farmers and 35 per cent of the cost to other category farmers. During the Tenth Plan the assistance was further scaled down to 25 per cent of the cost to all categories of farmers. The scaling down of assistance has adversely affected the take-off in adoption of microirrigation. The Task Force feels that since the initial investment for installing a microirrigation system is high, rendering it unaffordable by most of the farmers, the assistance should be restored to the level of 50 per cent of the cost of the system, which should be extended to all categories of farmers. Such assistance should be extended to viable crops after conducting proper soil and water analysis by qualified and experienced functionaries.

33. The assistance should be administered through a transparent system, preferably by way of credit linked back-ended subsidy mode. This assistance could be administered by involving the financial institutions, commercial and cooperative banks. The farmers intending to adopt microirrigation should have easy access to credit and the amount should be adjusted directly based on self certification by the farmer or representative of a group of farmers which is verifiable by the implementing agency. This will reduce the time lag and overhead expenditure and at the same time ensure the quality of product.
34. Since there has been rapid strides in the field of Information Technology and there is accessibility of computers at the block and district level, it would be appropriate to have an efficient method of disbursal of funds through electronic transfer as being done in the case of APMIP.

Tax Incentives

35. High taxes such as Sales Tax, Trade Tax, Purchase Tax and local taxes like Octroi, Entry Tax etc., ranging from 4 to 10 per cent, being charged on the system by the various States is a hindrance for its adoption by the farmers. It is, therefore, recommended that no taxes should be levied on the microirrigation system. This would facilitate in making the system more affordable to the farmers, and thus induce rapid acceptance of the technology.
36. It is estimated that plastic raw material for microirrigation in one ha will weigh to the tune of 300-500 Kgs, depending upon the crop and spacing. The raw material



used in the manufacture of MIS is Low Density Polyethylene, Linear Low Density Polyethylene, High Density Polyethylene, Polypropylene and PVC. These raw materials are available locally, but, as the capacity of local raw material manufacturers is limited, there is a large import. The materials are covered under Chapter 39 of Custom Tariff 2001-02 and attract basic Custom (30%), CVD (16%) and SAD (4%), which works out to 56.83%. The local raw material manufacturers pay only excise of 16%. But, they fix their prices as per the landed cost of the imported raw material. The Task Force recommended that the Import Duties on plastic raw materials required for the microirrigation industry should be abolished to help reduce the cost. A scheme for import of duty free raw material for microirrigation systems could be evolved on the principles of Deemed Exports within the country as detailed in the Handbook of Procedures of Ministry of Commerce & Industry.

37. The Task Force noted that imposition of Value Added Tax (VAT) is under the consideration of the Government and recommended that VAT should not be imposed on microirrigation system as it should be viewed as an infrastructure support for the overall development of agriculture.
38. Excise duty on microirrigation system including its components namely, lateral, tubing, main pipeline, sub main pipeline, filtration equipment and its automation, fertigation equipment or any other system used for the purposes of applying fertilizer along with microirrigation and such other accessories and fittings that go as a package along with microirrigation system, which presently is 16%, should be abolished.
39. The Task Force further noted that microirrigation system has to be handled in a holistic manner needing services on agronomic practices, market support etc and these services are currently being taxed, which add to the burden of the farmer. The Task Force, therefore, recommended that taxes on such services should not be levied.

Credit Support

40. The Task Force observed that credit on microirrigation should be viewed as a national priority and it should be made available to the system as a whole, which includes bore-well construction, water storage tank, watershed development etc.



In this context, it recommended the following:

- ▶ As a part of the integrated water use system, the interactive forces involving land, water, crop, livestock, fisheries, should be integrated with due consideration to equity, pricing and sustainable conservation of the natural resources.
- ▶ The Banks should not charge more than 6 to 7 % interest irrespective of the loan amount for microirrigation purpose.
- ▶ The Rural Infrastructure Development Fund (RIDF) can also be availed in the form of loan from NABARD for the development of the integrated system on microirrigation as done in the case of APMIP. Interest on RIDF loan should not exceed 5%.
- ▶ Recognizing the need for qualitative improvement in the agricultural infrastructural facilities, GoI has proposed to create an Agri-Infrastructure & Credit Fund (AICF) of Rs 50,000 crores in the NABARD in addition to that available under RIDF which will be available during the next 3 years at lower interest rate than that of RIDF. The fund is proposed to be used for waste lands development, minor irrigation, functioning and viability of co-operatives, grading, certification, storage of agro-products, their processing, cold chains and modern abattoirs. The Task Force recommended that microirrigation should be given priority consideration while allocating funds out of the proposed AICF.
- ▶ As an incentive for timely repayment of loan, 0.5% rebate in the interest amount could be provided by the banks at the time of closure of loan account.
- ▶ Microirrigation equipment should be taken as a prime security for loan purposes and not treated as moveable property. Pledging of land should not be a necessary condition.
- ▶ Charging of stamp duty for availing loan for microirrigation system is an impediment which discourage the farmers in adopting the improved technology. Therefore, the stamp duty and registration charges should be waived off to cover microirrigation. Moreover, equitable mortgage should be provided by all the branches of the respective banks.



- ▶ The State Cooperative Banks, Regional Rural Banks as well as NCDC should also make credit available to the microirrigation programmes. In order to enable them to do so, revitalization programme of the State Cooperative Banks and Regional Rural Banks should receive top priority.
- ▶ The Task Force desired that, in order to ensure smooth recovery of loan, emphasis should be given for taking up contract farming. This will enable the farmers in putting higher investments, as they would be assured of returns from the investment.
- ▶ The Task Force noted that land is invariably mortgaged to get credit support from the banks for purchasing agricultural equipments and machinery, which is a hindrance. The Task Force, therefore, recommended that the limit of Rs.50,000/- for getting loans without collateral security should be increased to Rs.1.00 lakh or the redeemable value of the microirrigation equipment. The collateral should be taken on the microirrigation hardware and there should not be any additional requirement of collateral.
- ▶ Further, since interest rates on agricultural loans have been reduced significantly, loans for microirrigation should be made available at concessional interest rate without any ceiling. It recommended that purchase of microirrigation systems are also considered as a part of agricultural loan for enabling the farmers to derive the benefits of low interest rates.
- ▶ Considering that large number of farmers are defaulters in payment of agricultural loan due to crop failure, the Task Force recommended that credit for microirrigation should be dealt separately so that the farmers could avail the credit to pay their dues.
- ▶ Lease financing for microirrigation by the manufacturing firms to provide credit support, like in the case of car, should be promoted.

Marketing and Contract Farming

41. The Task Force underscored that microirrigation has focus on land and water resources besides crop specificity, and noted that appropriate mechanism to



ensure timely disposal of the produce with remunerative returns will be the key factor to encourage the farmers for adoption of technologies. Therefore, it recommended that such marketing mechanisms should be established, which will connect the producer and consumer and duly address all the links in the chain involving on-farm handling, transport, storage, value addition and processing, resulting in sustained high profitability to the farmer.

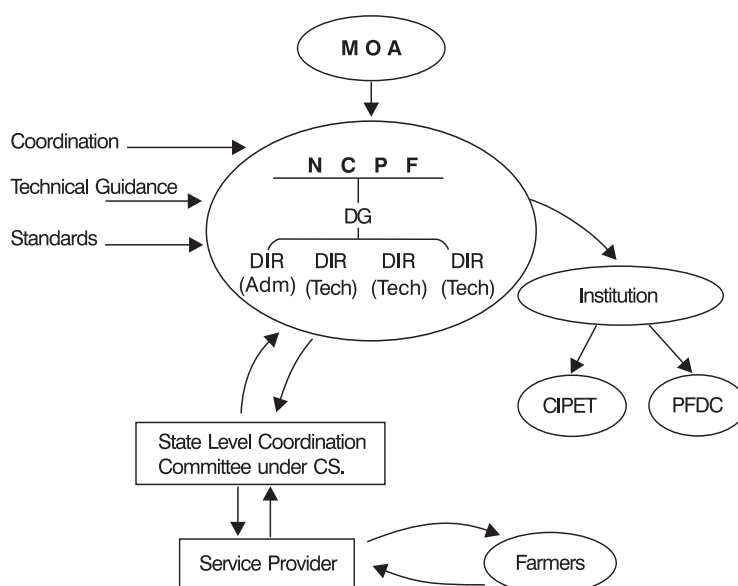
42. The Task Force further observed that promotion of contract farming will facilitate flow of improved technologies to the farmer and ensure assured returns through the buy-back arrangement. It therefore, recommended that contract farming may be promoted in the areas where microirrigation technologies are adopted. This would also help in speedy recovery of loans.

Institutional Mechanisms

43. The Task Force recognized that the National Committee on Plasticulture Applications in Horticulture (NCPAH) with a staff strength of 10 people has been instrumental in operationalizing the Scheme on Plasticulture in general and in popularizing the microirrigation technology in the country in particular. However, the lack of legal status of NCPAH has hindered the realization of stipulated benefits to the desired extent. A sound institutional mechanism is a must for ensuring proper advancement of the microirrigation sector in the country. Therefore, it recommended that an apex body in the form of National Council on Precision Farming (NCPF) be established which should be vested with the responsibility of providing technical guidance, channelising resources, monitoring and electronic database management, establishing linkage with market chain besides overseeing the overall development of microirrigation in the country. NCPF should be a professional body with Government playing the role of facilitator. It will be headed by an Officer, not below the rank of Deputy Director General (Pay scale Rs.25,000/-) supported with three senior level Officers [Pay scale of Rs.16,000/-] and one Administrative Officer of the rank of Director and one Accounts Officer with appropriate number of supporting staff, which exists in NCPAH. The NCPF will be self sustaining in due course of time. However, for initial establishment some funds will be needed as one time grant. The Task Force suggested that the GoI may provide a Corpus Fund to the tune of Rs.100.00 crores for creating NCPF.



44. The NCPF could also mobilize funds from national, international financial institutions and inter-ministerial budgetary allocations for implementing the promotional schemes and for activities such as:



- a) Promoting awareness, training, extension, capacity building of farmers, experts and manufacturers.
 - b) Testing, accreditation, quality certification and standardization of hardware.
 - c) Evaluation and monitoring of software services and assessment of capacity of individual processors.
 - d) Building National Data Base for capacities, services, crop coverage, etc.
 - e) Promoting indigenization, adoption of regionally differentiated technologies, at national level.
45. The Task Force further recommended that water users societies /federations should be promoted at state and national level. A participatory approach including the public, private, NGO and civil society to promote research–extension–farmer–market linkages is inevitable.
46. Recognizing that modern agriculture is knowledge based and technology driven which has to be farmer centred, the Task Force recommended that periodic upgradation of knowledge of farmers and field functionaries to keep



abreast with the advancement should have priority. This will not be possible without a sound infrastructure for upgrading the technical skills. Therefore, it further recommended that a sound infrastructure should be created for the purpose at state and district levels.

47. It also recommended that the industry should open a service center for every 500 hectare coverage on mandatory basis. Besides, post installation maintenance and extension support needs to be provided for a minimum period of five years by the industry. At the grassroot level there should be service providers to address the local problems related to microirrigation. These service providers could be young graduates or well-trained farmers.
48. It needs to be ensured that only good quality microirrigation systems having certification of Bureau of Indian Standards (BIS)/ISO are supplied to the farmers. It also need to be ensured that appropriate standards for microirrigation system components are developed and notified from time to time. Moreover, the anomalies in some of the existing BIS need to be removed for preventing misuse of the standards.
49. For ensuring manufacture and supply of good quality microirrigation system, the industry could be classified into four groups viz Class A, Class B, Class C and Class D. A system for classifying the manufacturing companies has been evolved, which needs to be disseminated to the existing microirrigation system manufacturers for self accreditation. In this context, the Task Force recommended that the Government should provide assistance for the upgradation of concerned industries.
50. Emphasizing the importance of quality assurance in microirrigation system, the Task Force recommended that the Central Institute of Plasticulture Engineering Technology (CIPET), Chennai should be brought under the control of the Ministry of Agriculture and be attached with the proposed NCPF for ensuring supply of good quality material to the farmers, who constitute a large proportion of consumers of plastics.
51. Since microirrigation results in saving of energy including diesel, the State Electricity Boards should be encouraged to provide power connection to those farmers who agree to install microirrigation sets.



52. In order to have proper flow of information it would be necessary to develop a portal on microirrigation containing all the relevant information. Facilities for internet counseling and use of satellite facility for two-way communication between farmers and experts should be created.

Technological Support

53. The network of 17 Precision Farming Development Centres (PFDC) has enabled the development of regionally differentiated technologies on microirrigation besides imparting training to a large number of farmers and departmental staff. These Centres need to be strengthened and selected Centres should be converted into Centres of excellence. Some of the PFDCs should be equipped to function as quality testing centers for microirrigation equipment.
54. The Task Force emphasized that new investment, technological advancement and participatory approaches in the context of optimizing water use by adoption of microirrigation technology should be given high priority. Accordingly, at least one per cent of the outlay on microirrigation need to be earmarked for microirrigation research.
55. Capacity building of the manufacturers is equally important for ensuring development of quality products and their application. There should be regular interaction between the microirrigation industry and the research organisations like PFDCs for updating the skills and knowledge.
56. The Task Force observed that the major concern or obstacle in the expansion of microirrigation among the farmers is the high initial investment. In spite of the fact that subsidy schemes do exist, many farmers are still finding it difficult to invest in the microirrigation system. To reduce the cost there is need to look into the technological options of which crop geometry modification is the most important one. Instead of adopting traditional spacing, adoption of paired row planting has been found to reduce the cost of the system by 40 per cent in many crops including tomato, brinjal, okra, etc.
57. Microirrigation has to be adopted for horticulture and row crops whereas sprinkler irrigation could be adopted for pulses and oilseeds.



58. Online type of microirrigation could be adopted in general for horticultural crops and in-line dripper system should be with those farmers, who have gained experience in microirrigation technology.
59. Precision irrigation invariably enhances the frequency of application of water and has been found to give better productivity with saving of water. Therefore, *pulse irrigation* should be promoted in water scarce areas. This will also help in reducing the temperature related stress to crops.
60. The Task Force emphasized that technology development has to be in an integrated manner with the involvement of farmers, scientists and system manufacturers. Service providers should be involved in the districts by devising a suitable mechanism for inflow & outflow of information, which can be supported initially and later on it would sustain on its own.
61. Large scale demonstrations of microirrigation technology has to be taken up at strategic locations with the involvement of the farmers. Operational Research Projects may be taken up in each State. The microirrigation system manufacturers should be involved in providing advice on agronomic packages to the farmers as an integral part of the system. Besides, inter-state visits should be arranged for a group of farmers to visit some of the progressive states. Since seeing is believing, large number of demonstrations on microirrigation should be laid at strategic locations.
62. There is need to develop human resources and entrepreneurship at the village level for regular monitoring of the system and offering technical guidance to the farmers, as and when needed. The village youths / agricultural graduates may be given short crash courses on technical, operational and maintenance aspects, who will act also as local consultants. They will have the internet facility and give advice to the farmers in consultation with selected panel of experts using internet.
63. The Task Force felt the need for introducing Certificate /Diploma level courses on Microirrigation to meet the growing demand of trained manpower. The ongoing programme of HRD in Horticulture could be reoriented, and few new Institutes among SAU/ICAR Institutes/Industries of repute could be identified for providing Diploma course on microirrigation.



64. The Task Force noted that microirrigation technology has been adopted comparatively more intensively in some states for selected horticultural crops. There is a need for popularizing this technology in additional crops and tribal areas, undulating situations and such settings. In these areas, the lack of power supply is the main problem. Therefore, cost effective and low head systems need to be developed and popularized.
65. The Task Force recognized that microirrigation is going to be the answer for productive agriculture in water scarcity arid / semi arid / saline / salty under ground water areas, systems which can be placed sub surface and operated with minimum head is the need of the hour. Such systems can reduce the water requirement over surface placed ones by 20 to 25 per cent through reducing the evaporative losses considerably.
66. The Task Force also noted that in about 15 lakhs hectares the farmers are forced to irrigate with saline water, which in long run deteriorates the soil health and ultimately the productivity. Further, in different states 30 to 80 per cent of under ground water is saline. Microirrigation coupled with other agro-techniques is the best option for sustaining agriculture under these adverse conditions.
67. It further noted that in India about 64 million hectares are categorized as wastelands. There is a lot of scope for promoting microirrigation in public wastelands with horticultural crops. These lands can be leased to local entrepreneurs / microirrigation cooperatives. To start with, efforts should be made to use these lands profitably with appropriate horticulture / multipurpose trees through the use of microirrigation along with other appropriate agro-techniques.
68. The Task Force recommended that the industry should be encouraged to develop latest technologies and for manufacturing efficient system components through joint ventures. Import of technology and components should be subject to the condition that all the technology would be transferred for indigenous manufacture within a period of two years.



Suggested Pattern and Delivery Mechanism:

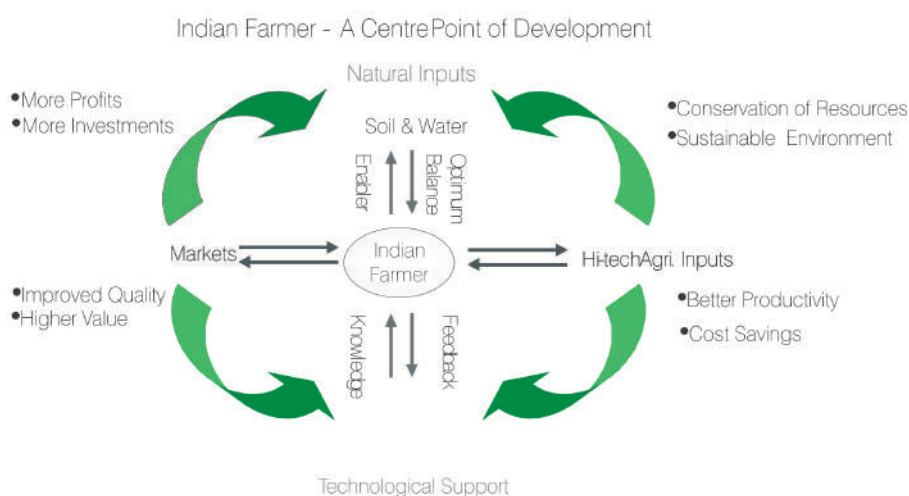
69. The Task Force emphasized the need for adequate measures and fool-proof methods for delivery and disbursal of funds for microirrigation projects through the states. It recommended the following approach to improve the delivery mechanism, is needed:

- The assistance for the purpose should be routed through NABARD. The State Government should be vested with the responsibility of sample verification system alongwith the banker. In this manner, there will be a built-in safeguard between the concerned banker and State Government. The rooting of the assistance through NABARD will also ensure that the funds are not used for other purposes and the appraisal as well as eligibility of the proposal of a given farmer will be the principal responsibility of the banker.
- Routing the subsidy through NABARD and Banking Structure will not only free Government Officials for providing better extension and technical support to farmers, but will also help in establishing better linkages between credit and subsidy support to farmers for investment in this technology.
- In some of the states, farmers have to wait for at least six months to get the assistance due for them. In order to encourage the adoption of microirrigation technology, adequate arrangements should be made to disburse the amount to the beneficiaries within a period of one month.
- Implementing officers and concerned companies/dealers should be held responsible for any malpractices in the field.
- Mechanisms evolved under the recent Andhra Pradesh Microirrigation Project for delivery of financial assistance and bank loan may be adopted by other states with the modifications, if needed. Under APMIP, GoAP has evolved a system for efficient disbursal of financial assistance for microirrigation. The entire transaction is expected to be almost paper-free. Moreover, the banks are expected to electronically transfer the funds to the suppliers of Microirrigation. The State Government authorities are only involved at one stage of installation and verification of the system. Even this function they are supposed to perform along with the banker. They are therefore not the only



authority for inspection and verification. In this manner, there is a built-in safeguard involving the concerned banker and state government official.

- The routing of the financial assistance through NABARD on the lines of “On Farm Water Management Programme for Eastern States” also ensures that the states do not divert the funds for other purposes/projects and the appraisal as well as eligibility of the proposal of a given farmer becomes the principal responsibility of the banker. Such policy changes will minimize, if not eliminate, the delays as well as malpractices in delivery of the assistance.
70. The Task Force recommended that the farmers should be the focus of development. All assistance for microirrigation should be in the name of the farmer and payments should be released to the Manufacturer/Supplier only after ensuring farmers’ satisfaction.



IMPACT

71. The Task Force projected that the coverage of an area of 17 M ha by the end of XI Plan under the microirrigation system comprising the suggested synergistic mechanisms involving investment, institutional support, technological upgradation, human resources development and services to the farmers, will have the following impact:
- ♦ There will be a saving of water to the tune of 59 BCM valued at Rs. 45,000 crores.



- ♦ The energy thus saved is estimated to be valued at Rs. 3800 crores.
- ♦ The cumulative saving in fertilizer is estimated at Rs. 18,000 crores.
- ♦ There will be an additional employment generation for about 21 million people during the project phase and thereafter 5 million people will have on-farm as well as off-farm additional employment annually.
- ♦ The self-sufficiency in pulses and oilseeds will be greatly enhanced, as also the nutritional adequacy.
- ♦ The additional cumulative income to the farmers on account of increased yield arising from the adoption of microirrigation system would be of the order of about Rs. 64,000 crores by the end of XI Plan and thereafter an annual additional income of Rs. 19,000 crores.

BALANCE SHEET ON INVESTMENTS TO COVER 17 M.ha BY XI PLAN

S.No.	Particulars	Amount, Rs. crore
Investments		
1.	Gol Share @ 40% as assistance	24,600.00
2.	Corpus for institutional support, data base, monitoring	600.00
3.	State Govt. share @ 10%	6,150.00
4.	Farmers contribution 50% as Own contribution or bank credit	30,750.00
5.	Sub Total	62,100.00
6.	Loss due to abolishing Excise duty Import duties	2,645.00 2,479.00
7.	Total loss due to abolishing Excise & Import Duties	5,124.00
8.	Total Investments	67,224.00
Benefits		
9.	Value of 59 BCM water saved	45,000.00
10.	Savings in electricity	3,800.00
11.	Savings in fertilizer	18,000.00
12.	Income due to increased Production	63,883.00
13.	Total Benefits	130,683.00
14.	Net Benefits	63,459.00

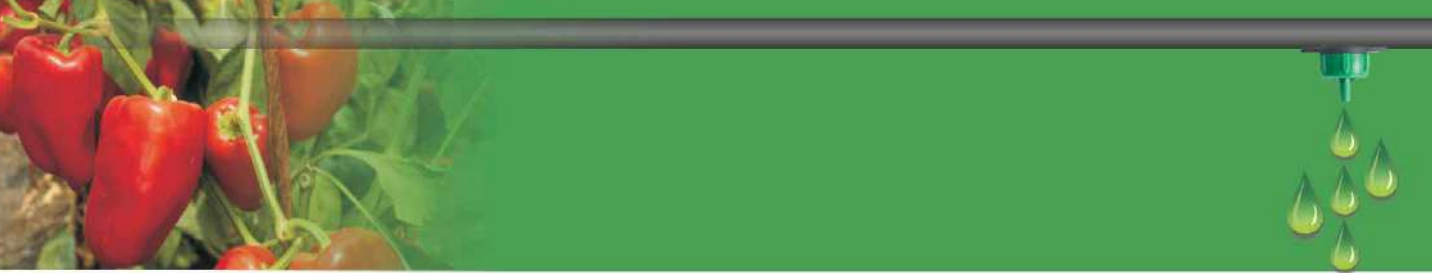


Net benefit will be of the order of about Rs. 63,459 crores over a period of 8 years, besides employment generation for 21 million people during the project period and thereafter employment to additional 5 million people annually.

CONCLUSION

72. Microirrigation led agriculture, armed with knowledge and technologies, with farmer as centre point, should be viewed as one of the eco-technological approaches to attain sustained and enhanced agricultural production and productivity. The technology is bound to maximize the synergistic interactions of improved seeds, water and fertilizer – the three components of the Green Revolution. Through microirrigation, the Green Revolution could be transformed into an Evergreen Revolution to ensure the congruence of sustainability, productivity, profitability and equity. Since microirrigation greatly enhances water, fertilizer and energy use efficiency and promotes precision agriculture, the Evergreen Revolution could be achieved without the burden of environmental degradation.





CHAPTER - I

INTRODUCTION

Agriculture, a main stay in the country, accounts for 25% of the Nation's Gross Domestic Product [GDP] and 15% of Exports has dependence of 65% of Indian population. There have been commendable developments, and the country transformed from food scarcity to food security, and to food surplus. The transformation is marked by green revolution, white revolution, blue revolution and now golden revolution. But the dependence on monsoon, declining farm income and high cost of infrastructure continue to be cause of concern. Water, which is at heart of intensive agriculture received serious thought about its limited availability and management since the 1992, International Conference on Water and Environment in Dublin and the June 1992 United Nations Conference on Environment and Development in Rio de Janeiro. These events have emphasized efficient water use for sustainability of agriculture.

The Agenda 21 of the Conference states that:

"Sustainability of food production increasingly depends on sound and efficient water use and conservation practices consisting primarily of irrigation development and management with respect to agriculture, livestock water supply, inland fisheries and agro forestry. Achieving food security is a high priority in many countries including India, and agriculture must not only provide food for rising population, but also save water for other uses. The challenge is to develop and supply water saving technology and management methods and, through capacity building enable farming communities to adopt new approaches in irrigated agriculture"

India with a geographic area of 329 M ha receives about 1170 mm of rainfall with a runoff of 400 M ha m. The surface flow is estimated to be 187 M ha m. Out of the total runoff, only 69 M ha m is utilizable and about 45 M ha m of ground water is estimated to be utilizable making a total exploitable water resource of 114 M ha m. Even if the full potential is exploited, with current efficiency of irrigation about 50 per cent of cultivated area will continue to be rain fed. To achieve the projected food grain production of 245 million tonnes, 30 million tonnes of sugar and jaggery and 360 million tonnes of horticultural produce by the end of year 2010, irrigated agriculture with minimum



required water is important. This necessitates improvement in Water Use Efficiency in the irrigation sector. With the ever-increasing population and industrialization, share of water for agriculture is expected to decrease from present level of 84% to 69%, although the demand of water for agricultural purposes is estimated to increase from 470 km³ to 740 km³ in a period of two decades (Table 1). During the same period, four-fold increase in the demand of water from non-agriculture sector is expected. This means that large population in India will live under water scarcity conditions. The crisis in water would be both availability and its management.

Table 1: Water Demand Pattern in India (km³)

S.No.	Area	1985	2025
1.	For Agriculture	470	740
2.	For Non Agriculture use	70	280

Therefore, efficient utilization of available water resources is crucial for a country like India, which shares 17 % of the global population with only 2.4 % of land and 4 % of the water resources. The per capita

water availability, in terms of average utilizable water resources in the country, which was 6008 m³ in 1947(presently 1250 m³) is expected to dwindle down to 760 m³ by 2050. All these emphasize the need for water conservation and improvement in water-use-efficiency, to achieve More Crop per Drop.

Recognizing the need for efficient use of water and the necessity for increasing the water use efficiency the Government of India have paid attention. In the budget speech of 2003-04, the Finance Minister has announced the constitution of National Task Force on Microirrigation with the following remarks:

“The recent drought again brings into sharp focus the need for conserving our water resources. A number of initiatives have already been taken to conserve land and water resources. States are also encouraged to promote drip and sprinkler irrigation through supply of equipment at subsidized rates. But these efforts have to be intensified. Therefore, a bipartisan Task Force, headed by the Chief Minister of Andhra Pradesh, and with a Minister of Agriculture from another State, as one of the members, will be constituted to recommend measures needed to be adopted firstly, to expand the coverage of such irrigation, thereafter to also suggest safeguards so that the intended benefits actually reach the target groups.”



In pursuance of the announcement, the Ministry of Finance requested the Ministry of Agriculture to be the Nodal Department for coordinating the activities of TFM. They were also requested for providing inputs for constituting the TFM. Accordingly, the draft composition and Terms of Reference (TOR) was provided to the Ministry of Finance with the approval of Union Agriculture Minister. Thereafter, Ministry of Finance constituted the Task Force as per the following composition and TOR.

1.1 Composition of TFM:

(i)	Shri N. Chandrababu Naidu Chief Minister, Andhra Pradesh	Chairman
(ii)	Minister of Agriculture, Government of Rajasthan	Ex-officio Member
(iii)	Minister of Agriculture, Government of Maharashtra	Ex-officio Member
(iv)	Dr. M.S. Swaminathan Chairman, Swaminathan Foundation, Chennai.	Member
(v)	Chairman, NABARD, Mumbai.	Ex-officio Member
(vi)	Shri J.N .L. Srivastava, Ex- Secretary, Deptt. of Agri. & Cooperation	Member
(vii)	Dy. Director Gen. (Engg.), ICAR, Krishi Anusandhan Bhawan, New Delhi.	Ex-officio Member
(viii)	Dr. H.P. Singh, Horticulture Comm. Deptt. of Agri. & Coopn.	Member Secretary

The Chairman of the Task Force could co-opt and include members in the form of special invitees. Accordingly, Minister of Horticulture, Govt. of Maharashtra and Secretary (A&C), Gol, and Shri B.H. Jain, the Chairman of Jain Irrigation Systems Ltd., Jalgaon were requested to join as Special Invitees.



1.2 Terms of Reference of TFM:

- i. To suggest strategies to expand coverage of area under microirrigation in the country.
- ii. To suggest institutional mechanism needed for promoting microirrigation including quality assurance, regionally differentiated technologies and interventions.
- iii. To suggest technological support for regions and crop specific interventions on microirrigation.
- iv. To suggest measures so that the intended benefits reach the target groups.

The Task Force will submit its Report within six months time.

The Member Secretary of the TFM held preliminary discussion with the Chairman TFM on 26th July 2003 to chalk out the plan of action and to finalise the web page for seeking feed back from the public. The broad framework of action plan was finalised, which was updated from time to time. A copy of the same is placed at Annexure-I. It was also decided to finalise the recommendations of the Task Force within a period of three months. The action plan was further ratified during the first meeting of the TFM, which was held at New Delhi on 21st August, 2003 (Annexure-II). As per schedule, a web page was also launched (<http://agricoop.nic.in>) on 1st of August, 2003 for seeking suggestions from the public. Letters were also sent to the State Governments to give suggestions regarding TOR.

The Chairman and the Members of TFM visited Jain Irrigation's High-Tech Agri Institute and R&D, Demo, Training Center at Jalgaon, Maharashtra on 4th September 2003 to see and understand the model for all round agricultural development with the help of frontier technologies including microirrigation. The Chairman and Members also interacted with farmers. Some of the members also visited Tissue Culture Banana farm with microirrigation belonging to a cultivator. The minutes of the deliberations held at Jalgaon is given at Annexure- III.

The Chairman and Member Secretary of the TFM visited Israel from 15th to 18th of September 2003 to interact with the microirrigation Industry there in Israel and to see the progress achieved under microirrigation. They also participated in the Agricultural exhibition there.



The Second meeting of TFM was held at Hyderabad on 25th September, 2003, which was attended by all the stakeholders in the microirrigation sector including Agriculture Ministers of the State Governments. The minutes of the meeting is placed at Annexure-IV. Apart from the regular meetings of the TFM, State-level consultations were also held in the States of Gujarat, Haryana, Punjab, Rajasthan, Tamil Nadu and Uttar Pradesh.

The third meeting of TFM was held at Hyderabad on 24th November, 2003 which was convened with a view to discuss issues relating to credit support for microirrigation industry. The meeting was attended by the Members of TFM and representatives of various Banks and microirrigation industry. The minutes of the meeting is placed at Annexure-V. The fourth meeting of Task Force was held at Delhi on 15th December 2003, which finalized the report. The Chairman had consultations with Union Minister of Agriculture and Union Finance Minister for Operationalization of the Recommendations.



SOME GLIMPSES OF VISIT OF CHAIRMAN, MEMBER SECRETARY AND OTHER MEMBERS OF TFM TO JAIN IRRIGATION SYSTEMS LTD., JALGAON



On-line Drip Tubing is being viewed by Chairman, TFM

Chairman, TFM examining the Drip-line insertion mechanism



Polytube Extrusion is being explained to Chairman, TFM



SOME GLIMPSES OF VISIT OF CHAIRMAN, MEMBER SECRETARY AND OTHER MEMBERS OF TFM TO JAIN HI-TECH AGRI INSTITUTE, JALGAON



Chairman, TFM observing Filtration and Fertigation Station

Demonstration of On-Line and In-line Drip Technology is being observed by Chairman & Members of TFM



B.H. Jain, JISL explaining about Floppy Sprinkler Nozzle to Chairman, TFM



SOME GLIMPSES OF VISIT OF CHAIRMAN AND MEMBER SECRETARY TO ISRAEL



Chairman of TFM Meeting Minister of Agriculture, Israel

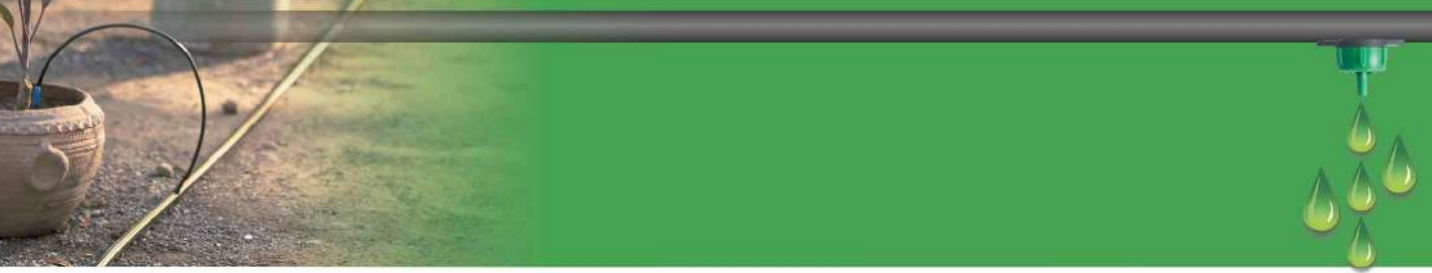


Visit to Weizman Institute of Science



Member Secretary discussing with Israeli farmers





CHAPTER II

INDIAN AGRICULTURE & HORTICULTURE

Basically India is an agrarian country and more than 72 per cent of the population live in rural areas (Table 2.1). From 82% in 1951, the Rural population percentage has reduced to 72% in 2001 due to industrialization and urbanization during the last five decades.

Table 2.1: Growth Trend of Population and Agricultural Workers (million)

Year	Total Population	Annual Growth %	Rural Population	% of Rural Population	Cultivators in the Rural Population	% Cultivators in Rural Population
	(1)	(2)	(3)	$= (3)/(2)$	(4)	$= (4)/(3)$
1951	361.1	1.25	298.6	82.7	69.9	23.4
1961	439.2	1.96	360.3	82.0	99.6	27.6
1971	548.2	2.22	439.0	80.1	78.2	17.8
1981	683.3	2.20	523.9	76.7	92.5	17.6
1991	846.3	2.14	628.7	74.3	110.7	17.6
2001	1027.0	1.93	741.7	72.2	127.6	17.2

Source: Agricultural Statistics at a Glance 2003, Ministry of Agriculture, Gol, New Delhi and www.agricoop.nic.in

Another feature is that the actual percentage of cultivator population has been steadily declining. While, during 1951 almost 23.4 per cent of the rural population were cultivators involved personally in agriculture, as on 2001, Cultivators as per cent of rural population has come down to 17 per cent.

1. AGRICULTURAL SCENARIO

The Indian Agriculture during its development after independence has undergone different phases. Immediately after the independence and upto the ushering of Green Revolution (mid 1960s) it was only traditional agriculture with the available local varieties and with a growth rate of 2.8 per cent. With the advent of high yielding varieties coupled with more irrigation facilities and application of fertilizers, the growth rate increased to



3.5 per cent between 1970s and 80s. During the post green revolution era more emphasis was given for the diversification, sustainability, and judicious utilization of natural resources. Beginning 21st century, agricultural growth rate of 4.5 per cent is envisaged to meet the food demands of more than 1 billion population.

Despite the significant increase in the food grain production from 82 million tones during 1960-61 to 212 million tonnes in 2001-02, the per capita availability of food grains remained almost static as shown in the Table-2.2 below.

Table 2.2: Food Grain Production and Per Capita Availability

Particulars	Unit	1960-61	1970-71	1980-81	1990-91	2000-01	2001-02	2002-03
Foodgarin production	Million tones	82	108	130	1176	200	212	184
Per capita food availability	Kg	189	200	191	210	196	204	174

Source: Agricultural Statistics at a Glance 2002, Ministry of Agriculture, Gol, New Delhi and www.agricoop.nic.in

There is an imperative need to improve the per capita availability of food grains on a sustained basis, thereby the food security, in comparison with WHO Standards for per capita food consumption. As per the International Food Policy Research Institute’s estimate, the cereal demand in 2020 for India will be between 301 and 375 million tonnes. To meet this demand India has to almost double its food production. Recognising the need, the hon’ble Prime Minister of India has announced for the doubling of food production by the year 2011-12.

The growth in the agriculture sector remained stagnant during the pre- independence era when there was more dependence on imports. This forced the planners to initiate measures to accelerate the growth through the Plan process, earmarking Plan outlays and fixing targets at the State and Central levels. The first three Five Year Plans focused on growth with some reforms including elimination of intermediaries like Zamindars and Jagirdars, in agriculture. Subsequently, new technologies in the form of High Yielding Varieties (HYV), improved production systems, control of pests and diseases; were introduced during the Mid -Sixties which resulted in ushering of Green Revolution.

Apart from new technologies, public investment in agriculture, particularly in irrigation, was stepped up significantly. Large investments were also made for agricultural development and research under the aegis of Indian Council of Agricultural Research



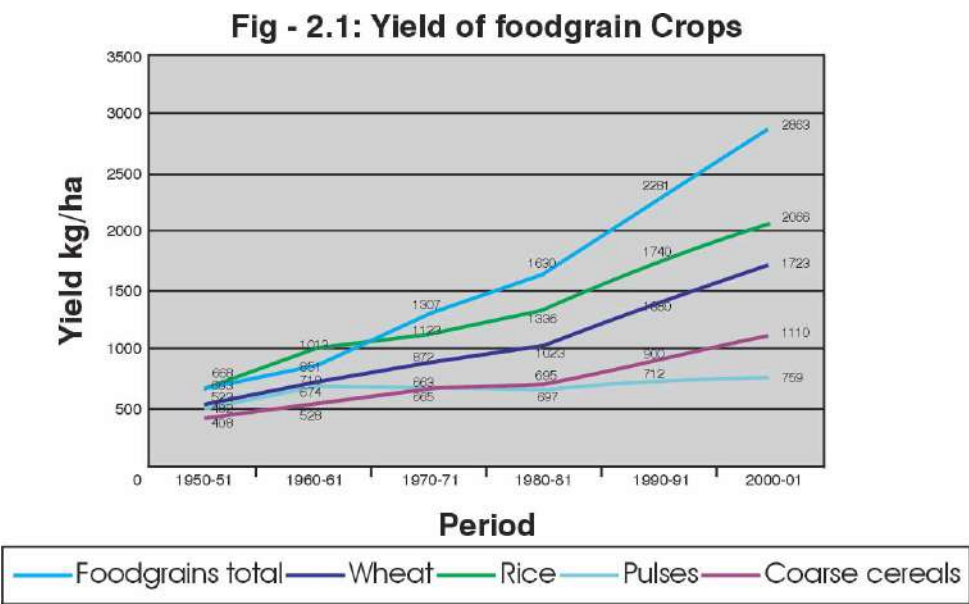


(ICAR) and the State Agricultural Universities (SAUs). A well-designed extension network was also created for disseminating new technologies to the farmers. An administrated price policy was implemented, which provided incentives to the farmers. The focus during the subsequent Plan periods was on improving infrastructure for irrigation, stepping up the use of chemical fertilizers, seeds of improved varieties, implements & machinery and supply of credit. Passing through various revolutions i.e. Green Revolution, Blue Revolution, White Revolution and Golden Revolution, Indian Agriculture achieved quantum jump in production resulting in surpluses of food grains and self sufficiency in milk and fish and improved availability of horticultural produce. However, regional imbalances, degradation of land in the areas of Green revolution, gap in production of oil seeds, pulses, fruits and vegetables continue. Limited efforts made for diversification to horticulture have been rewarding in terms of higher productivity of land and better employment. However, integrated approach is needed in terms of diversification for achieving sustainability in agriculture.

The fiscal and policy initiatives taken by the Government helped the Indian agriculture to transform from despair & food shortage stage to self-reliance and exports, a major share of the credit to which has been attributed to the Green Revolution. A major share of the food grains (77.8%) includes rice and wheat while the share of pulses is about 6.5%. The noteworthy feature is that while the area under food grains increased



only by about 26 per cent, the production has increased by 315%, which has been possible through significant increase in the productivity levels (Fig 2.1).



The major focus being on cereal crops, the high yielding varieties of these crops (rice and wheat) responded well to the inputs particularly irrigation and fertilizers. Almost 43% of the area under food grains has been covered under irrigation. Out of the irrigated crops rice and wheat occupy a major area, as 52% of the cropped area under rice and 86% of area under wheat, are irrigated. Sugarcane, another major crop witnessed a production increase from 57 million tonnes in 1980-91 to 289 million tonnes in 2001-02 and about 92% of the crop is irrigated.

The agriculture and allied sectors now provide food to a population of more than one billion people and raw material for thousands of agro based industries. It contributes to about 1/7th of the country’s exports and 1/4th of country’s Gross Domestic Product (GDP) and 650 million people are dependent on agriculture for on farm and off farm employment. This has been possible through various initiatives taken by the government, researchers, extension agencies, private sector and above all, the farming community who has been receptive in adopting the new technologies.

The Food Grain demand for the country in the years 2010, 2025 and 2050 has been worked out as given in Table-2.3.

Table-2.3: Projected Food Grain Demand and Irrigated Cropped Area

S.No	Particular	Unit	2010	2025	2050
1	Food grain demand	Million MT	247	320	494
2	Net cultivable area	Mha	143	144	145
3	Total Cropped area	Mha	193	204	232
4	Total irrigated cropped area	Mha	79	98	146

Source: National Commission on Integrated Water Resources Development Planning, GOI.

For achieving the projected food grain demand, the Total irrigated cropped area has to be 146 million hectares under food grain cultivation.

2.0 HORTICULTURAL SCENARIO

The role of horticulture in enhancing productivity of land, generating employment, value addition, improving economic conditions of the farmers and entrepreneurs, increasing exports and above all providing nutritional balance to the people has been well acknowledged. The sector includes a wide variety of crops under different groups such as fruits, vegetables, root and tuber crops, mushroom, floriculture, medicinal and aromatic plants, nuts, plantation crops including coconut and oil palm.



The horticulture sector has emerged as a promising area for diversification in agriculture on account of high-income generation per unit of area, water and other farm inputs and environmental friendly production systems. Government of India accorded high priority for the development of this sector, particularly since the VIII Plan when the outlay for horticulture development programmes was stepped up by more than 40 times from Rs 24 crores during VII Plan to Rs 1000 crores. The impact has been visible in terms of increase in production and productivity of horticultural crops. The production of horticultural crops, which was only 96.53 million tonnes during 1991-92, has increased to 152.50 million tonnes during 2000-01 and the area under horticultural crops increased by 12.33 million ha to 15.71 million ha as is evident from Table 2.4. India has emerged as world leader in the production of a variety of fruits like mango and banana and is the second largest producer of fruits and vegetables. Besides, India has maintained its dominance in the production of coconut, cashew-nut and a number of spices.

Table 2.4: Area and Production of Horticultural Crops
A -Area in Million ha; P -Production in Million Tonnes

Crop	1991- 92		1996 -97		2000 -01	
	A	P	A	P	A	P
Fruit	2.87	28.63	3.58	40.46	3.89	45.37
Vegetables	5.14	58.56	5.51	75.10	6.25	93.92
Spices	2.05	1.90	2.38	2.80	2.50	3.02
Coconut	1.53	6.93	1.89	8.98	1.84	8.67
Cashew	0.53	0.30	0.66	0.43	0.72	0.45
Others	0.21	0.24	0.26	0.30	0.51	1.07
Total	12.33	96.53	14.28	128.07	15.71	152.50

Horticulture offers not only a wide range of options to the farmers for crop diversification, but also provides ample scope for sustaining large number of Agro-industries which generate huge employment opportunities. At the present, horticulture is contributing 29.6% to the Agricultural share to GDP from 8.5% land area. The rapid development in the horticulture sector in the past decade has led to its declaration as a Golden Revolution by the Union Agriculture Minister at the National Horticulture Board in October 2001.

Despite the achievements in the horticulture sector, there still exists a wide gap between potential and actual realization. The requirements are increasing with growing population and greater urbanization as well as need for nutritional balance and supplement. To meet the requirements, horticulture production has to increase to the level of 360 million tonnes by 2020 AD from the current year production of about 152.5 million tones.

The Hon’ble Prime Minister, in his Independence Day speech on 15th August 2003, has projected the need for doubling the horticulture production by 2010 and had announced launching of a National Horticulture Mission. Accordingly, the projected demand for horticulture produce over different time periods has been worked out as given in Table 2.5.

Table 2.5: Production and Projected Demand of Horticulture Produce
(production in million MT)

Commodity	2001-02	2007-08	2010-11	2020-21
	Present	Projected	Projected	Projected
Fruits	45.37	75.00	81.00	98.00
Vegetables	93.92	160.00	185.00	220.00
Spices	3.02	5.00	5.50	6.50
Coconut	8.67	18.00	20.00	24.00
Cashew nut	0.45	1.50	1.70	2.00
Others	1.07	6.00	7.10	9.50
Total	152.50	265.50	300.30	360.00

3. INPUTS AND PRODUCTIVITY RELATIONSHIPS

There has been a substantial increase in the productivities of various agriculture and horticulture crops over the years. This can be attributed to the modern technologies developed, which include use of High Yielding Varieties, increase in the fertilizer and pesticide usage and most importantly the irrigation expansion. In the absence of irrigation, the varieties will not be able to respond to inputs and attain their full potential. The productivity increase has been due to the adoption of newer technologies. There has been multifold increase in the levels of various inputs subsequent to the Green Revolution as presented in Table 2.6.

Table 2.6: Progressive Use of Agricultural Inputs and Yield Behaviour

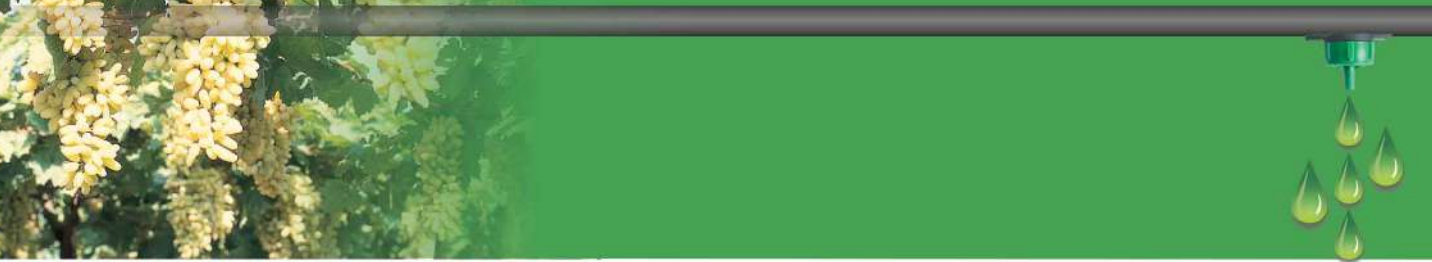
Input	Unit	50-51	60-61	70-71	80-81	90-91	97-98
High Yielding Varieties	M.ha	—	1.58	13.37	24.37	67.0	76.0
NPK	Kg/ha	Neg	1.90	13.13	31.8	70.0	85.0
Pesticides	000 MT	2.3	8.6	24.3	45.0	75.0	52.0
Irrigation	%	18.0	19.0	24.0	30.0	35.0	37.0
Yield of Food Grains	kg/ha	522	710	872	1023	1382	1552

Source: Agricultural Statistics at a Glance (various issues), Ministry of Agriculture, GoI, New Delhi



The Table reveals that, between 1950-51 to 1997-98, the area under irrigation increased by more than two folds. The production of the food grain crops tripled during that period. This brings out the synergistic relationship between the two.





CHAPTER III

WATER RESOURCES AND
THEIR UTILISATION IN INDIA

Total surface water availability in all basins in the country as estimated by National Committee on Integrated Water Resources Development (NCIWRD) is 1953 Billion Cubic Meters (BCM) of which only 690 BCM is utilizable. Similarly out of total replenishable groundwater estimated by Central Ground Water Board (CGWB) at 432 BCM the utilizable groundwater is only 342 BCM. Thus the utilizable water resources in the country are 1032 BCM. Out of the 1032 BCM utilizable resources, only 605 BCM of water is presently being used, which amounts to 44% of the utilizable water resources.

Table 3.1: Sector-wise utilization of Water resources

S. No.	Sector	Present Utilization of Water, BCM	% of Total Water Utilized
1	Irrigation	501	82.8%
2	Domestic	30	5.0%
3	Industrial	20	3.3%
4	Energy	20	3.3%
5	Others	34	5.6%
	Total	605	100%

Source: National Commission on Integrated Water Resources Development Planning, GoI.

Present sector-wise utilization of available water is given in Table 3.1, which shows that the share of irrigation sector in total water utilization is about 82%.

However, it is estimated that by 2050, loss of storage capacity due to sedimentation would be

about 65 BCM. Thus the storage would be only 319 BCM, which is 83 % of designed storages. With loss of live storage and competitive uses by other sectors, agriculture in the country would be under great water stress, which would result in further decline of productivity.

Realizing the fact that spatial and temporal distribution of monsoon rains is highly uneven and that development of agriculture is very difficult without irrigation, the Government laid major emphasis on creation of irrigation potential during different Plan periods. By 1997-98 irrigation potential has been created for 92.7Mha with an utilization of 82.7 million hectares as presented in Table 3.2.



Table 3.2: Ultimate, Created & Utilized Potential for Irrigation in India (97-98)

Source	Ultimate Potential, M ha	Created Potential, M ha	Utilized Potential, M ha
Major & Medium	58.5	33.7	29.0
Minor-			
Surface	17.4	12.6	11.0
Ground Water	64.0	46.5	53.7
Total	81.4	59.1	53.7
Grand Total	139.9	92.7	82.7

Source: Agricultural Statistics at a Glance, 2003

As of 1999-2000, out of 311 major, 944 medium and 170 Extension/ Renovation/ Modernisation (ERM) projects undertaken, only 129 major, 688 medium, and 96 ERM projects are completed and the remaining are languishing for 6 to 20 years mainly for paucity of funds. It is also estimated that on completion of all major and medium projects a total storage of 384 BCM would be available. Additionally, 76.3 BCM is created from surface water and minor irrigation schemes.



1 IRRIGATION STATUS AT THE NATIONAL AND STATE LEVEL

Out of the 140 M ha of net sown area in the country, 53 M ha is under irrigation working out to a percentage of about 35 (Table 3.3). Out of this 1/3rd is under canal irrigation and more than 55 per cent under lift through tube wells and other wells. Tank irrigation is only less than 10 per cent and confined mainly to the peninsular portion of the country

Table 3.3 : Source wise Irrigation Statusn in India 1995-96

SOURCE	AREA, M ha	PERCENTAGE
Canal	17.1	32
Tube Wells	17.9	33
Other Wells	11.8	22
Tanks	3.1	6
Others	3.5	7
Total	53.4	100

With respect to the status of irrigated land the different states, the net irrigation per cent varies from 12 in Mizoram to as high as 90 in Punjab, Table 3.4.

In Assam, Himachal Pradesh, Orissa and other North Eastern States it is predominantly canal system while in Gujarat, Punjab, Rajasthan and Uttar Pradesh the ground water is the major source. In Tamil Nadu tank irrigation is an important irrigation source with almost quarter of the irrigated area under this system. In the other southern states as well as Orissa, tank system is also in vogue to a considerable extent. In the different states, the net irrigation per cent varies from 12 in Mizoram to as high as 90 in the Punjab. In Assam, Himachal Pradesh, Orissa and the other North Eastern states it is predominantly canal system while in Gujarat, Punjab, Rajasthan and Uttar Pradesh the ground water is the major source. In Tamil Nadu tank irrigation is an important irrigation source with almost quarter of the irrigated area under this system. In the other southern states as well as Orissa, tank system is also in vogue to a considerable extent.



Table 3.4: Source wise Net Irrigation Status in different States

Name	Net Irrigated Area, %	Source wise Distribution, %		
		Canal	Tanks	Ground Water
Andhra Pradesh	38.2	46.2	17.2	36.6
Bihar	51.3	42.6	3.7	53.7
Gujarat	28.3	21.0	1.4	77.6
Haryana	75.9	52.1	Neg	47.9
Himachal Pradesh	18.8	87.6	0.9	11.5
Karnataka	21.2	52.7	11.4	35.9
Kerala	15.1	57.8	14.8	27.4
Madhya Pradesh	28.2	46.7	3.2	50.1
Maharashtra	13.9	45.4	—	54.6
Orissa	50.5	70.3	14.4	15.3
Punjab	90.5	38.7	—	61.3
Rajasthan	29.4	32.8	4.4	62.8
Tamilnadu	52.3	31.1	23.1	45.2
Uttar Pradesh	63.9	31.6	0.6	67.8
West Bengal	53.0	54.7	10.9	34.4
Arunachal Pradesh	20.8	94.0	—	6.0
Manipur	46.4	100.0	—	—
Meghalaya	18.2	76.0	—	24.0
Mizoram	12.3	75.0	—	25.0
Tripura	15.2	63.0	—	37.0
Sikkim	16.8	75.0	—	25.0
Nagaland	32.0	78.0	—	22.0

Source: Ministry of Water Resources, Gol, New Delhi

As regards groundwater, though only 35% of the utilizable resources are used at present, water tables are progressively declining at an alarming rate of 1 meter per year due to excessive extraction. Presently about 435 blocks/Mandals/watersheds are critical/dark and 422 blocks/mandal/watersheds semi-critical/grey. Construction of new wells in 435 dark areas is not allowed while a cautious slower development is required in 422 Grey areas.



2. PRODUCTIVITY PROBLEMS IN IRRIGATED AGRICULTURE

Huge investments were made during the plan periods for developing irrigation potential by construction of multipurpose reservoirs. They did result in increasing the productivity of different crops. Yet, of late, it has been revealed that indiscriminate use of water could lead to problems like water logging and soil salinity resulting in productivity decline. Further, in the lift irrigated areas also the tendency of over drafting is leading to various productivity problems including water pollution and fast receding water table. Excessive irrigation often calls for more plant protection measures resulting in increased cost of cultivation, and affects the productivity. Ultimately, the Water Use Efficiency (WUE) at the farm and project levels are greatly and adversely affected.



2.1 Problems of Canal Command Areas

The most important aspect presently affecting the Water Use Efficiency (WUE) in crops in the canal command areas is water logging and poor drainage. In the Tungabhadra project of Karnataka more than 33,000 hectares are water logged. Similar grave situations prevail in most of the commands in the country. As per the report of the National Commission on Agriculture (1976) the water logged area in some major states in the country was totaling to a figure of 39.93 lakh hectares (Table 3.5). Out of the total water logged area 60 per cent is surface water stagnation during kharif and rest on account of high water table, both affecting crop growth adversely.



Table 3.5: Distribution of Water logged Areas in some Selected States

State	Area, Lakh ha
Andhra Pradesh	3.39
Bihar	1.17
Gujarat	4.84
Haryana	6.20
Panjab	10.9
Rajasthan	3.48
Uttar Pradesh	8.10
West Bengal	1.85
Total	39.93

Source: Ministry of Agriculture, Gol, New Delhi

The high water table conditions arise due to misuse and abuse of water at the field level as well as the conveyance losses occurring in the canal distribution system. In most of the commands the water table is rising at the rate of 0.3 meter annually (Table 3.6) though in some commands rate is as high as even one meter. The high water table conditions reduce crop productivity and soil fertility.

Table 3.6: Rate of rise in water table in different irrigation commands

Name of the irrigation command	Rate, m/year
Mahi Right Bank Canal Command, Gujarat	0.28
Rajasthan Canal Command, Rajasthan	0.29 -0.88
Western Jamuna & Bhakra Canal Command, Haryana	0.30 – 1.00
Sirhand Canal Command, Punjab	0.10-1.00
Sharda Sahayak Canal Command, Utter Pradesh	0.68
Malaprabaha Canal Command, Karnataka	0.60 -1.2
Nagarujan Sagar Irrigation Project, Andhra Pradesh	0.32
Sriram Sagar Irrigation Project, Andhra Pradesh	0.26

Source: Ministry of Water Resources, Gol, New Delhi



In Ukai Kakrapara command in South Gujarat, the high water table conditions (water table fluctuating from surface to 1.5 meter) are reported to reduce the yield of sugarcane by 30 per cent during different years (Table 3.7).

Table 3.7: Effect of High Water Table on Sugarcane Production

Year	Yield, MT/ha		Per cent Reduction
	High Water Table	Low Water Table	
86-87	73.5	97.3	23.8
87-88	90.0	116.0	26.0
88-89	87.0	108.0	21.0
90-91	39.0	98.0	59.0
92-93	101.0	145.0	44.0
Mean	78.0	113.3	31.2

Source: Ministry of Agriculture, Gol, New Delhi

2.2 Problems of Well Irrigated Areas

While the rise in water table and water logging is the main problem of canal commands, the receding ground water due to over draft results in multifarious problems under well irrigation in different parts of the nation. In many states the under ground water table is falling at an annual rate of 1 meter. In Punjab, Haryana and Rajasthan the fast receding water table contributes to the water salinity problems and in the peninsular India its major effect is that many wells are becoming dry. In Gujarat it is a combination of both, with the added problem of Fluoride contamination. In West Bengal the arsenic toxicity is observed as a result of excessive draft. In the coastal areas it results in the ingress of seawater.



If the practice of mining the underground water by way of over pumping continues, it will result in the area becoming slowly, but surely, unproductive and barren. In many States the compound annual growth rate of ground water balance is negative (Table 3.8). The excessive mining is observed in Punjab with a growth rate value of -12 per cent followed by Rajasthan, Tamil Nadu and Haryana with a percentage of around -4. While, the states of Bihar, Kerala and Karnataka record a positive change, yet the percentage is only around 1. In South Gujarat the growth rate is almost static and this may be due to the very poor ground water utilization there. But in North Gujarat and Kutch the present level of draft is falling to Dark or to Over Exploitation category.

Table 3.8: Compounded Annual Growth Rate of Under Ground Water Balance

State	Growth Rate, (%)
Andhra Pradesh	-1.38
Bihar	1.00
Gujarat	0.01
Haryana	-4.03
Himachal Pradesh	-0.23
Karnataka	0.80
Kerala	0.38
Madhya Pradesh	-0.37
Maharashtra	-0.10
Orissa	-0.25
Punjab	-12.40
Rajasthan	-4.88
Tamilnadu	-4.21
Uttar Pradesh	-0.02
West Bengal	-0.04

Source: Central Ground Water Board, Ministry of Water Resources, Gol, New Delhi

All the above problems will impair the region’s agricultural productivity. In fact the ground water is the most ideal water source for agriculture provided it is used scientifically and judiciously. The productivity with ground water is 1.5 to 2.0 times more than the canal irrigated ones (Table 3.9).



Table 3.9: Yield Behaviour with the Source of Water

State	Crop	Grain Yield, Mt/Ha		
		Well	Canal	Tanks
Punjab	Wheat	3.06	2.08	
Haryana	Wheat	2.20	1.80	-
Andhra Pradesh	Rice	4.84	2.70	1.86
TamilNadu	Rice	4.77	2.14	2.09

Source: Ministry of Agriculture, Gol, New Delhi

Consequently agriculture productivity from ground water is likely to become unsustainable both because of undependable water availability and high cost of power for pumping. This trend could be arrested and even reversed by judicious use of groundwater preferably through use of microirrigation technologies.

3. WATER RESOURCES – FUTURE PROSPECTS

The ultimate irrigation potential is estimated at 139 M ha out of net sown area of 143 M ha. For meeting future food grain demand of 494 million MT for projected population at 2050, it is required to bring 146 M ha under irrigation which is quite high compared to the present Gross Irrigated area of around 82 M ha. Thus it is difficult to achieve the requirement of 146 M ha of irrigated area considering the area that would continue to remain rainfed. Alternatively, it is essential to increase the crop productivity from present 2.3 tonnes/ha to 4 tonnes/ha under irrigated conditions and from 1 ton/ha to 1.5ton/ha for rainfed area.

Most of the irrigation projects are operating at dismally low efficiency of 35 %, wasting enormous water and adding to waterlogged and saline areas and depriving the tail end farmers of their legitimate right. With increasing pressure on land and water, immediate action is needed to improve and increase irrigation efficiency to 60% for surface water and 75-80 % for groundwater. The data presented above shows that, with almost no increase in Net Sown Area (NSA) likely in near and distant future, there will be greater pressure to cultivate the available land intensively by increasing the cropping intensity from 132% to 145% by 2025 to step up Gross Cultivated Area (GCA) from 194 Mha to 210 M ha.

If current trends are any indication, increase in GCA does not necessarily imply corresponding increase in food grain area. In fact in the last 25 years the increase in



GCA has been for non-food grain crops and area under food grain hovering between 123Mha and 128 Mha. Likewise, not much change in switch over from rainfed to irrigated conditions could be expected and about 86 Mha areas would continue to be rainfed. Table 3.10 gives the projected water requirements up to year 2050.

Table 3.10: Projected Water Requirements for Irrigation

S.No	Particular	Unit, Million	Year 2010	Year2025	Year 2050
1	Food grain demand	MT	247	320	494
2	Net cultivable area	ha	143	144	145
3	Total Cropped area	ha	193	204	232
4	Total irrigated cropped area	ha	79	98	146
5	Total unirrigated cropped area	ha	114	106	86
6	Food crop area irrigated	ha	55.4	68.7	102.3
7	Food crop area unirrigated	ha	75.2	70.2	56.7
8	Total food grain production from irrigated and unirrigated area	MT	249	322	494
9	Irrigated area under food grain from surface water	ha	37.2	50.1	75.9
10	Irrigated area under food grain from ground water	ha	41.9	48.1	70.3
11	Total water required for irrigation	BCM	557	611	807
	a. Surface water	BCM	339	366	463
	b. Groundwater	BCM	218	245	344

Source: National Commission on Integrated Water Resources Development Planning, GOI.

It is possible to augment the estimated utilizable water resources through proper regulation and protection of reservoir for which it is necessary to look for following possibilities.

- Large scale adoption of microirrigation technologies for surface water and groundwater irrigation schemes to improve irrigation efficiency.
- Increase system efficiency through modernization.
- Reduce seepage losses by lining.
- Encourage Water User Associations (WUA) to take over more irrigation systems from minor and below for better Operation and Maintenance (O&M) and achieve higher productivity.





CHAPTER IV

IRRIGATION METHODS

The concept of irrigation is as old as the human civilization. There has been regular improvement in the irrigation methodology. To day we have arrived at a stage where we are in a position to apply precise quantity of water at the desired interval, at the required area, at the required time and at the desired application rate. The methods used for irrigation have an important bearing on water management. Irrigation water may be applied to crops by flooding, by applying it beneath the soil surface, by spraying it under pressure or by applying it in drops or trickles. Generally speaking, relatively high application efficiencies can be attained by most irrigation methods if the soil, topographic and climatic conditions are favourable. However, for any given set of conditions, usually higher application efficiency may be attained with one particular method, which may not be possible with another method. For example, a close-growing crop on a near-level field of deep medium textured soils where normal wind velocities exceed 24 kilometers per hour could be irrigated by the border method with high application efficiency. Under the same conditions a sprinkler system would have much lower application efficiency. If the same crop were to be irrigated on a sloping field with relatively calm wind conditions, the sprinkler system would prove to be more efficient. Thus in order to attain high application efficiency, it is important that the most adaptable method of irrigation be selected.

1. CONVENTIONAL METHODS

Water is applied to the crops through different methods viz. surface, sub surface pressurized systems etc. of which surface method is the oldest and most common one. In this method the water is applied directly to the soil surface from a channel or from an open ditch at the top end of the land. The overall conveyance and application efficiency of irrigation water is the relationship between the quantity of water that has actually wetted the root zone of the crop and the quantity of water released from the source. Normally surface irrigation methods are poor in their irrigation efficiencies. About 60 to 70 per cent of the water released from the source is lost on the way by way of seepage, evaporation etc. as conveyance losses (Table 4.1).



Table 4.1: Irrigation Efficiencies under Different Methods of Irrigation. (Per cent)

Irrigation Efficiencies	Methods of Irrigation		
	Surface	Sprinkler	Drip
Conveyance efficiency	40-50 (canal) 60-70 (well)	100	100
Application efficiency	60-70	70-80	90
Surface water moisture evaporation	30-40	30-40	20-25
Overall efficiency	30-35	50-60	80-90

Source: Sivanappan (1998).

The surface method of irrigation practiced from ancient times consists of diverting a stream from the head of a field into furrows or borders and allowing it to flow across the slope by gravity. No basic change has taken place in these surface or gravity irrigation methods over the years, though certain refinements or some degree of sophistication did take place. Under the gravity system, water infiltrates the soil while traversing the furrow, border or basin. By subsequent ponding and lateral movement of the water, the soil profile is filled up to its water holding capacity to a depth which depends *inter alia* on the quantity applied, the duration, rate of stream flow, the gradient, the soil structure and texture.



Flooding is the primitive uncontrolled surface irrigation method, while check basin, border strip and furrow methods are some of the improved methods over the flooding.

1.1. Basin Irrigation: Flood irrigation is generally adopted for cereal crops like paddy which are closely spaced where standing water is required for long duration of crop growth and are cultivated on fairly level fields surrounded by bunds/dykes. Under this system the irrigation water is flooded on the entire surface of the field



through a channel. This is the simplest method of irrigation and widely practiced in India. The fruit crops like mango, guava, sapota, citrus etc when planted on the bunds receive the benefit of such irrigation. Soil having medium to heavy texture i.e. loam to clayey soils with medium to low infiltration rates, low percolation losses and high water holding capacity are suited for basin irrigation. There are two methods of supplying water to basins viz. (i) direct method and (ii) the cascade method. In direct method the water is applied directly to the basin through siphons, spills or bund breaks. In the cascade method, where the basins are made on terrace, the water is allowed to flow from the upper to the lower terrace.

1.2. Border Irrigation: In border irrigation, the water is applied in small strips of land, known as borders, which are uniformly graded. The bunds along the borders help to guide the water to flow down the field. This method is commonly used to irrigate crops like wheat, maize, pulses and oilseeds. The borders can be dismantled after harvesting the crop. This is suited for medium to heavy textured soils. The borders are irrigated by diverting the stream of water to the upper end of the border. The water flows down the slope. When the desired amount of water is delivered to the border, the stream is turned off.

1.3. Furrow Irrigation: In this system, the water is applied through a series of parallel furrows, which are in turn connected with the main channel. Furrow irrigation is suitable for crops like potato, sugarcane, vegetables, etc, which are raised on ridges. Fruit crops like mango, guava, papaya, citrus, grapes and banana are also irrigated by furrow irrigation method. The furrows are irrigated using spill siphons by connecting one end in the water channel and the other end in the furrow. Several furrows can be irrigated simultaneously depending upon the availability of water.



Generally, under open ditch conveyance and surface irrigation methods, less than one half of the water released from the source reaches the plants. The plants actually use only about 50% of the water delivered. In projects, which may be assumed to be planned, designed and operated properly, the efficiency ranges



from 30-50%. These low efficiencies may be, due to conveyance losses resulting from seepage and evaporation. The losses are also partly the result of poor farm distribution of water due to inadequate land preparation, and lack of know-how in the application of water, with consequent excess applications and deep percolation. Moreover, in addition to these low efficiencies, erosion, salination and water-logging take their toll of land productivity and water quality, degrading these two basic natural resources.

Higher efficiencies in gravity irrigation can be obtained under certain conditions, like in Research Stations and on projects managed and operated by highly skilled and trained personnel. These skills include the planning and execution of land forming operations, including leveling and shaping” introduction of advanced techniques in the determination of irrigation frequencies, quantities, stream size and duration of irrigation, the installation of water measurement and regulation systems, lining of canals, the adoption of surface irrigation delivery to suit the crop water requirements and providing proper drainage system for the removal of excess water. In summary, the gravity/surface irrigation has the following disadvantages:

- More water is needed per unit area, and application of small doses of water is almost impossible.
- The absence of proper drainage arrangements would result in accumulation of excess water thereby causing water-logging and salinity.
- Continuous care and vigilance are needed for proper water applications and adjustment of head of water.

The major advantage of gravity irrigation are that the initial on-farm capital cost required to serve an irrigated area is low and also the expenditure on O&M costs are low as no energy charges are involved. The criterion for the selection of the proper irrigation method depends upon the soil type, design of the system, cropping pattern etc. The water use efficiencies in these types of irrigation methods can be improved by adoption of appropriate design criteria keeping in view crop needs. Some of the selection criteria for surface irrigation methods are given in Table 4.2a.



4.2a Selection Criteria for the Surface Irrigation Methods

Parameter	Border	Check Basin	Furrow
Soils	All except coarse sand	Most of the soils	Most except sandy
Infiltration Rate	Moderately low to moderately high	Moderate to low	Moderate to low
Slope, %	0.2 to 1.0	No limits	From less > 0.5% to 0.5 % and even up to 2.0% in certain cases
Stream Size, lps	2 -15	Any Basin size to be adjusted	Between 0.3 and 12
Length, m	60-300	Square, Rectangle and Ring	50-400. Spacing 45 – 60 cm as per the crop needs, with a depth of 7.5 – 12.0 cm normally
Crops	Wheat, Sorghum, Bajra, Pulses	Orchard crops, Vegetable crops	Cotton, Potato, Sugarcane, Brinjal, Cabbage, Cauliflower, Tomato, Bhindi, Turmeric, Ginger, Yam, Sweet potato etc.

Widely spaced crops are generally grown in the furrow system. Normally, furrow system is more efficient method than other surface irrigation systems, unless the crop type lends itself more amenable to some other system.

2. MODERN METHODS OF IRRIGATION

Presently, the problem facing the country is not the development of water resources, but their management in a sustainable manner. The need of the day is to economize water in agriculture and to bring more area under irrigation, reduce the cost of irrigation on unit land, and increase the yield per unit area and unit quantum of water. This can be achieved only by introducing advanced irrigation methods like microirrigation. This when done will not only improve the water productivity, but also results in arresting the water logging and secondary salinisation problems of the canal command areas and check the receding water table and deteriorating water quality in the well command areas.

Modern methods of irrigation have surely a number of advantages over the conventional irrigation methods like border, check basin, furrow or surge irrigation. The following table shows some of the important points of differences between modern and other conventional methods of irrigation. (Table 4.2b)



Table 4.2b Performance of Conventional and Modern Irrigation Methods

Performance Indicator	Conventional irrigation Methods	Modern Irrigation methods
Water saving	Waste lot of water. Losses occur due to percolation, runoff and evaporation	40-70% of water can be saved over conventional irrigation methods. Runoff and deep percolation losses are nil or negligible.
Water use efficiency	30-50%, because losses are very high	80-95%
Saving in labour	Labour engaged per irrigation is higher than drip	Labour required only for operation and periodic maintenance of the system
Reduced weed Intensity	Weed infestation is very high	Less wetting of soil, weed infestation is very less or almost nil.
Use of saline water	Concentration of salts increases and adversely affects the plant growth. Saline water can not be used for irrigation	Frequent irrigation keeps the salt concentration within root zone below harmful level.
Diseases and pest problems	High	Relatively less because of less atmospheric humidity
Suitability in different Soil Type	Deep percolation is more in light soil and with limited soil depths. Runoff loss is more in heavy soils.	Suitable for all soil types as flow rate can be controlled.
Water control	Inadequate	Very precise and easy
Efficiency of fertilizer use	Efficiency is low because of heavy losses due to leaching and runoff	Very high due to reduced loss of nutrients through leaching and runoff water.
Soil erosion	Soil erosion is high because of large stream sizes used for irrigation.	Partial wetting of soil surface and slow application rates eliminate any possibility of soil erosion
Increase in crop yield	Non-uniformity in available moisture reducing the crop yield	Frequent watering eliminates moisture stress and yield can be increased up to 15-150% as compared to conventional methods of irrigation.

Source: Sivanappan, R.K. 1994. *Prospects of Micro Irrigation in India. Irrigation and Drainage Systems, Vol.8, pp.49-58.*

Narayanamoorthy, A (1997). "Drip Irrigation – A viable option for future irrigation development, *Productivity, Vol.38, No.3, October-December.*



2.1 Types of Microirrigation Systems:

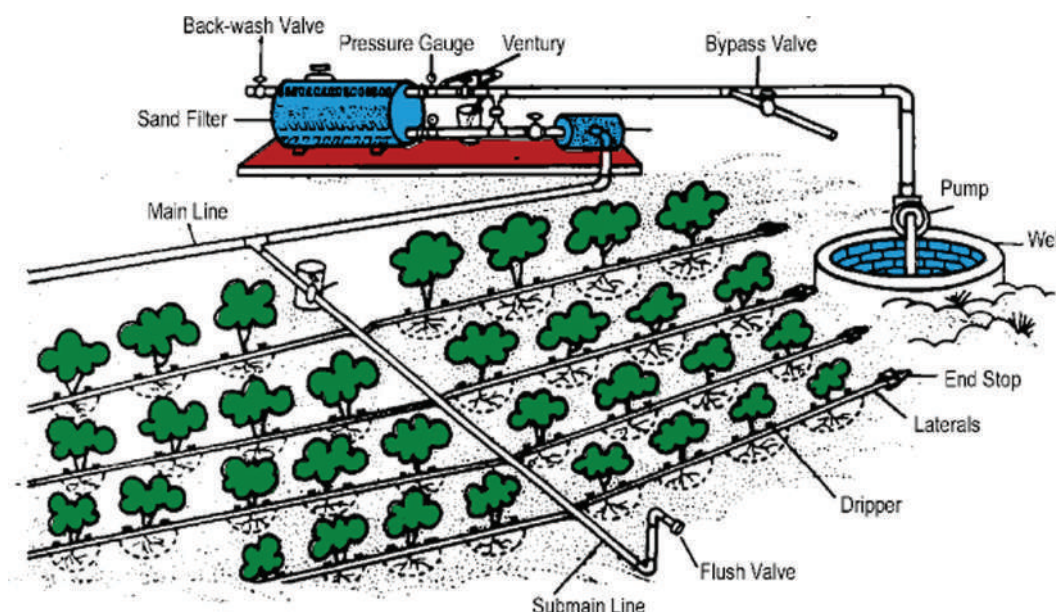
There are many microirrigation systems, which comprise of

- Drip Irrigation Systems
- Sprinkler Irrigation Systems

3. DRIP IRRIGATION

Drip irrigation is a method of irrigation with high frequency application of water in and around the root zone of plants. The microirrigation system consists of a network of pipes along with suitable emitting devices.

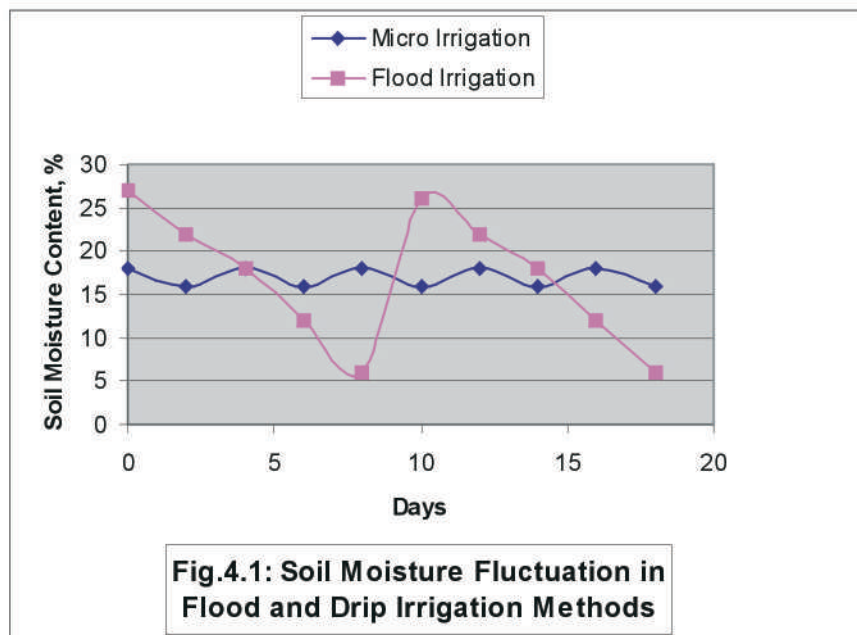
Drip irrigation is based on the fundamental concept of irrigating only the root zone of the crop rather than the entire land surface, as done during surface irrigation. Drip irrigation system is known to be able to achieve high water use efficiency, and also results in improved crop yield. In traditional types of surface irrigation, huge amount of water is lost through seepage and conveyance of water from the source to field. These losses can be avoided to a greater extent by adopting drip irrigation. In conventional irrigation methods, the plants are stressed for a good part of irrigation interval from the desirable water regime of field capacity of root zone. On the other hand, drip irrigation system allows frequent application of small quantities of water, which ultimately provides a nearly constant soil water condition in the major portion of the root zone.



Drip irrigation can thus be defined as a method of irrigation in which:

- Water is applied to the root zone of the plants directly,
- Water is applied at frequent intervals (daily) in controlled quantities as per requirements of plants,
- Water is applied through a low-pressure network of piping including Main, Sub main and Lateral lines with emitters or drippers spaced along the lateral lines.
- Water is essentially passed through a filtration system to prevent suspended impurities, which may otherwise block the emitters.
- Water-soluble fertilizers and nutrients can also be applied along with drip irrigation through a fertilizer tank and/or ventury.

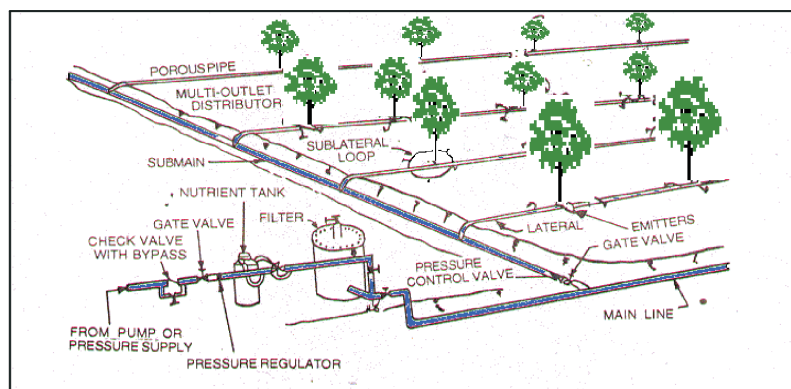
Such direct application of water to the root zone, in controlled quantities as per the plants' requirements, results in uniform growth of the plants, higher crop yields and improved quality of produce ensuring substantial saving in water required for irrigation. In drip irrigation, the cyclical nature of the conventional irrigation methods can be avoided and the soil moisture levels can be maintained at optimum Field Capacity levels continuously, whereby the conditions for plant growth are ideal all along the duration of the crop. The Fig.4.1 compares the Soil Moisture Status in Flood Irrigation method with Drip Irrigation method.



In Drip Irrigation Systems (DIS), water and nutrients enter the soil from the emitters or drippers, seeping into the root zone of the plants. In this way, the plants' withdrawals of moisture and nutrients are replenished almost immediately, ensuring that the plants never undergo water or nutrient stress, thus enabling the plants to achieve optimum growth and high yields with better quality. The above comparative graph displays feast and famine or indigestion and starvation cycles inherent in flood irrigation method and low variation in drip irrigation method.

A typical drip irrigation system has the following components:

- Dripper/ micro sprinkler/ sprayer
- Distribution lines and fittings
- Control head system
- Fertilizer tank
- Fittings



3.1 History of Drip Irrigation Technologies–World:

Around 1850, various researchers experimented with many kinds of surface and sub-surface irrigation techniques. Early attempts at a crude subsurface irrigation system were made in 1860 by German researchers, who simply pumped irrigation water into existing underground drainage systems. In the nineteen twenties and thirties, various types of porous pipes were used by a number of researchers: at Michigan State University in 1934, Professor O.E. Robey experimented with a drip tube made of porous canvas. All these efforts could not see the light of the day as they involved cumbersome and costly materials and methods as well as lack of suitable materials, which can



withstand the rigors of farming. The metal or clay conveyance systems deteriorated sooner due to weather, handling and quality of water. Thus, the simple concept of carrying and delivering water right at the root zone of the plants has not been practical until very recently, due to the lack of suitable and economical materials.

A breakthrough in the field of material science, gave an opportunity for improving the useful life of conveying systems or pipes, when polyethylene was accidentally produced in a British laboratory in 1935. Polyethylene, or PE, is produced when the monomer ethylene, a component of natural gas and other fossil fuels, is subjected to heat and pressure. In the early years of its development, only the low density form of polyethylene was known. Low density polyethylene (LDPE), produced at relatively high pressures (up to 3500 kg/cm²), was found to possess excellent resistance to most chemicals and extraordinary electrical insulating properties. However, the LDPE pipes were soon found to be cracking due to degradation by UV light from the Sun in open fields and there was need for a material with good characteristics to withstand the degradation from UV light. In 1948 the discovery of high density polyethylene (HDPE), produced at low pressures (20 kg/cm²), broadened the scope of applications for polyethylene.

In 1977 the polyethylene industry achieved a significant breakthrough with the development of a low-pressure process for polyethylene production, which lowered the cost and improved the quality of polyethylene resins. The state of the art in plastics development has continued to advance, with the recent introduction of linear low density polyethylene (LLDPE), which exhibits greatly improved strength and environmental stress-crack resistance. Polyethylene is a remarkably tough and flexible material, with a wide range of physical properties depending on the size and arrangement of the polyethylene molecules.

Polyethylene manufactures currently produce polyethylene resins, which are tailored specifically for use by manufacturers of film (for bags, plastic sheeting), by injection molders (for emitters, toys, etc.) and by manufacturers of extruded products (Drip laterals, Emitting pipes, porous pipes, etc). When suitable additives, including antioxidants, stabilizers and carbon black, were added to the clear plastic, a durable and economical product for microirrigation lateral pipes became a reality. The large scale commercial use of microirrigation began in the 1960's and early 1970's. Interest in microirrigation was most keen in Australia, Southern California, Israel



and the Middle East areas, which have traditionally suffered from scarcity of irrigation water.

Farmers quickly discovered that the microirrigation systems manufactured out of good quality plastic materials were affordable as well as in many cases they could increase their yields substantially, while simultaneously reducing water usage by 25 to 50 per cent and also reducing their operating costs.

Other historical developments are summarized below:

- In 1920, Charles Lee in California was granted a U.S. Patent for an irrigation tile that included orifices on a raised ridge inside the pipe. While the irrigation tiles were intended to be used in connection with drainage tiles, apparently their use was not intended to create a water table, as in sub-irrigation, but to “moisten the soil around the tile”; hence, this was probably one of the earliest forms of subsurface drip irrigation.
- Availability of plastics following World War II allowed the development of drip irrigation, initially in Great Britain and possibly other countries, and later in Israel and the USA. Drip irrigation development in the USA picked up beginning about 1959, especially in California and Hawaii.
- During the 1960s, laterals were produced using polyethylene or PVC pipe with holes or slits drilled, punched, or cut into the pipe or discrete emitter inserts punched into the pipe. Typically, these systems were operated at low pressures with varying water quality and filtration.
- During 1969 Whitney and Lo evaluated plugging and performance of several emitters, concluding that the plastic insert orifice was the preferred type.
- By 1970, trial installations on commercial farms and sugar plantations were being taken up using a variety of both experimental and commercial emitters and laterals. These systems were used for a variety of crops including citrus, sugarcane, pineapple, cotton, vegetables, fruits, turf grass, avocado, sweet corn, potato, etc. Most problems were related to poor uniformity, system maintenance, and emitter plugging, which was caused by iron oxide or soil particles.



- By the 1970s, equipment for installing subsurface drip systems were developed. Some equipment, while installing the laterals, either punched holes or inserted plastic emitters in the tubing.
- About the same time, i.e., during 1970s surface drip irrigation systems, including fertilizer injection equipment, were being developed in Israel. As commercial drip emitters and tubing became more reliable, surface applications grew at a greater rate than did subsurface applications because of problems with emitter plugging and root intrusion.
- In the early 1980s, interest in subsurface drip increased once again, possibly because of affordable material and equipment cost, improved nutrient management, and overall lower system cost that resulted from multiple-year use.
- During the first half of the 1980s, research work included information on lateral depth and spacing, chemical injection via the irrigation system, crop yield, water and filtration requirements, and comparisons with other types of irrigation systems.
- In 1982 Mitchell and Tilmon reported that subsurface drip systems had been in use for 10 years in their research program and offered guidelines for design, installation, and management of these systems.
- In 1985 Tollefson reported experiences with subsurface drip irrigation for cotton and wheat on a large commercial farm, which started with a test area in 1979.
- Interest in drip irrigation increased greatly after 1985, the period when most reports of replicated research studies have been published.

(Source: Camp, C.R., 1998, SUBSURFACE DRIP IRRIGATION: A REVIEW, Transactions of the ASAE, American Society of Agricultural Engineers, VOL. 41(5): 1353-1367.)

3.2 History of Drip Irrigation Technologies – India

Historically, in India also there have been efforts to improve the efficiency of irrigation since time immemorial by resorting to the methods such as use of clay pipes for conveying water from the water source to the field to avoid conveyance losses, use of bamboo pipes in Meghalaya for diverting water from perennial springs on the hilltops to the lower reaches by gravity.



Perforated clay pipes were reported to be used in Maharashtra in good old days. Similarly in several parts of the country, Pitcher Irrigation, in which a Pitcher or Pot, with bottom holes, is placed near the root zone of the tree and water poured into the Pitches manually. The water in Pitches leaks into the soil and irrigates the root zone of plants. The Pitcher Irrigation was in practice in dry regions of Maharashtra and Rajasthan.



In Meghalaya, an ingenious system of tapping of stream and spring water by using bamboo pipes to irrigate plantations is widely prevalent. It is so perfected that about 18-20 liters of water entering the bamboo pipe system per minute gets transported over several hundred meters and finally gets reduced to 20-80 drops per minute at the site of the plant. The tribal farmers of Khasi and Jaintia hills use this 200-year-old



system. The bamboo drip irrigation system is normally used to irrigate the betel leaf or black pepper crops planted in arecanut orchards or in mixed orchards. Bamboo pipes are used to divert perennial springs on the hilltops to the lower reaches by gravity. The channel sections, made of bamboo, divert and convey water to the plot site where it is distributed without leakage into branches, again made and laid out with different forms of bamboo pipes. Manipulating the intake pipe positions also controls the flow of water into the lateral pipes. Reduced channel sections and diversion units are used at

the last stage of water application. The last channel section enables the water to be dropped near the roots of the plant.

However, the further developments in the field of microirrigation ceased with lack of organized research during the British rule until 1947. Later during 60s and 70s there were few installations and research trials on drip irrigation in India, using imported components. During early 80s few companies and some progressive and innovative farmers imported drip irrigation components such as emitters and lateral pipes and were assembling the systems using local PVC pipes. However, the concept did not



catch on with the farmers, due to lack of technical support, post installation maintenance and agronomical support from the trading Companies. These systems soon fell into disuse, as they clogged due to deposition of salts in the emitters. Non-availability of spare parts and lack of chemical treatments further aggravated the problems.

3.2.1 Private Sector Contribution:

Netafim, Israel, a leading world manufacturer, was associated with some trading companies for marketing their drip components and systems in India since late 1970s. Since then they have associated themselves with different Indian partners. Ultimately, in 2002, they commenced the manufacturing operations in Gujarat through a wholly owned subsidiary. A major boost to the drip irrigation technology came in India in late 1980s when a motivated-farmer-turned-industrialist, Mr. B.H. Jain, floated a Public Corporation, Jain Irrigation Systems Ltd. (JISL) at Jalgaon. They commenced manufacturing operations with collaboration from world-leader James Hardie, USA & Australia, in early 1989. Over the years JISL has developed into an integrated manufacturer and a comprehensive service provider. They further added training and extension to their activities for spreading the message throughout the country and have setup a trend-setting example for development of the industry. The Company's R&D and Demonstration farms spanning over 1000 acres in Jalgaon, Maharashtra has become a major Center of Excellence for Hi-Tech Agri activities and is being visited by thousands of farmers, agri-extension & research officials from all over the country as well as other developing countries.

Agricultural Finance Corporation (AFC) conducted a study commissioned by AOMC&C, Gol, in October 1998 to take stock of the Drip irrigation, its status, progress and results achieved in the country. The study documented the status of Drip Irrigation industry as well. AFC summarized the status of Drip Irrigation Industry after surveying 30 firms and concluded "JISL is the only large scale manufacturer working on National Level having complete infrastructure and is mainly responsible for Drip Irrigation Development in the India. While the market share of 29 companies totaled to 41%, the share of JISL was 59%. Five companies JISL, EPC, Premier, Agro-Plast and Krishi Irrigation together were found to be having a market share of 78%, the remaining 25 companies having 22% share in the market." During later half of 1990s many Israeli manufacturers including Plastro, Netafim, Palma, Metzerplas and Naan entered the Indian market either directly



or through collaborations with Indian partners. In the field of sprinkler irrigation, Premier Irrigation, W. Bengal, have been active since late 1960s. EPC & JISL also entered the sprinkler irrigation field in early 1980s and 1990s respectively.

3.2.2 Government's Role:

The Government support by means of subsidies for Drip Irrigation systems in the country was originally initiated by Shri Sharad G. Pawar, as Chief Minister in the state of Maharashtra in the year 1988. After his visit to several countries such as USA, Europe he was convinced of potential and importance of Drip Irrigation, he evolved the first ever subsidy scheme for drip at the State level. Later, the Government of India took up a Centrally sponsored scheme for promotion of Sprinkler irrigation in VII plan period and Drip irrigation in VIII Plan period. However, the Centrally sponsored scheme for promotion of Drip Irrigation in the country got a fillip with the efforts of Late Mr. Devlal, the then Deputy Prime Minister, who declared Rs 200 crores of subsidy allocation for promoting drip, after his visit to the facilities of Jain Irrigation Systems Ltd in 1992.

Recently, Shri N. Chandra Babu Naidu, Chief Minister of Andhra Pradesh, has conceived and launched probably the world's largest microirrigation project under name of 'Andhra Pradesh microirrigation Project (APMIP)'. He plans to bring 250,000 ha under microirrigation Systems within a short period of 2 years. Under this scheme the farmers would be given 50% subsidy with an upper limit of Rs 50,000 for each farmer. The scheme is unique in several aspects such as all crops are approved for coverage under microirrigation, payments to suppliers are routed through banks to avoid delays, mal-practices in subsidy distribution, the MI suppliers are obligated to provide agronomic services under an agreement signed with the State Government, etc. This is a historic step in the history of MI not only in India but also in the world.

Dr. H.P. Singh, with his long experience of more than 30 years in water management, has contributed significantly to the promotion of microirrigation in the country, starting from its inception in eighties, which got major boost when he handled microirrigation as Horticulture commissioner, Gol and member secretary of National Committee on Plasticulture Application in Horticulture, both in terms of scientific inputs and coverage of area. Dr H. P. Singh's concepts and perceptions mixed with capacity to put forward views convincingly have given a major boost to acceptance of microirrigation in achieving the goal of knowledge based and technology-driven development of horticulture. Similarly, Dr. Jose C. Samuel has played a pivotal role in accelerating the



promotion of microirrigation in the country through his contributions in formulating guidelines and its adoption.

Other notable Agricultural Researchers, Scientists and Administrators who took deep, committed and sustained interest for spreading the concept of MICROIRRIGATION in the country include Dr. R.K. Sivanappan, Dr. H. S. Magar, Shri G.V.K. Rao, Mr. U. C. Sarangi, Dr. B.D. Dhawan, Dr. G.L. Kaul, Dr. S.R. Singh, Dr. A. Narayanamoorthy, Dr. S. Raman, Mr. N.T. Tankhiwale, Dr. V.P. Jauhari, Mr. J.S.V. Prasad and Mr. G.K. Vasant Kumar. Among the institutions, outstanding work has been by WALMIs, INCID, New Delhi; Gokhale Institute of Economics and Politics, Pune; Agricultural Finance Corporation, NABARD, ICAR Institutes and State Agricultural Universities in the country.

3.3 Advantages of Drip Irrigation:

The major advantages of Drip Irrigation Systems with respect are:

3.3.1 Increased Yield:

Under traditional irrigation methods plants extract water from the soil from Field Capacity down towards Permanent wilting point. During this transition in the soil moisture, it becomes increasingly difficult for the plant to extract water and therefore the consumptive water use rate decreases. This reduction in water use accompanied by a reduction in growth of the plants results in reduced yields. Ideally to achieve maximum yields the soil moisture level should be slightly below field capacity. The drip irrigation system with its controlled application of water makes possible the task of maintaining the soil moisture close to the field capacity, thus resulting in noticeable increase in growth and yield. The more favorable growing conditions made possible by drip irrigation will bring the crops into maturity earlier than traditional irrigation methods. Table 4.3 provides data on yield increase with DIS in different crops.



Table 4.3: Yield Increase with DIS

Crop	Yield (MT/ha)		
	Conventional	Drip	%Yield Increase
Banana	57.5	87.5	52
Grapes	26.4	32.5	23
Sweet lime	100.0	150.0	50
Pomegranate	55.0	109.0	98
Papaya	13.4	23.5	75
Tomato	32.0	48.0	50
Water Melon	24.0	45.0	88
Okra	15.3	17.7	16
Chillies	4.2	6.1	44
Sweet Potato	4.2	5.9	39
Sugarcane	128.0	170.0	33
Cotton	2.3	2.9	26

Source: INCID (1994), *Drip Irrigation in India*, New Delhi

3.3.2 Water Saving:

Due to elimination of water transmission losses such as seepage, evaporation, deep percolation; amount of water required for irrigation will be lower than that with the conventional surface irrigation methods. Also, as only a small portion of root zone actually receiving the water, wastage of water in wetting the unwanted areas is also eliminated. Thus, there will be considerable amount of water saving with drip irrigation. Thus it is generally observed that water saving achieved by DIS is 50% as compared to conventional irrigation method. Table- 4.4 shows the water savings with DIS in different crops.

3.3.3 Improved Quality:

Crop quality under drip irrigation is improved as drip irrigation results in uniform growth producing more consistent quality and better colour complexion. In addition, damage and losses due to water contact with foliage are eliminated resulting in improved quality of produce. (Sivanappan, 1994; Narayanamoorthy, 1996, 2001; Dhawan, 2002)



3.3.4 Fertilizer Application Efficiency:

A drip irrigation system is an effective means of applying fertilizer and other nutrients into the root zone where they are needed. This ability to apply fertilizer directly to roots assists crops in growing well with lesser amounts of fertilizer. Thus, the efficiency of fertilizer application improves with the use of drip irrigation systems. (VSI, 2000; NCPAH, 2001; Dhawan, 2002). Table- 4.5 gives the details of Fertilizer saving in different crops with the use of drip irrigation.

Table- 4.5: Savings in fertilizer and increase in crop yield under fertigation

Crop	Saving in fertilizer, %	Increase in Yield, %
Sugarcane	50	40
Banana	20	11
Onion	40	16
Cotton	30	20
Potato	40	30
Tomato	40	33
Castor	60	32
Okra	40	18
Broccoli	40	10

Source: NCPAH, (2001), *National Committee on Plasticulture applications in Horticulture, Progress Report 2001, Ministry of Agriculture, GoI, New Delhi*

3.3.5 Energy Conservation:

When compared to other methods of irrigation, 25 to 30 per cent energy savings in pumping water are possible with drip irrigation. This is due to the low-pressure requirement, lower water application rates and improved efficiency, the energy requirements are lower than with other methods of irrigation, thus saving the energy. (Narayanamoorthy, 1996, 1997, 2001)

3.3.6 Reduced Labour Costs:

Labour requirements are low because of reduced field preparation, elimination of fertilizer application as a separate operation, lesser number of weeding, fewer harvesting



rounds due to more uniform ripening, higher ratooning & picking possibilities and cropping intensity. (Sivanappan,1994; Narayanamoorthy, 1996,1997,2001)

3.3.7 Water Use Efficiency:

Table- 4.6 shows the Water Use Efficiency observed in different crops by adopting DIS. The increase in yields combined with savings in water result in higher water use efficiency.

Table- 4.6: Water Use Efficiency with DIS

Crop	Yield increase,%	Water Saving,%	Increase in Water Use Efficiency,%
Banana	52	45	176
Chilly	45	63	291
Grapes	23	48	136
Groundnut	91	36	197
Sweet Lime	50	61	289
Pomegranate	45	45	167
Sugarcane	33	56	204
Tomato	50	31	119
Water Melon	88	36	195

Source: INCID (1994), *Drip Irrigation in India*, New Delhi

3.3.8 Improved Disease and Pest Management:

Due to application of water only to the root zone of plants, areas surrounding the plants remain dry and thus weed growth will be under control. With little or no weed growth, the intensity of Pest and Disease incidence is reduced. In addition, the spread of disease causing organisms by water movement is much less likely since surface water runoff is eliminated. (Source: James Hardie Design Manual, 1988)

3.3.9 Feasibility of Irrigating Difficult Terrains:

Hilly and undulating areas cannot be irrigated by conventional methods of irrigation due to differences in gradients. However, with DIS such difficult terrains can be irrigated easily as the DIS is a pressurized irrigation system, which can be designed to take care of the changing field gradients. Thus, the difficult terrains which were previously unused can be put to productive use.



3.3.10 Suitability for Problem Soils:

In highly clay soils, low application rates can be chosen to meet the low infiltration rates of such soils. Water can be applied in very slow rates adequate enough for the soil to absorb without causing run-off. On the other hand for soils with very high infiltration rates, such as sandy soils, the water can be applied in small quantities more frequently, avoiding percolation and seepage losses.

3.3.11 Improved Tolerance to Salinity:

In general drip irrigation will reduce the sensitivity of most crops to saline soils and waters, due to its ability to maintain low water tension in the root zone. The frequent application of water with drip irrigation reduces the concentration of salts in the root zone by moving the salts away from the root zone to the edges of the wetter perimeter. This process called micro leaching, prevents the harmful combination of high soil salinity and low soil moisture from occurring. Thus, crops under drip irrigation are more tolerant to saline soil and water conditions. In short, drip irrigation technologies, which irrigate the crop rather than the land are environmentally friendly, sustainable and lead to optimal use of both land and water resources for maximizing production and help in improving the economic condition of Indian farmers through sustainable improvement in agricultural productivity per unit of water and land. Recognising water stress and scarcity there is no option left but to adopt modern irrigation technologies, which save water, double the area under irrigation, improves yields and quality as well as save on labour, energy and crop production costs. The DIS should be viewed as a total plant support system and management tool for high production of premium quality at reduced cost. With advancement in software and hardware, DIS is not at all location, crop, soil or water quality specific and could be a versatile management tool in the hands of a farmer, whether small or large.

3.3.12 Environmental Reasons:

Most of the environmental problems associated with irrigation occur mainly because of predominant practice of the flood method of irrigation. The conventional method of irrigation not only leads to inefficient use of irrigation water due to enormous losses in evaporation and distribution but also results in over-use of water, which ultimately brings many negative externalities in agriculture. While over-use of irrigation water causes damage to soils in the form of water logging and soil salinity on the one side, it also reduces the yield of crops on the other side (Chopra, 1996).



Groundwater irrigation also has its own share of problems although the magnitude is different from MI system. With the fast increase of density of wells, the rate of exploitation of groundwater has been increasing at a rapid pace. As a result of over-exploitation of water, problems like sea water intrusion, progressive lowering of water table, increase in fluoride level in groundwater, etc., have been reported in different parts of the country (Vaidyanathan, 1994). Thus, drip method of irrigation will help to reduce the environmental problems associated with flood method of irrigation to a larger extent, as the management of irrigation is much easier and less quantity of water is used for crop cultivation. (Narayanamoorthy, 2003).

3.3.13 Equity in reaching the benefits of irrigated agriculture:

Under flood irrigated conditions farmers located at the tail end of an irrigation project normally, do not get the water as compared to those closer to the distribution network. Thus, the benefits of irrigation projects are not equally distributed among all the farmers in the command area. But, with the implementation of drip irrigation, enormous amount of water would be saved even during the scarcity period, which can be made available to the farmers in the tail end, thus bringing equity among the farmers.

3.3.14 Improved Combined Efficiency of Inputs:

Microirrigation helps all other inputs in crop cultivation such as seed material, fertilizers, plant protection chemicals, etc to perform better conjunctively, whereby their combined efficiency is much higher than the efficiency of these inputs in isolation. Thus, drip method of irrigation helps in optimizing the input use as well as results in higher productivity of inputs used.

3.4 Drip Irrigation Technologies - Hardware

3.4.1. Emitting Devices-General:

In microirrigation systems, emitters or drippers are the key components through which water is released in regulated amounts as evenly as possible depending on its construction. The actual application of water in a micro-irrigation system is through an emitter. The emitter is a metering device made usually from plastic that delivers a small but precise amount of water in an unit time ie. Discharge rate. The quantity of water delivered from these emitters is usually expressed in liters per hour (lph) or gallons per hour (gph). Emission devices deliver water in different modes: drip, spray, jet, fog, mist, bubbler and micro-sprinkler. In drip mode, water is applied as droplets or



trickles. In bubbler mode, water ‘bubbles out’ from the emitters. Water is sprinkled, sprayed, or misted in the micro-sprinkler, jet/spray, mister, fogger mode. Emitters for each of these modes are available in several discharge increments. Some emitters are adapted to apply water to closely spaced crops planted in rows. Other emitters are used to irrigate several plants at once. There are emitters that apply water to a single plant.

These emitters dissipate water pressure through the use of long-paths, small orifices or diaphragms. Some emitters are pressure compensating meaning they discharge water at a constant rate over a range of pressures. The major emitter types and their definitions are summarized below for a quick reference:

- *Emitters*: Small microirrigation dispensing devices designed to dissipate pressure and discharge a small uniform flow or trickle of water at a constant discharge, which does not vary significantly because of minor differences in pressure head. Also called “dripper” or “trickler” (ASAE).
- *Compensating emitter*: Designed to discharge water at a constant rate of a wide range of lateral line pressures (ASAE).
- *Continuous flushing emitter*: Designed to continuously permit passage of large solid particles while operating at a trickle or drip flow thus reducing filter fineness requirements (ASAE).
- *Flushing emitter*: Designed to have a flushing flow of water to clear the discharge opening every time the system is turned on (ASAE).
- *Line-source emitter*: Water is discharged from closely spaced perforations, emitters, or a porous wall along the tubing (ASAE).
- *Long path emitter*: Employs a long capillary-sized tube or channel to dissipate pressure (ASAE).
- *Multi-outlet emitter*: Supplies water to 2 or more points through small diameter auxiliary tubing (ASAE).
- *Orifice emitter*: Employs a series of orifices to dissipate pressure (ASAE).
- *Vortex emitter*: Employs a vortex effect to dissipate pressure (ASAE).



An ideal Dripper or emitter should possess the following desirable feature in order to ensure successful operation and maintenance of drip irrigation systems in the farmers' fields. It should be inexpensive, easy to manufacture, easy to install, resistant to clogging, having uniformity in discharge, having constant performance over a given length of time, reliable in performance and accurate.

In practice, most emission devices possess a few of these attributes, and therefore it is necessary to discuss the subject in little more detail. The need for specific features from the above list depends upon information about the field, crop and water. For example, resistance to clogging may be extremely desirable with poor quality water sources, and relatively unimportant with clean well water source. Likewise, pressure compensation may be useful on steep or undulating terrain, but offers fewer real advantages in a properly designed microirrigation system on moderate, uniform terrain.

Laminar Flow Drippers: In laminar flow, fluid particles move in a slow and orderly fashion, following smoothly and at low velocity. Laminar flow devices regulate water flow by dissipating energy via friction against the walls of the water passage. The smaller or longer the passage, the more frictional resistance it will offer to the flow of water. Therefore, laminar flow device typically utilize long and narrow flow paths. Microtubes, capillary tubes, and spiral path emitters are good examples of laminar flow devices.

Laminar flow devices are simple, reliable, and inexpensive, and with proper system design and operation, these devices will perform well. The drawback to these device are that they are relatively pressure-sensitive (their flow rate varies significantly with pressure), and they are susceptible to clogging because of their low velocity flow and small flow path diameters. Laminar flow devices are also sensitive to water viscosity, which means their flow rate will vary with water temperature.

Turbulent Flow Emitters: In turbulent flow, fluid particles move rapidly in irregular, random motions. Turbulent flow drippers regulate water flow by dissipating energy in friction against the walls of the water passage and also between the fluid particles themselves. Tortuous flow path emitters are to some extent turbulent flow devices, relying both upon turbulence and wall friction to dissipate energy. Compared to laminar flow, turbulent flow devices have the advantage of shorter and wider flow paths and higher flow velocities, which are advantageous in terms of resistance to clogging.



Also, to the extent that a device is truly a turbulent flow device, its flow rate will be less sensitive to pressure variations, than laminar flow devices, and its flow rate will be unaffected by water temperature.

Vortex Flow Emitters: Vortex emitters are designed to take advantage of the fact that a vortex, or whirlpool, possesses a lowered pressure at its center. As water rotates within a vortex emitter, centrifugal force pushes it towards the outer edge of the vortex, resulting in a low-pressure area at the center. The emission point, usually an orifice located at the center of the vortex where there is lower pressure and emits a correspondingly lower flow. A well-designed vortex emitter is less pressure sensitive than a turbulent flow emitter. Vortex emitters generally have the drawback that their water passages are very small and easily clogged by soil particles or other contaminants. Thus, vortex emitter will require a high quality filtration system and attentive management.

Pressure Compensating Emitters: Pressure compensating devices may be either laminar or turbulent flow devices. In either case, these devices utilize the inlet pressure to modify the flow path size, shape or length. This flow path modification is usually accomplished by means of a pressure-induced deformation of an elastomeric disc, diaphragm, or water passage. In this way, pressure-compensating devices are able to deliver the correct flow rate over a fairly wide range of inlet pressures, and within that range their flow rates are relatively constant. Pressure compensating emitters suffer from the drawback that the elastomeric materials used in their construction have a tendency to change properties as they age. Depending on the material, the elastomer may have a tendency to absorb water, lose its elasticity, or creep under prolonged stress. Changing elastomer properties over time will result in a change in performance of the dripper. Thus, it is extremely important that the elastomeric material used in emitter construction be of highest quality.

Theory of Laminar and Turbulent Flow Emitters: Despite the large number of emission devices available, and the range of claims made for them, emission devices all regulate water flow by dissipation of energy through frictional resistance. Emission devices generally operate according to the flow formula,



$$Q = K (P)^X$$

Where Q = Flow Rate, lph
 P = Operating Pressure, kg/cm²
 K = Flow Coefficient
 X = Flow Exponent or Emitter Exponent

The value of the flow coefficient K is related to the physical dimensions of the water passage. The flow exponent X may range from zero to one, depending upon the dripper type and design. The value of X is important because it plays a major role in the uniformity of water application. The lower the value of X , the more pressure compensating the device is. Thus, in the case of fully pressure-compensating emitters, X equals zero, the flow rate is constant within the specified range of operating pressures, and the uniformity of the system will theoretically be perfect. In the case of non-pressure-compensating emitters, the value of X depends upon whether the emitter flow is vortical, fully turbulent, fully laminar, or somewhere between turbulent and laminar.

Table- 4.7: Exponent (X) Values for Various Flow Regimes & Drippers

Dripper Type	Value of Exponent, x
Laminar Flow Drippers	More than 0.5
Turbulent Flow Drippers	Between 0.2 to 0.5
Pressure Compensate Drippers	Less than 0.2
Vortex Flow Drippers	Between 0.4 to 0.3
Micro Tube	0.8 to 0.9

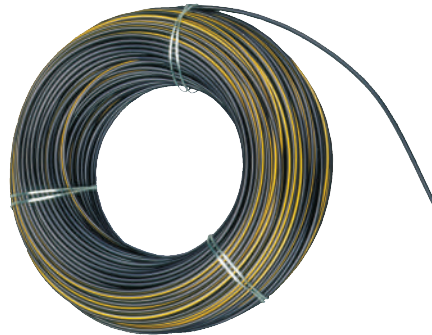
Specific details about each of the emitter/dripper types are given below:

3.4.1.1 Micro tubing:

The technique involves the application of water through small tubes of internal diameters ranging from 0.5 mm to 1.2 mm. These tubes are usually made of LDPE or LLDPE, the discharge of which depends upon their length. The longer the Micro tube, the lower will be the discharge from it. The usual range of discharges from micro tubes varies from 1 lph for a length of 6' micro tube to 10 lph from a micro tube of length 6 inches. These tubes are also called 'spaghetti tubes' and are the earliest forms of emitters



during the early days of drip irrigation development. These micro tubes can be used for orchard trees as well as for row crops. For row crops, the outlets are spaced at 2' to 3' intervals along each lateral line, and in orchards, one or more outlets are inserted into the lateral line at each tree.



As the flow regime through these micro tubes is laminar in nature, the variation in discharge with varying pressure is enormous which results in excessive non-uniformity in the water applied to plants within an irrigation zone. Thus, the effectiveness of system will depend upon land topography, size of irrigation zones and water quality. Also, these tubes are more prone to clogging due to physical and chemical contaminants in the water. However, these systems are still in wide use in India owing to their simplicity in construction and ease of de-clogging compared to the complexities of modern day emitters. A micro tube based irrigation system costs less due to lower price of these tubes compared to ideal emitters.

3.4.1.2 Drippers or Emitters:

The commonly used drippers are non-pressure compensating dripper or pressure compensating drippers, in-line drippers, adjustable discharge type drippers, vortex type drippers and micro tubing of 1 to 4 mm diameter. The choice among these drippers depends on the pressure discharge relationship of the dripper, the type of crop, topography and soil type of the area. In this system, water is applied to the soil near the root zone of the plants. The system applies water slowly under pressure to help maintaining the soil moisture within the desired range of plant growth. The volume of soil wetted by surface drip irrigation is much less than that wetted by other surface irrigation methods.

Online Pressure Compensating Drippers

With the help of Pressure Compensated Drippers, water can be applied uniformly on long rows and on uneven slopes. Pressure compensating drippers are manufactured so that the discharge from each dripper is uniform at varying operating pressures. A flexible internal diaphragm or disc inside the emitter changes shape at higher pressures





to create greater restriction to flow as the pressure rises. As a result, the discharge remains constant over the operating pressure range. At low pressure, such as at system start-up, the internal diaphragm has not begun to change shape, leaving the flow path and/or orifice, inside the emitter at maximum size. At this pressure, the emitter is operating in flushing mode.

Hence these drippers are also believed to have the feature of “Self Flushing”. When the system reaches its designed operating pressure (usually 1.5 kg/cm^2), pressure compensation becomes effective, and the discharge rate remains the same for all higher pressures up to the maximum operating pressure (say 2.5 to 3 kg/cm^2).

The discharge for the non-pressure compensating drippers increases directly with an increase in pressure while that for the pressure compensating drippers remains nearly the same for its operating range. Thus, the pressure compensating drippers can also be operated at higher pressures.

Emitters are installed on the laterals in the field. Alternatively, they can be pre-installed in the factory at the required spacing. Some types are made so they can be buried in the soil along the crop row. The use of pressure compensating drippers simplifies the design of drip irrigation systems and improves the uniformity of water application in the field especially in undulating and hilly terrains. Larger fields can be irrigated at one time using lesser quantum of Submain piping and fewer pressure regulation devices. Disadvantages may include higher initial investment costs and higher operating pressures and hence higher operating costs compared to systems using non-pressure compensating drippers.

Online Non-Pressure Compensating Drippers: Non pressure compensating does not possess the pressure compensation feature explained as above and hence their discharge tends to vary with operating pressure much widely than that of the pressure compensating drippers.





These drippers will be ideally suitable for the fields with little or no undulations and almost flat terrains. These drippers are less costly and are most widely used.

3.4.1.3 Inline Drippers/Inline Tubes:

In an online drip system, the drippers or emitters are inserted into the holes punched on drip laterals. Such punching of drippers or emitters on the lateral lines will be cumbersome in installing drip systems in large fields as well as in row crops. In row crops, a continuous wetting pattern is essential for irrigating all the plants in the rows. For achieving such continuous wetting pattern, the spacing between the drippers will be as close as 100 cm to 30cm, whereby insertion of typical online emitters will be very cumbersome on account of the very high number of drippers involved.

Thus, in order to reduce the labour involved in installing drip systems in row crops and on large areas, inline tubes are suitable. In these inline tubes, drippers are inserted into the tube at the time of extruding the lateral tubes in the factory. The drippers are inserted at desired intervals as per the crop and soil requirements.





Various types of inline tubes are available, which include; inline tubes with cylindrical drippers; inline tubes with patch drippers; inline tubes where the emitters are moulded on the tube itself; Porous Tapes / tubes.

While the inline drip tubes with cylindrical drippers and patch drippers are most popular on the tube itself are also increasingly becoming popular outside the country and they are likely to catch up soon. Similarly, few traders introduced in the country, Porous pipe products, which emit water all along their length from literally thousands of points per meter from which water weeps out of the tubing. These porous pipes have not been used on a large scale due to their disadvantages such as poor resistance to plugging by roots, plugging by fine particles, clogging due to chemical precipitates, low application uniformities and low efficiencies. Recently, some of the progressive farmers have introduced this system in Gujarat.

The suitability of a specific type of inline tube depends upon the water quality and the experience of farmer in handling the drip irrigation systems. As the drippers are inserted permanently inside the drip lateral, the only possibility of declogging these lines is to inject acids and chlorine, whereas in an online drip system, the drippers can be separated from the lateral and declogged manually or in a chemical solution. The emitters in an inline tube are injection moulded separately and inserted into the lateral tube during its extrusion process. Inline drippers are available with pressure compensation feature also. As the farm sizes in India are small, and as the farmers prefer foolproof systems, which can be used over a long period of time, the inline tubes are not popular in the country.



3.4.1.4 Micro Jets or Micro Spray:



The main advantages of the Micro Jets or Micro Sprays are low operating pressure requirements of from 0.8 to 1.5 kg/cm², low water application rates, less demanding filtration, and suitability for stony or very coarse sandy soils. The objective of these micro jets and micro sprays is to emit water in the form of small droplets without causing any misting at all. These Jets/Sprays can meet the requirements of under-tree frost protection as well. Micro Jets and Sprays offer various spray patterns, discharge rates, and positioning possibilities (from flat on the ground, on risers of various lengths, and attached to trellis wires). In windy conditions the jets/sprays with low angle of emission need to be installed.

3.4.1.5 Micro & Mini Sprinklers:



These are small plastic sprinklers with rotating spinners. The spinners rotate with water pressure and sprinkle the water. Due to the impact created by the rotating spinners the water can be sprinkled on a larger area than jets/sprays. These are available in different discharges and diameters of coverage and can operate at low pressure in the range of 1.0 to 1.5 kg/cm². These are useful for high discharge requirements in case of orchards and also where the crop canopy as well as the root zone spread is wider.

The sprinkler heads are individually connected to the lateral pipe typically using “spaghetti tubing,” or extension tube of small diameters such as 6 mm diameter tubing. These micro-sprinkler heads can be mounted on a special support stake or on a plastic pipe riser connected to the supply pipe.

3.4.1.6 Foggers / Misters:

The foggers and misters are designed to produce very fine droplets creating a uniform cloud of miniature droplets, for applications such as cooling, humidification and misting as well as for irrigating plants in greenhouses and nurseries. The fine mist and fog creates suitable microclimate necessary for germination and

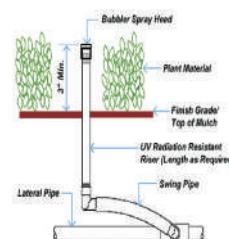


plant propagation requirements. The amount of water applied will be quite low compared to the jets, sprays and micro/mini sprinklers.

3.4.1.7 Bubbler systems:



These are low-pressure emitters designed to bubble-out water with rapid discharge rates. The bubbling patterns will be either in the form of sheet of water like an umbrella or in the form of streams. The bubbler emission devices are equipped with single or multiple port outlets.



Most bubbler heads are used in planter boxes, tree wells, or specialized landscape applications where deep localized watering is preferable. The typical flow rate from bubbler is between 8 and 80 liters per hour. Bubbler systems do not require elaborate filtration systems, which are otherwise necessary for dripper type microirrigation systems. The irrigation water delivered by each bubbler is distributed uniformly by filling small basins, surrounded by low ridges. These are suitable in situations where large amounts of water need to be applied in a short period of time and suitable for irrigating trees with wide root zones and high water requirements.

These are also suitable for irrigating shrubs in which a bubbler can be installed alongside group of shrubs. Despite many advantages, bubbler systems have not been widely used.

In order to avoid variation in discharge along a row of bubblers, pressure compensation feature is now a days available similar to the feature in Pressure Compensated emitters.

3.4.1.8 Low Energy Precision Application (LEPA)



A low cost micro sprinkler head named as LEPA (Low Energy Precision Application) Type Micro Sprinkler head, which is affordable, dependable and simple and farmer friendly is being developed and quite famous now-a-days in the field of microirrigation. Water is delivered through a network of main pipes, submains and laterals and falls as a circular spray through these sprinkler heads. It is very simple in design and clog free system of irrigation,



ensuring complete wetting of the basin area of the crop. Its wetted area can be more than that is possible with drippers and less than that of the mini-sprinkler systems.

Advantages of the LEPA system are:

- Does not have any sophisticated components
- Lesser operating pressure than in the sprinkler irrigation
- Clogging susceptibility is almost nil
- Area of coverage – in between drip and mini sprinkler
- More distribution uniformity in crop root zone than in drip system
- Complete wetting of the basin area, and providing a cool environment for plant

3.4.2 Filtration Systems for Drip Irrigation Systems:

Physical treatment of a water source is necessary when the water contains suspended solids, which create clogging problems inside the drip irrigation systems, if not removed. The type and quantity of contaminants in the irrigation source water are determining factors in selecting the type of irrigation filter to use. Physical contaminants in irrigation water consist of both organic and inorganic matter. The organic contaminants include algae, weed seeds, snails, moss, certain forms of bacteria, and generally anything that is/was alive. The inorganic contaminants include the range of sand, silt, clay particles, and any chemical precipitates that might occur.

There are various types of filtration systems available for removing these physical impurities from the source waters. They are:

- Hydrocyclones or Centrifugal Sand Separators
- Pressure Screen Filters
- Sand and Gravel Media Filters
- Disc Filters



3.4.2.1 Hydrocyclones or Centrifugal Sand Separators

Hydrocyclones or Centrifugal sand separators are used to remove sand, scale, and other particulates that are appreciably heavier than water. They will



remove particles down to a size of 74 microns (200 mesh) under normal operation. The operation of a hydrocyclone separator depends upon centrifugal forces within a vortex created by the incoming flow, thus separator size must be carefully matched to the design flow rate. They are self-cleaning and require a minimum of maintenance. Hydrocyclones will not remove organic materials, and they suffer from the drawback that the head loss across them is higher (0.5 to 0.7 kg/cm²) than with other types of filters.

3.4.2.2 Screen Filters:

Screen filters consist of a fine mesh screen encased within a closed housing. Often used as a primary filtration unit for well water sources, screen filters serve to remove inorganic physical contaminants such as silts, sand, scales, etc. Screen filters are available in a wide variety of types and flow rate capacities, with screen sizes ranging from 20 mesh to 200 mesh. In addition to primary filtration of water sources, screen filters often act as backup filters to catch sand or scale which may have accidentally entered the system through pipeline breaks, media filter failures, or other unforeseen circumstances. The aperture size of the screen opening should be between one seventh and one tenth of the orifice size of the emission devices used. The material of construction of the Housing as well as the screen element can be either mild steel or plastic. Screen filters require periodic cleaning of the screen element for removing the filtered materials from the surface of the screen and from inside the housing. Arrangements such as Drain valves, ports for measuring pressure on both inlet and outlet of screen filter, etc are essential accessories required along with the screen filter for its proper use and operation. Careful attention to maintenance and cleaning is necessary with screen filters. When screens become blocked, the pressure differential



across the screen may force particles, which would normally be retained through the screen. Because most screen filters must be disassembled for cleaning, they are not practical for use with waters containing significant levels of contaminants, since this would require frequent disassembly and cleaning. However, screen filter with brush arrangements and filters with automatic washing arrangements are now a days available with which the process of filter cleaning can be taken up without disassembling the unit. Every microirrigation system should incorporate a screen filter as a minimum requirement irrespective of the presence of absence of other types of filters.

3.4.2.3 Sand Filters:

Sand filters are ideally suited for filtering water with either organic or inorganic contaminants. Sand filters are the best selection for filtering source water that is heavily contaminated with organic matter. Sand media filters have the ability to entrap and hold large quantities of contaminants, due to the three-dimensional nature of the filter bed. A media filter is basically a tank filled with fine sand and/or gravel, most common being Sand. These filters are especially suitable for



microirrigation systems because they are three-dimensional filters. Sand Filters are often used inline drip systems, particularly where the water is from a surface source. They serve to remove fine suspended solids such as algae, soil particles, and organic debris. They are absolutely necessary where surface water sources such as streams or reservoirs are used for irrigation. These filters are available in both Horizontal and Vertical models.



The quality of water from a sand filter depends upon the flow rate through the filter, and on the type of sand used. In general, the lower the flow rate and the finer the sand, the better the filtration will be. However, a lower flow rate means more filters, and hence a higher cost. Similarly a finer sand may result in a greater head loss across the filter and a more frequent backwashing requirement. Thus, the cost of a sand filter station must be weighed against the required water quality from the filter and the manageable frequency of backwashing. Sand filters are cleaned by backwashing. During this process, the normal downward direction of water flow is reversed, passing upwards through the media, fluidizing the media bed and removing trapped contaminants. The velocity of the backwash is carefully regulated so that only the filtered material is removed and the media remains in the filter body. Sand media filters should be followed by a pressure screen filter to protect against the possibility of the filter sand finding its way out of the filter into the system.

Selection of proper sand media filter type and size is dependent on several important factors such as:

- type, size and concentration of contamination in the irrigation source water.
- quality requirement for the filtered water.
- design flow rate.

To be effective, the filter station must be designed to function under the most adverse conditions expected. Water quality varies widely from one water source to the next, and frequently the quality of a single water source varies widely with the seasons. This is particularly true of surface water sources such as streams and reservoirs. Storm runoff introduces large quantities of soil, debris, and nutrients into streams, rivers and lakes. This will result in high silt and clay loads in the water, and may promote “blooms” of algae and other aquatic organisms.

Well water sources, naturally, tend to be far more stable than surface waters, although they are by no means immune to seasonal variations. Well water may vary in salinity and dissolved solids in accordance with the seasonal rise or fall of ground water tables, or as a result of variations in pumping rate. Also, well waters may contain sand and scale loads which vary with the pumping rate. The effluent quality required for a given irrigation system will obviously depend on the system and the type and size of emission devices to be used. A very successful rule of thumb is to filter the water to the equivalent



of a 74 micron particle size. This corresponds to a 200 mesh screen or a media filter with a No. 11 sand media bed.

3.4.2.4 Disc Filters:

Disc filters carry out a three dimensional filtration. The grooved discs have trapezoidal channels on both sides, whose cross sectional area reduces along the depth of the disc.



The grooved discs have trapezoidal channels on both sides, whose cross sectional area reduces along the depth of the disc. The particles are retained first at a single point, as in the mesh, but also along the whole depth of the tapered tunnel, and therefore the area of retention is increased. As a result, the disc filtration can retain other smaller particles due to the forces of adhesion and cohesion, which exist between them and the channel walls, thus increasing the performance of the system.

Disc filters are also sometimes used to remove biological impurities from irrigation water. During back-flushing, the discs within the filters are separated and are cleaned. Disc filters require less water than media filters for online back-flushing, but they may require back-flushing pressures as high as 2 to 3 kg/cm².

If sand is a particular concern for a given system, choice of disc filters may not be correct. During back flushing or during the manual cleaning of discs, when the discs are separated, sand may become lodged between discs. If this happens, the effective mesh size of the filter is reduced and filtration will be less effective. In such cases where sand is a major contaminant, use of hydro cyclone combined with a sand and screen filter combination may be necessary. Also, the quantum of physical contaminant that can be held by a disc filter of a given capacity may be little higher than that of a screen filter of same capacity but it is certainly less than that of a media filter. This is because, the amount of pore space in a media filter is much higher than the space between the disc in a disc filter. Hence, for waters where biological and/or physical impurities are high it is advisable to use a media filter rather than a disc filter.

The filter bodies especially for Sand and other media filters as well as screen/disc filters are metallic tanks, which need to be protected from the corrosive action of salts in source waters, fertilizer solutions and chemicals being injected into the system. In the absence of such measures, their useful life will be very short due to accelerated



corrosion of metal surfaces. For protection against corrosion, measures such as systematic surface cleaning, Powder coating with pure polyester colours, etc should be followed by the manufacturers and shall be made a part and parcel of the BIS Standards for these products.

3.4.3 Injection Equipment:

Chemicals for declogging the drip irrigation systems from the chemical precipitates or water soluble fertilizers may be injected into a micro-irrigation system by the use of venturi suction devices, or fertigation tanks operating on the principle of differential pressure or Injection Pumps. Typical Injection equipment are:

3.4.3.1 Ventury Suction Devices:



Venturi devices are popular and most ideal for small microirrigation systems because of their simplicity and low cost, and because they do not require additional power source. Venturi devices generally have a significant head loss across them. The injection rate of these devices is low and would be dependant on the system pressure and discharge. This will tend to limit their use on large systems and for crops where the fertigation requirements are high, higher injection rates may be necessary. This difficulty can be overcome by the installation of the series of venturi with a small centrifugal pump in a parallel circuit.

3.4.3.2 Fertigation Tanks:



Fertigation Tanks operate on the principle of differential pressure created across them with the help of a throttling valve. These are simple Mild Steel tanks and are effective as well as reliable injection devices. They are used where higher dosages of chemical or fertilizer application are required without regard to the concentration of the chemical/

fertilizer. These fertigation tanks have their inlet and outlet connected to the main line at two points having different water pressures, across a simple throttling valve or a pressure-reducing valve. This causes the water to flow through the injector, gradually



displacing the chemical it contains. Thus, the concentration of the applied chemical decreases continuously, and the chemical is gradually diluted until it has all been discharged into the irrigation system. Fertigation tanks can provide adequate service when their advantages and limitations are understood. They are frequently the best means of applying chemicals/fertilizers when no additional power source is available. Their chief disadvantage is that the chemical concentration decreases with time. On small irrigation systems the decreasing concentration may be unimportant and hence use of fertigation tank for injection is ideal and simpler compared to use injection pumps.

Where several field blocks are to be irrigated in sequence, uniform distribution of the injected chemical will require careful planning and management.

The metallic fertigation tanks need to be protected from the corrosive action of fertilizers and chemicals being injected, otherwise their useful life will be very short due to accelerated corrosion of metal surfaces. For protection against corrosion, measures such as systematic surface cleaning, powder coating with pure polyester colours, etc should be followed by the manufacturers and shall be made a part and parcel of the BIS Standards for these products.

3.4.3.3 Positive Displacement Pumps:

Piston or diaphragm type pumps are quite popular and provide for much better precision than other methods. They have the disadvantage that they are more costly and require more maintenance than other methods, and they can be operated using the pressure of water in the irrigation system. With a good injection pump, injection can be regulated precisely and chemicals can be injected at constant concentration until the required amount has been applied.



3.4.4 Distribution Network of Microirrigation Systems:

The distribution network for a micro-irrigation system will typically consist of the following main components:

- Mainlines, which transport water within the fields.
- Submains, which distribute water evenly to a number of lateral lines.
- Lateral Lines, which distribute the water uniformly along their length by means of drippers or emitters. Lateral lines may be polyethylene hose with emitting devices spaced along their length.



Mainlines and Submains are usually, PVC pipes and in some cases HDPE pipes are also used. PVC pipes are most cost effective and simple to handle and hence they are popular in use as Main and Submain pipes. PVC pipes of sizes 40mm and above upto 90mm are generally used as Submains. Mainlines are sized based on the irrigation sectioning or sequencing.

Planning the lay out of mainlines and submains in a field is most critical as it determines the cost on the same. As the mainline connects the different submains in the field to the water source, its layout, size and pressure class are all important in achieving uniform water application as well as for economizing on the cost of the system. Alternative layouts should be evaluated for their cost and operational efficiency for arriving at a most economically viable and efficient system.

A submain is normally connected to the main line via a control valve assembly. The design of the submain control valve assembly will usually depend upon cost. The function of this assembly is to regulate the water pressure in the submain, and this is best accomplished with a throttling valve. The function of a submain is to distribute water uniformly to a number of lateral lines. Uniform distribution requires that the pressure along the submain be relatively constant, with a minimum of pressure variation. On a sub-main, additional, components such as air and vacuum relief, pressure relief, pressure measurement, filtration, and automatic on-off control, valve at the end of the submain for flushing the submains in order to remove any contaminants and physical and chemical sediments, etc; will be necessary depending upon the requirements specific to the individual farm, crop, and level of control required over irrigation as well as fertigation.

Lateral lines are usually made of LDPE and LLDPE and ranges from 10 mm to 32 mm outside diameter. Appropriate fittings are available for connecting these lateral lines to PVC, HDPE and Polyethylene distribution lines. PVC pipes can be joined by using solvent cement where as the HDPE pipes can be joined by heat butt-welding. Sometimes Polyethylene tubing can be connected with barbed or compression type fittings. Common fittings are elbows, tees, crosses, unions and plugs or end caps. Similarly, for jointing of PVC/HDPE pipes, fittings of various sizes such as Couplers, Tees, Elbows, Bends, Threaded adapters, Tail Pieces, Repair collars, and host of other reducers are required, which can be selected based on the sizes of pipes chosen for the Distribution network. Distribution systems must be rugged, because the conditions under which they must operate are adverse. Fire, vandalism, flooding, careless workers,



heavy machinery, rats, rocks, roots, ants, chemicals, and sunlight can all cause damage to the distribution system. For this reason, many farmers find it worthwhile to bury most parts of the distribution network.

3.4.5 Pumping Units:

When water must be lifted, transported, or pressurized, energy is required. Water in high-level reservoirs might possess a level of useful potential energy proportional to their height above the area to be irrigated. Unfortunately, many irrigation systems must utilize water from low-level sources such as wells, which have zero or negative potential energy relative to the cropland. Where potential energy is insufficient, some type of pump must be used. Thus, the purpose of a pump is to add energy to water.

There are a number of basic variables involved in the selection of a pump and the overall design of a pumping plant suitable for an irrigation system. The type and horsepower rating of the pump will depend upon the required flow rate, the vertical distance, or “suction lift”, from the water level to the pump, and the discharge pressure required. The design of a pumping plant will also encompass such factors as the source of power required to drive the pump, and various kinds of control valves and appurtenances needed for safety and proper operation. Several different types of pumps are available to meet the needs of irrigation. The centrifugal, turbine, and propeller pumps are the types commonly used for irrigation pumping. The prime-movers for the pumps can be electric motors or diesel/petrol engines.

3.4.5.1 Electric Motor Driven Pumps

The most commonly used driver for irrigation pumps is the electric three-phase induction motor. The efficiency of electric motors is good, in some cases exceeding 95 per cent. Electric motors generally require very little maintenance, and with proper care may provide many years of trouble-free service. In addition, electric motors are quiet and compact, making them suitable for a wide variety of applications.



3.4.5.2 Diesel Engine Driven Pumps

In addition to electric motors, diesel engines are often used to power irrigation pumps. While electric motors have the advantages of being quiet, efficient, and economical to operate and maintain, diesel



engines offer portability and low installation costs. Diesel engines can be installed virtually anywhere, they are easily moved, and they do not require costly installation of electric power lines.

The use of a diesel engine in irrigation pumping requires that the designer understands the operating principles and limitations of diesel engines.

3.4.5.3 Solar Photovoltaic Pumps

Use of Solar energy for pumping water to small drip irrigation systems can be a sustainable solution for locations where electricity is not available and/or for reducing the dependence on electricity generation from other non-renewable resources. The system involves solar generator, which provides electricity for driving the motor of a pump, which in turn pumps water into an elevated water tank. The water tank bridges periods of low insolation (sunshine intensity) and supplies the pressure needed for the irrigation system as long as there is adequate water in it.



One major advantage of solar pumps is that they do not require electrical batteries, which are expensive and need a lot of maintenance. Force of gravity causes the water to flow from the tank to the fields. Some pilot projects are in progress for testing pumping units that can feed directly into the irrigation system and therefore do not require a water tank. Drip irrigation enables the economical use of water, and its relatively low operating pressure makes it particularly well-suited for combination with photovoltaic pumping systems.

3.4.6 Accessories:

3.4.6.1 Air Relief and Vacuum Relief

Air and vacuum relief valves are normally installed at the high points of mainlines, submains and control risers, and other system high points for the following reasons:

- To allow air to escape when filling pipelines with water.
- To allow air to enter when draining pipelines.
- To remove air pockets at system high points caused by entrained or dissolved air.
- To prevent negative (suction) pressure in laterals after system shutdown.



3.4.6.2 Pressure Relief Valves and Regulators

Pressure relief valves may be installed at any point where the possibility exists for excessively high pressures, either static or surge pressures, to occur. Abnormally high-pressure conditions may result from any of the following:

- Sudden opening or closing of a valve.
- Starting or stopping of a pump.
- Failure of a pressure regulating valve.
- The sudden closure of an air vent under high pressure.
- The slamming shut of a check valve.
- Failure by the designer to evaluate static as well as dynamic pressure conditions for a pipeline.



Many of these potential problems are best prevented by proper design and the need for costly pressure relief valves can be avoided by following the guidelines given below:

- Manually operated valves should be closed slowly
- Proper selection of size and number of Air vents to avoid build-up of high pressures in the pipeline.
- Static pressure conditions within the pipeline should be evaluated, particularly on gravity fed systems.

Alternatively, a simple arrangement to by-pass the excess water being pumped by the Pump, will be adequate to avoid problems of high pressure. This arrangement is called “Bye-Pass Arrangement” which is the most simplest and cost effective means for pressure relief in small irrigation systems, instead of the costly Pressure Relief Valves.

3.4.6.3 Check Valves or Non Return Valves:

Non return valves or check valves are used to prevent unwanted flow reversal. They are used to prevent damaging backflow from the system and to avoid return flow of chemicals and fertilizers from the system into the water source itself to avoid contamination of the water source.



3.4.7 Surge and Water Hammer:

Surge and Water hammer conditions can be avoided by restricting the flow in mainlines to 1.5 m/sec. In low-pressure micro-irrigation systems, flow velocity is not higher than 1.5 m/sec and thus is not a serious issue in small irrigation systems.

3.4.8 Automation Equipment:

The microirrigation systems are designed to be operated in a given sequence of opening and closing of valves as per the irrigation schedules. The irrigation schedules, ie both duration and frequency of irrigation are decided based on several parameters such as Evapotranspiration, Moisture holding capacity of the soil type, Field capacity, water requirements of the crops at different growth stages, etc and hence the farmer is required to operate the sectional valves and pumps in a prescribed sequence for the required duration.



Present day Microirrigation systems in the country are mostly manually operated, owing to the small size of fields, less number of sectional valves and non-availability of quality electricity to run sophisticated control equipment. However, in order to automate the irrigation scheduling, electronic programmable controllers as well as host of sensors along with Irrigation Management software, are available. Use of such automation equipment will further enhance the efficiency of the MI systems, as water and fertilizers can be applied with better control. The efficiency improvements result in additional water and nutrient conservation leading to more optimal yields.

Types of Automation systems available are:

- Time based automation
- Sensor based automation

In Time based automation systems, the operation of valves is based on pre-fixed irrigation start times and end times and the sequence of valve operations required. The controller in these systems can be programmed with different valve sequences and irrigation times. These controllers activate/deactivate the low voltage electric solenoid valves in the field as per the program fed into the controllers.



In Sensor based automation systems, the operation of valves is based on the various parameters sensed from the field such as soil moisture, leaf temperature, Weather data sensed, Electronic water meters, etc. Any of these sensors either individually or in combination can be attached to the controller for activating and deactivating the low voltage electric solenoid valves and pumps so that the irrigation system can be operated automatically based on the sensor readings.

The use of Automation equipment is growing in the country and there exists an immense potential for these systems, as the quality of electricity supplied to the agriculture sectors improves in days to come and as the extent of areas under MITs increases.



3.5 Types of Drip Irrigation Systems:

Within Drip Irrigation Systems there are several variations depending upon the installation location of drip laterals, type of drip laterals, etc. Based on the installation location of drip laterals with respect to the depth of installation, the drip irrigation systems can be classified as

- Surface Drip Irrigation Systems in which the drippers and the lateral lines are laid on the soil surface.
- Subsurface Drip Irrigation Systems in which the drippers and the lateral lines are laid below the ground level in the plants' root zone.

Similarly, based on the type of drip laterals and/or the emitting devices used, the drip irrigation systems can be classified as:

- On Line Drip Irrigation Systems in which the Drippers or Emitters are fixed on the Lateral Pipes by punching suitable holes on the drip lateral pipes at the locations specific to the crop being irrigated. These drippers are hence also called Point Source Drippers. For trees and orchards, On Line emitters are used so that only the root zone beneath them is watered.
- In Line Drip Irrigation Systems in which the Drippers are factory installed within or on the drip lateral at regular intervals and are suitable for closely spaced field crops in order to achieve a continuous strip of wetting along the crop rows.



- Sprayer/Mister/Fogger/Mini Sprinkler type Irrigation Systems consist of emitting devices, which spray or sprinkle the water under pressure and wet the area around them in the diameter ranges of 1m to 5m. The unit application rates are higher and the diameter of coverage will be lower than that of the Sprinkler type Irrigation Systems. These are useful for under tree irrigation of large trees whose root zones are extensive, for completing irrigation in a shorter period of time, for irrigating/misting/fogging applications in Nurseries, Shade houses, Greenhouses and other forms of controlled environment agriculture.

Surface and Subsurface Drip Irrigation Systems:

Depending upon the depth of installation of the drip laterals in the root zone of the crops the drip irrigation systems are classified as

- Surface Drip Irrigation Systems and
- Subsurface Drip Irrigation Systems

3.5.1 Surface Drip Irrigation Systems:

Surface drip irrigation systems are the conventional drop irrigation systems in which the drip laterals and/or the emitting devices are placed on ground surface along the rows of crops. The emitting devices are located in the root zone area of the trees in case on Point Source emitters and all along the rows of crops in case of In Line drip tube based systems.



As the water is applied on the ground surface, there are possibilities of loss of water due to evaporation, especially in heavy soils where the soil infiltration rate is slow due to which ponding of water occurs near the emitters.

3.5.2 Subsurface Drip Irrigation Systems:

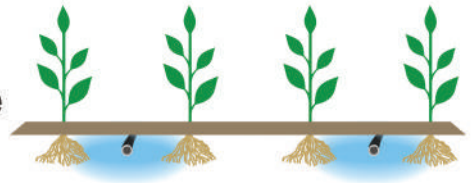
The sub-surface installations are generally preferred in semi-permanent/ permanent installations, particularly for crops where ratooning is practised and for some orchards crops as well as for irrigating turfs in home and commercial lawns and landscapes.

Subsurface drip has been part of drip irrigation development in the USA since its



beginning about 1960, but its use has accelerated since 1980 with availability of reliable equipment. Published research results show

Sub-Surface Drip



that yields of over 30 crops with subsurface drip are equal to or greater than other irrigation methods, including surface drip, and usually require less water. The drip tubes may be installed 2 to 70 cm deep and 0.25 to 5 m apart, depending primarily upon the crop. One advantage of subsurface drip is that the tubes remain in the soil for years together in some cases for more than 10 years, provided the tube does not interfere with any required tillage practices. The longer system life is critical to making the systems profitable. Nutrients and pesticides are easily applied to crops by injecting them into the irrigation system as frequently as required.

Proper system design and management are critical and include good water filtration, water treatment if necessary, frequent system flushing to remove particles, and preventing roots from plugging the system emitters. Overall profitability depends on local conditions. For orchards when drip laterals are used with online drippers, the laterals are laid 45-60 cm below soil surface, to avoid any damage during interculture operations. The online drippers/micro-sprinkler or any other emitting device is installed with a help of spaghetti / microtube on surface near the tree as per the layout of the system.

However, the inline drip system when used as a sub-surface method, the depth of its installation is governed by required wetting zone. The sub-surface method has an advantage over the surface method as it provides better life for the system and even thinner laterals can be used, which reduces the overall cost of the system as well saves little more water than that with the Surface Drip Irrigation Systems. As far as the main and sub-main pipelines are concerned, these should be used under-ground for better life. These should be buried at least 60 cm below the ground surface to avoid any damage due to lateral pressure. The sub-surface pipes are also saved from the deterioration due to ultra violet radiation.

The general advantages of subsurface drip are frequent and precise applications resulting in additional saving in water, efficient nutrient management, and low labor requirement. In addition, it can be adapted to any field size and shape and can utilize several, low-capacity water supplies distributed throughout the system. Subsurface



drip can effectively provide water and nutrients for many crops, even in areas with high seasonal rainfall. Crop yield response to irrigation will depend on the crop and efficacy of these systems will vary from site to site and crop to crop.

Subsurface drip irrigation offers many advantages beyond those of surface drip irrigation which are :

- Permanent installation below the plow depth provides considerable labor savings and irrigation can be applied while equipment is in the field.
- The top 15-20 cm of soil remains dry; hence, evaporation of water from the soil surface will be limited to vapor diffusion because of the mulching effect of the dry soil and less salt will accumulate at the surface.
- Any soil surface crusts, which usually cause infiltration problems can be avoided. Non-uniformity of application usually associated with water running off the surface or ponding will be eliminated, hence water distribution throughout the field along the laterals can be improved.
- The subsurface drip system is buried and not handled annually. The subsurface system is out of the sunlight and not subjected to constant wetting and drying and heating and cooling, therefore it is expected that the system will last longer than one, which is on the surface and exposed to the changing environment.
- Equipment traffic through the field will be easier and less cumbersome because all pipes and laterals are buried. In addition, the soil surface is kept dry after the initial irrigation for germination, thus, traction through the field will be better and soil compaction will be less.
- Water and nutrients are applied directly to the root zone. In addition, the roots will take up and use nutrients more efficiently provided that the irrigation and fertilization schedules are adequate.
- Application of fumigants and/or pesticides through the subsurface drip system will provide enhanced use of chemicals for weeds and pest control; particularly if the surface is irrigated simultaneously to seal the soil surface temporarily.
- Since the topsoil is kept dry during most of the growing season, occurrence of fruit rot and soil borne diseases enhanced by wet soils will be minimized. Germination of shallow weed seeds will be decreased because of lack of necessary soil water.
- Multiple cropping or ratoon cropping will be easier because laterals remain in place.



However, in India the surface drip irrigation systems are more prevalent than the subsurface drip systems owing to the ease of installation and also because the de-clogging of drip systems with the help of chemical treatments is still not practiced widely. Farmers prefer cleaning emitters and drip laterals manually rather than injecting chemicals into the systems. As such, manual cleaning is not feasible in a Subsurface drip irrigation system and hence the lack of interest in the sub surface drip systems. Apart from the conventional pressurized drip irrigation systems, small scale gravity operated drip irrigation systems are also available. These systems are suitable for very small fields of sizes ranging from few square meters to not more than 500 m². They are ideally suitable for very small farmers, kitchen gardening, etc. The various types of such systems are described below:

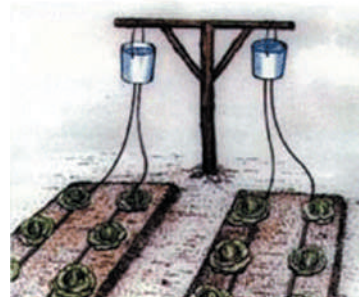
3.6 Low-cost drip irrigation systems:

For very small plot sizes and for small fields where separate water source is not viable, low-cost small farm drip irrigation systems are being promoted by some organizations including International Development Enterprises (IDE). These systems are operated with gravitational head available from an elevated water source which is usually a small bucket or a drum. Thin-wall drip tapes, cloth filtration systems, etc reduce the cost of these systems.

However, these systems need to be fed with water routinely which is cumbersome and farmers do not find them convenient whenever the water source is far off from their small fields. The labour involved in filling the tank or bucket will be highly difficult if the water source happens to be far off from the field. Also, lack of proper filtration systems, lack of chemical treatments to avoid clogging, very low useful life of the components, etc these systems fall into disuse sooner. Thus, the cost of such systems, on face value, appears to be quite affordable, however on per unit area basis their cost works out to be exorbitant, if not prohibitive. Hence these systems should not be promoted widely, but only when there are no other options and/or alternatives.

3.6.1 Bucket kit:

Bucket kit is the smallest drip kit and most popular among housewives to grow a small kitchen garden. It has 2 lateral lines of 5 m each, fitted with a total of 40 micro tubes and a 20 litres bucket. Depending on the type of crop, the housewives could grow 40-200 vegetables plants, which are sufficient to provide vegetables to a small family. The bucket



needs to be filled up twice daily.

3.6.2 Drum kit (vegetable):

Drum kit has been designed for a small commercial vegetable garden. This is being extremely popular with marginal farmers in villages who have little access to water. It is similar to bucket kit in principle and is 5 times bigger. It has 5 lateral lines of 10 m each and fitted with a total of 200 microtubes. It covers a total area of 150 m². Depending on the crop it is suitable for irrigating 200-800 vegetables plants. This kit has been designed



to be fitted to a drum of water placed at 1m height. However, this can also be fitted to a running water from a tap or stream. Depending on the season the drum needs to be filled once or twice a day. The total investment on this kit is about Rs 1500 which can cover 150 square meters of area and the farmer could earn a net income of Rs. 5000 a season. With the increase in disposable income the farmer could also expand by adding more kits.

3.7 Drip Irrigation Systems – Software or Services:

Every irrigation system is unique, and hence the installation of a microirrigation system should be tailor made just as is the case with design of a microirrigation system. Thus, an integrated approach in which all the services are provided by a single agency as close as possible to the farmers' fields, becomes imperative. The major steps involved in successful implementation of a microirrigation system are survey, design, supply, installation, commissioning and testing, maintenance, agronomic support and market linkages for the farmers' produce.

3.7.1 Survey:

Accurate topographic maps of the area required to be brought under microirrigation are obtained by way of an engineering survey. A contour interval of 2 to 3 m will be necessary if the elevation differences in a given field are beyond 2%.

Water source and other pertinent features of the area, such as an electricity source, availability of pump, operational details of the pump, number of hours for



which electricity is available in the area, number of hours within which the farmer would wish to complete the irrigation in a day, details of obstructions and non-planted areas, crop details such as spacing, age, variety, row direction, etc; climatological details such as Evapo-transpiration, rainfall, maximum and minimum temperature, relative humidity, etc are all required to be collected during the field survey.

3.7.2 Soil and Water Sampling and Analysis:

Soil samples have to be collected and analysed for the physical and chemical properties, including pH, EC, Nutrient Status, etc. Water samples have to be collected and analyzed with respect to the clogging potential of the water and its suitability for Microirrigation as well as for designing a suitable filtration system.



3.7.3 Design of Drip Irrigation System:

Each field being different with respect to its geometry, topography, crop geometry, extent, water quality, soil type, etc; the design of Microirrigation systems needs to be based on all the above information collected during Survey, Sampling and Analysis. Hydraulic design of the system is necessary for ensuring water application uniformity based on the selected emitter.



The design process also makes it possible to bring out the list of various components required to build the irrigation system at the field. This process also involves hardware selection such as Filters, Valves, Pipes, Emitters, etc.

3.7.4 Supply of Systems Components/Hardware:

All the components involved in building the Microirrigation system need to be transported from the closest stock point of the Manufacturer/supplier. A typical Microirrigation system requires about 40 to 50 different Plastic and Metal components all of which are essential and installation of the system cannot be completed even if one single component is not available. Hence, supply of all the components becomes essential for completion of a typical installation. Care must be taken to supply the material completely in the required quantities and as per the required sizes and other specifications.



3.7.5 Installation of Microirrigation Systems:

Prior to installing the supplied components, the farmer has to trench his field for laying mainlines and submains below the ground level. Once the trenching is complete the mainline, submain, laterals, emitters, filtration station are all installed as per the guidelines prescribed by the supplier companies.



3.7.6 Training in Operation and Maintenance:

The concept of Microirrigation being new, the knowledge of its operation and use needs to be explained in detail to the farmers and their field caretakers to enable them to operate and run the system for achieving desired yields and results. Also regular flushing of the system, cleaning the filtration systems, acid and chlorine treatments for de-clogging the system, injection of water-soluble fertilizers, etc are necessary. In order to train the farmer about these aspects, regular visits of qualified technicians are necessary.

3.7.6.1 System Maintenance:

Depending upon the design and the quality of materials used, a drip irrigation system may be very reliable and trouble-free, or can be a source of continuous difficulties. However, even the best systems will require routine inspection and preventive maintenance, and these operations must be carried out by adequate understanding of the issues involved.



A drip irrigation system will function satisfactorily for a long term only if a suitable maintenance program is drawn up and adhered to from the very start.

One of the problems facing drip irrigation is the clogging or plugging of orifices and emitters. Researchers have discovered and identified a number of factors which may be responsible for the clogging phenomenon, including the presence of microorganisms, the size and quantity of suspended solids in the water, and the presence of certain dissolved solids such as iron, manganese and calcium which



may precipitate and form deposits within the lateral lines and emitters. Where these or other factors constitute a potential problem, a detailed program of system maintenance must be developed to ensure optimal performance. (Please refer discussion on various types of clogging related problems and the available solutions for the same, detailed under “Special Problems with Drip Irrigation Systems” at 3.7 in this Chapter)

3.7.6.2 Maintenance of Filtration Systems:

Maintenance of the filtration system forms a very important part of overall system maintenance. Media filters and screen filters of various types will, from time to time, require cleaning, backwashing, or replacement of filter elements.

3.7.6.3 Cleaning Screen Filters:

Manual screen filters must be regularly disassembled to clean the elements. Failure to do this will lead to a buildup of material on the screen and an excessive pressure loss across the filter. This will result in inefficient operation of the system. An excessive pressure loss across the screen will also serve to force particles, particularly organic material, through the screen, where they can pass into the system and cause clogging problems. Local experience will dictate the cleaning frequency required to keep the screen filter in good condition.

3.7.6.4 Sand Filter Backwashing:

Many media filter failures have been caused by use of poor quality sand, improper backwash flow control, inadequate backwash flow, and poor maintenance.

A Sand filter is basically a tank filled with fine sand. The water normally flows in over the top of the bed of sand, down through the bed, and out the bottom of the filter, leaving soil particles and other impurities trapped within the sand bed. When too much foreign matter has accumulated within the sand bed, it becomes difficult to force the water through the filter, and the head loss across the filter is increased. This increased head loss indicates that the filter needs to be cleaned by backwashing.



The backwashing of a media filter refers to the process of reversing the direction of water flow through the sand bed. This flow reversal suspends and agitates the sand bed and washes away foreign matter caught by the filter. The media filter must be backwashed frequently enough to keep the media free of excess filtered material. Failure to do this will result in high head losses across the filter, and aggregation and cementing of the sand bed, particularly where there is iron or manganese present in the source water. If the system contains a manually backwashed media filter, it will require attention to backwashing frequencies and periods. Automated backwashing controls may consist of a timer, which initiates backwashing at a pre-set interval, or a pressure differential sensing device, which will cause filter backwashing to occur whenever the head loss across the filter exceeds specified limits. Automatic backwash controls are generally reliable and greatly reduce the labor requirement needed to backwash media filters.

It is important that the backwash flow rate be high enough to vigorously fluidize and agitate the sand bed, yet low enough so that only the filtered material is washed from the chamber of the filter and not the filter media itself. Selection of sand is important to media filter performance. The ideal sand is sharp-edged and of a uniform size, made by crushing rock and carefully grading it according to size. Sand found in nature is often rounded, poorly graded, and full of 'fines' which seriously impair filter performance.

3.7.6.5 End – Of – Season Maintenance:

At the end of the irrigation season, media filters should be thoroughly backwashed and chlorinated to prevent the growth of microorganisms. Tanks should be drained and allowed to dry, the sand level should be checked, and the sand should be inspected for signs of caking or other problems.

3.7.7 Monitoring System Performance:

The well-designed micro-irrigation system will have built-in diagnostic tools, which will allow the operator to monitor the performance of the system, and to detect possible problems in the early stages. Included in this category are pressure gauges, water meters, etc.



3.7.7.1 Water Meters

Water Meters should be installed on the main supply lines, and should provide readings of both instantaneous and cumulative flow. These meters should be read regularly and the readings kept in a logbook. Variations in the system consumption may indicate problems in the system.

For example, a gradual decline in system consumption measured by the water meter may indicate a problem with the pumping station, or a clogging problem in the field. On the other hand, an unexpected increase in the system consumption might be an indication of a pipeline break or the presence of leakage in the system. Measurements of cumulative consumption will serve to verify water application schedules.

3.7.7.2 Pressure Test Points

The system should have sufficient pressure testing points so that an overall check of the system pressures can be made. Widely differing pressures in different sections of the system may indicate that some blockage, leakage or other problem has arisen in some section of the system. Pressure checks should be regularly made, and the pressures recorded.

3.7.8 Maintenance and Flushing of Submains and Laterals

The field conditions can be adverse to the lateral lines. When the tube is installed, it is usually subjected to tensile stresses of some magnitude, and also to field machinery, which may scratch or otherwise damage the tubing. If the tubing is laid on the surface, it may be subjected to direct sunlight. Rocks, plant stalks and roots will tend to pinch the tube. Rats, ants and vandals cause significant damage in some areas. The tube must withstand exposure to chemical fertilizers, chlorine and pesticides.

In drip irrigation systems provisions must be made to flush submain lines and lateral lines to remove settled sediments, and thus flushing constitutes



an important maintenance routine. A major factor is the irrigation water and its contents. Regardless of treatment, the water will usually contain impurities, which will tend to plug the orifices or emitters, and these impurities will also settle out of the water, forming a deposit in the bottom of the lateral lines. These sediment deposits must be flushed from the laterals periodically, and a variety of flush valves and drain valves have been developed to accomplish this in an efficient way. Emitters should be occasionally inspected and the flow rate measured. A wide variation from the design emission rate should be investigated. A general decrease in flow rates may be the first symptom of a potentially major biological or chemical clogging problem within the system. This type of problem is far easier to treat if known in the early stages.

Submains and lateral lines should be manually flushed several times during the season by opening the ends of the lateral lines while the system is running and allowing water to run until it runs clear. Collecting some of the dirty water in a glass jar, and examining it carefully can show the nature of the impurities in the water. The nature of impurities can be bacterial slime, iron precipitation, precipitated salts, salt scales, sand and soil particles, algal blooms, etc.

3.7.9 Agronomic Support Services:

As microirrigation involves controlled and regulated application of water and nutrients adequate enough to meet the plant/crop requirements, it is very important that the farmer is made aware of the levels of water and fertilizer to be applied while using the microirrigation system. Certain other agronomic practices such as planting patterns, frequency of irrigation and fertigation, etc will be different to what the farmer was adopting before the commissioning of microirrigation system. Hence there is a need for supporting the farmer about all these aspects, which need to be taken up by the farmer with the help of experienced professionals in agriculture/horticulture.

3.8 Special Problems with Drip Irrigation Systems:

The following special problems need to be given attention as any of them can affect the system performance and success.

3.8.1 Emitter Clogging:

The biggest potential problem facing drip irrigation system is emitter clogging. Because the water passages in most emitters are very small, they easily become clogged by



particles of mineral or organic matter. This can reduce emission rates, cause non-uniformity of water distribution and thereby cause stress and damage to plants.

In some cases, contaminants are present in irrigation water delivered from the source, which include soil particles, living or dead organic materials, and scale from rusty pipes.

In other cases, contaminants enter the system during the installation phase, and are not adequately flushed out of the system. Included in this category are insects, teflon tape, PVC pipe shavings, and soil particles.

Finally, contaminants may grow, aggregate, or precipitate in water as it stands in the pipes and lateral lines or evaporates from emitters or orifices between irrigation. Iron oxide, manganese dioxide, calcium carbonate, algae, and bacterial slimes can form in drip irrigation systems under certain circumstances.

The solution to a particular clogging problem must be based upon the nature of the problem. Acid treatment has been used successfully to dissolve manganese, iron and calcium precipitates, and chlorine has been used to decompose organic materials. Where possible, allowing the system to thoroughly dry out will sometimes serve to shrink organic materials enough to partially open clogged emitters or orifices, which can then be treated more effectively with chemicals.

3.8.2 Salinity Management:

In areas where significant rainfall occurs during the year, there is frequent leaching of salts deposited by irrigation waters. However, in drier areas, considerable deposits of salt may accumulate in the soil due to the absence of natural leaching. This salt buildup will be proportional to the salinity of the irrigation water.



In arid regions where saline irrigation water is used, a buildup of salts will frequently occur on the soil surface. Salts also concentrate below the soil surface at the perimeter of the soil volume wetted by each emitter. In the absence of rain, this buildup can be tolerated with a properly designed and managed irrigation system. However, an infrequent heavy rain



may wash accumulated salts back into the root zone, causing seriously high salinity if the system is not operating. Therefore, when rain occurs after a period of salt accumulation, irrigation water should be applied until about 2 inches of rain has fallen, to prevent salts from moving into the root zone and to aid leaching of salts below the root zone.

Another consideration to be addressed when using saline water is the movement of salts through the root zone. Salts will move readily with soil water, and will concentrate at the outer edges of the wetted perimeter. Thus, emitting devices should be situated in such a way as to result in water [and salt] movement away from plants, rather than towards them.

3.8.3 Bacterial Precipitation of Iron

Micro-irrigation problems related to iron are caused by the introduction of soluble iron salts [ferrous iron] into the system, where, due to a number of factors, they may be oxidized [ferric iron] and precipitate to cause clogging.

There are certain forms of bacteria, which can produce precipitation of insoluble ferric oxide by oxidizing soluble ferrous oxide. Problems with iron bacteria have occurred with iron concentrations as low as 0.1 ppm. The iron precipitate forms as a red filamentous sludge, which can attach to PVC and polyethylene tubing and may completely block emitters. The usual treatment for bacterial precipitation of iron is chlorination of the water to kill or inhibit bacterial activity. Chlorination may be performed continuously at the rate of 1 ppm free available chlorine, or intermittently at the rate of 10 to 20 ppm for 30 to 60 minutes daily. If the presence of bacteria is due to contamination of the well, super chlorination of the well may greatly reduce the problem. This is done by injecting chlorine at 200 to 500 ppm into the well. The volume of water to be treated can be estimated by knowing the depth and diameter of the well.



3.8.4 Bacterial Precipitation of Sulphur

Bacteria can produce an organic sulphur slime if the water contains more than 0.1 ppm of total sulphides. These bacteria produce white cottony masses of slime, which may completely block the emitting devices. Problems can also be created by interactions of iron and sulfur in the system. Stainless steel filter screens can cause precipitation of iron sulphide if used to filter water with a high concentration of sulphides. The presence of dissolved iron and sulphides may produce a chemical reaction in which insoluble iron sulfides are formed. Under certain conditions, the injection of nutrients containing iron into a sulphide-bearing water will also cause precipitation. The recommended treatment to control sulphur slime bacteria is intermittent chlorination at 1 ppm free available chlorine as measured in the field for 30 to 60 minutes daily.

3.8.5 Chemical Precipitation of Iron

When water is pumped out of an aquifer and into an irrigation system, many changes occur in the water's physical and chemical environment. In terms of iron solubility, the pressure, pH and temperature are the most important variables. Any dissolved iron in the aquifer water will generally be in the ferrous form as ferrous oxide.

While conditions may favor the solubility of iron when the water is in the aquifer beneath the ground, precipitation will occur once the water is pumped into the irrigation system, particularly between irrigations. This leads to the precipitation of iron in the system. If even minute quantities of iron are present [0.1 ppm or more], clogging of emitters may occur. The injection of unchelated phosphates or calcium salts will accelerate this process and should be avoided in iron-bearing waters.

Treatment of iron-bearing waters where chemical precipitation is a problem may be achieved by removing the iron from the water, or by retaining the iron in solution. The recommended techniques are as follows:

3.8.5.1 Aeration and settling is the most reliable method of removing iron from irrigation water. The system operates by thoroughly aerating the water on entry to a settling basin, either by allowing it to fall through or run over a series of baffles, or by spraying the water through the air. Either method will allow the incorporation of large amounts of oxygen into the water, which oxidizes the ferrous oxide to ferric oxide. The ferric oxide will precipitate out of the water and settle to the bottom of the basin, provided that sufficient settling time is allowed. Aeration and settling is an inexpensive and almost



foolproof method of iron removal, requiring low maintenance and little training. Because most iron-bearing waters are well waters, they are pumped out of the well into a pressurized system. Therefore, the aeration and settling process suffers from the drawback that water must be 'double-pumped', that is, there is the requirement for an additional pump at the outlet of the settling basin to re-pressurize the water. While it is true that double-pumping requires two pumps, it does not result in higher energy costs, because the total pumping lift remains the same.



3.8.5.2 Chlorine precipitation. Free chlorine will instantly oxidize ferrous oxide to ferric oxide, which will then precipitate out of solution. The iron concentration must be determined and chlorine must be injected at the rate of 1 ppm for each 0.7 ppm of iron. Some additional chlorine may be required to kill any iron bacteria and to control the growth of bacterial slime. Complete mixing of the chlorine is best achieved by creating turbulence within the system. If complete mixing is not achieved, iron will pass into the submain and lateral lines where it will precipitate. After complete mixing, the iron is removed by filtration. A sand media filter is the most appropriate filter, it should be frequently backwashed and preferably automated. The use of chlorine to precipitate iron is effective when proper procedures are followed. However, it requires careful attention to the operation and maintenance of the chlorine injection equipment and the filtration unit, and the cost of chlorine may be significant in large systems with high levels of iron in the water sources. Normally, chlorine is used to precipitate iron when aeration and settling is not feasible. Caution must be used in those cases where manganese is present in the water source, since the oxidation of manganese by chlorine proceeds at a much slower pace than does the oxidation of iron. Thus, where manganese is present, the use of chlorine may result in manganese precipitation after the filter, causing clogging problems in the systems.

3.8.5.1 pH Control: Iron is more soluble at lower (acidic) pH values. The pH may rise when water is pumped out of an aquifer and the iron will precipitate out. Acid may be injected to maintain the iron in solution, or it may be used to periodically dissolve iron sediments, which have built up over a period of time. Acid injection can also be used



to clear a system, which has become partially blocked with iron prior to implementing one of the above preventative measures. The pH is reduced to 4.0 or less for a period of 30 to 60 minutes. This dissolves the iron and flushes it from the system.

3.8.6 Precipitation of Calcium Salts:

The precipitation of calcium salts in emitters and lateral lines is common with some waters, and appears as a white film or plating on the inner surfaces of the system. This problem is easily corrected by the injection of acid at a rate such that the pH is lowered to less than 4.0 for between 30 and 60 minutes. However, it is important that this is done before total blockage of the emitters occurs, because the acid will not come into contact with water passages that are closed to the flow of water. The solution for treating calcium blockages is treatment with hydrochloric (muriatic) acid. Hydrochloric acid is injected at a rate to achieve a pH of 4.0 in the irrigation water for about 30 to 60 minutes.

3.8.7 Ant Damage:



Ant damage to thin-walled polyethylene tubing has occurred in various parts of the world, and has constituted a major problem in some areas. Ant damage typically takes the form of holes chewed through the sides of strip tubing, and enlargement of orifices in strip tubing. This damage destroys the hydraulic integrity of the strip tubing, and may result in severe economic losses to growers. It has been noted by researchers in Hawaii that ant damage to strip tubing is most severe in tubing having wall thicknesses of less than 15 mils (0.015 inches).

Ant damage has been successfully controlled with chlorinated hydrocarbon insecticides (i.e. Chlordane, Heptachlor). However, these chemicals are highly toxic and persist in the environment. Hence tubes with sufficient wall thickness are essential to face the problems of ant damages.

3.8.8 Boron Toxicity:

Boron (B) occurs in water in one or another anion form. The usual range in natural waters is from 0.01 ppm to 10 ppm. Concentrations greater than this are known but are most often from hot springs or brines. Boron has no measurable effect on the

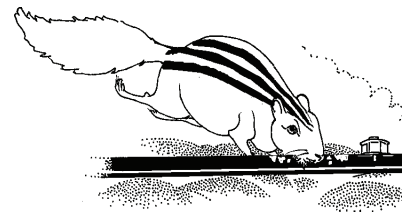


physical properties of soil in the amounts that can be tolerated by plants. Boron is not as readily removed from the soil as chloride or nitrate but most of it can be removed by successive leaching.

A small amount of boron is essential for plant growth, but a concentration slightly above the optimum is toxic to plants. Some plants are more sensitive to excess Boron than others. Plants grown on some sandy soils, which have been irrigated for several years by water exceedingly low in boron (less than 0.02 ppm) may develop boron deficiency.

3.8.9 Animal Damage to Infield Distribution Systems:

Animal damage is rarely a significant problem with drip irrigation systems in row crops, probably because of the fact that the frequent tillage and intensive farming practices destroy the animal's habitats. More often, animal damage is associated with tree crops, especially in areas bordering on undeveloped land.



There are several kinds of burrowing animals which can cause damage to surface or buried polyethylene laterals, including rats, mice, squirrels, dogs, rabbits, etc. If present in sufficient numbers, these animals are able to heavily damage a drip irrigation system by chewing holes in the lateral lines. The three basic approaches to the solution of this problem are (1) the use of repellents to keep the animals away from the lateral lines, (2) baiting or trapping to control the animal population, and (3) elimination of the animal's food supply.

Repellents are used to keep the animals away from the lateral lines by the introduction of some type of chemical, which tastes or smells bad to the animal. Repellents may either be injected through the system or laid down with the laterals during installation. Injection of the chemical through the system is the preferred technique, since chemicals applied during installation will eventually lose their potency or be leached away over time. There are a number of chemicals available which are obnoxious to animals, including anhydrous or aqua ammonia and a number of insecticides. Trapping is often effective on smaller installations, but may be impractical for large acreages because of the high labor requirement. Trapping may be valuable in determining what species of animal is responsible for the damage. Baiting is often achieved by manual application, by injecting bait material underground, etc. Like all animals, burrowing animals require a food supply. This food supply will generally either be weeds or the crop being grown.



If the food supply is weeds, weed control may eliminate the problem: if the food supply is the crop, then control of the animal population will probably be beneficial in terms of the health and yield of the crop.

3.8.10 Field Failure of Polyethylene Hose and Tubing:

Polyethylene is subject to failure in the field due to two primary causes; degradation due to exposure to ultra-violet light (UV degradation), and environmental stress cracking. These two types of failure are very different in terms of their causes and symptoms, and must be carefully distinguished in order to make an accurate diagnosis.

U.V. Degradation

U.V. degradation of polyethylene hose and tubing occurs when ultra-violet light penetrates the plastic and causes molecular changes to occur, resulting in progressive deterioration of the plastic. The symptoms of U.V. degradation are cracking of the hose or tubing, usually along the top half, which is exposed to sunlight. The standard method of preventing U.V. degradation is by the incorporation of a small amount of “carbon black”, into the resin prior to extrusion. This carbon black colors the clear polyethylene black and absorbs the ultra-violet light, shielding the product and preventing degradation. U.V. degradation is the result of insufficient levels of carbon black in the product, and can be prevented by careful manufacturing controls. A minimum of two per cent carbon black is needed for good resistance to U.V. degradation.

Environmental Stress Cracking

Environmental stress cracking is a broad term, which refers to splitting or cracking of hose or tubing which has been exposed to the environment. Failure often occurs at points where the material has been stressed; a typical example of environmental stress cracking is the cracking of polyethylene hose at the location where it is attached to an insert fitting or in-line emitter. Environmental stress cracking is most often due to the use of inappropriate types of polyethylene, poor quality grades of polyethylene, use of polyethylene scrap obtained from toy makes, and so forth. Because there is no visible difference between good product and product which is likely to fail due to stress cracking, the only defense against stress-cracking is to obtain hose and tubing from reputable manufacturers. Extruded polyethylene hose and tubing is tested for its environmental stress-crack resistance through a test prescribed in Standards. Experience has shown that field failures are likely to occur within six months to one year of installation of material, which has not passed these tests.



3.9 Economic Viability of Drip Irrigation Technologies:

Consequent to the increase in productivity and water use efficiency (water required to produce one quintal of yield) on account of saving in water required and increase in crop yield as well as saving in cost of electricity, fertilizer and labour, the drip irrigation technologies have attractive economic viability. The data available on various crops confirming the economic viability are presented in the Table- 4.8. Benefit-cost analysis carried out using the available data also shows that Drip Irrigation technologies are viable.

Table 4.8: Benefit-Cost Ratio of Different Drip Irrigated Crops.

Name of the Crop	Spacing (m x m)	Capital Cost (Rs/ha)	Benefit-Cost Ratio	
			Excluding Water Saving	Including Water Saving
Coconut	7.62 x 7.62	11053	1.41	5.14
Grapes	3.04 x 3.04	19019	13.35	32.32
Grapes	2.44 x 2.44	23070	11.50	27.08
Banana	1.52 x 1.52	33765	1.52	3.02
Orange	4.57 x 4.57	19859	1.76	6.01
Pomegranate	3.04 x 3.04	19109	1.31	4.40
Mango	7.62 x 7.62	11053	1.35	8.02
Papaya	2.13 x 2.13	23465	1.54	4.01
Sugarcane	Between inline 1.86	31492	1.31	2.78
Vegetables	Between inline 1.86	31492	1.35	3.09

Source: Compiled from INCID, (1994).

Many studies have attempted to analyse the economic and social advantages including water saving of drip method of irrigation using the survey data collected from sample farmers. Narayanamoorthy (1996a; 1997b; 2001) has carried out studies in three crops namely banana, grapes and sugarcane using the sample survey data collected from Maharashtra. Data for these studies have been collected from districts like Nashik (grapes), Jalgaon (banana) and Pune and Ahmednagar (sugarcane). The adoption of drip method of irrigation is relatively higher in these districts because of the prevalence of favourable cropping pattern and severe water shortage. The main results of the studies are presented in Table 4.9.



Table 4.9: Advantages of Drip Method of Irrigation: Results of Field Survey.

Particulars	Crop's Name	Method of Irrigation		Benefit over FMI	
		Drip	Flood	In per cent	In value
Water Consumption (HP/hours/ha)	Banana	7884.70	11130.30	29.20	3245.60
	Grapes	3310.40	5278.40	37.30	1968.00
	Sugarcane	1767.00	3179.98	44.43	1412.98
Productivity (quintal/ha)	Banana	679.50	526.35	29.10	153.20
	Grapes	243.25	204.29	19.10	38.96
	Sugarcane	138.36	112.44	23.05	25.92
Electricity Consumption (Kwh/ha)	Banana	5913.33	8347.75	29.16	2434.42
	Grapes	2482.77	3958.78	37.28	1476.01
	Sugarcane	1325.25	2384.99	44.43	1059.74
Water Use Efficiency (HP hours/quintal)	Banana	11.60	21.10	45.10	9.50
	Grapes	13.60	25.80	47.30	12.20
	Sugarcane	12.77	28.28	54.84	15.51
Cost of Cultivation (Rs/ha)	Banana	51437	52740	2.50	1303
	Grapes	134506	147915	9.10	13409
	Sugarcane	41993.20	48539.88	13.49	6547
Gross Income (Rs/ha)	Banana	134044	102935	30.22	31109
	Grapes	247817	211038	17.40	36779
	Sugarcane	106366	85488	24.00	20878
Capital Cost of Drip-set (Rs/ha) (without subsidy)	Banana	33595	—	—	—
	Grapes	32721	—	—	—
	Sugarcane	52811	—	—	—
Net Present Worth (Rs/ha)* (without subsidy)	Banana	241753	—	—	—
	Grapes	540240	—	—	—
	Sugarcane	169896	—	—	—
Benefit-Cost Ratio* (without subsidy)	Banana	2.16	—	—	—
	Sugarcane	1.91	—	—	—
	Grapes	1.76	—	—	—

Notes: 1) Banana and grapes data relate to the year 1993-94 and sugarcane data relate to the year 1998-99. Life period of drip set is considered as 5 years for banana and sugarcane and 10 years for grapes for computing benefit cost ratio.

* - 15 per cent of discount rate is considered for computing benefit cost ratio.

(Source: Narayanamoorthy (1996a; 1997b; 2001))



It is clear from the Table-4.9, that consumption of water by crops under drip method of irrigation is significantly less than the crops that are cultivated under flood method of irrigation. In terms of percentage, the saving of water by drip is about 29, 37 and 44 per cent per hectare respectively for banana, grapes and sugarcane over flood irrigation. All these indicate that drip irrigation not only reduces the consumption of water but also improves the water use efficiency by increasing the productivity of crops substantially.

Though water saving and water use efficiency of drip irrigation is substantially higher than that of flood, it may not help to achieve sustainable resource use if that technology is not economically viable for the users. Since drip technology involves a relatively higher amount of fixed capital, it is essential to find out whether the investment is economically viable or otherwise. The economic viability of drip investment, assessed through Net Present Worth (NPW) and Benefit-Cost Ratio (BCR) using discounted cash flow technique for these three crops show that NPW works out to be about Rs. 2.48 lakh/ha for banana, about Rs. 5.40 lakh/ha for grapes and Rs. 1.70 lakh for sugarcane at 15 per cent discount rate at the end of life period of drip-set. The benefit-cost ratio also indicates that the investment on drip irrigation is economically viable. The estimate also further shows that farmers can realise the whole capital cost invested on drip system from the profit of the very first year itself in both banana and grapes. These observations sufficiently confirm, as shown by the experimental station results, that drip irrigation technology is an efficient method of irrigation and highly suitable for the sustainable use of water as well as for higher returns to the farmers.

3.10 Economic viability Analysis by NABARD FOR DIS:

Guidelines issued by NABARD on economics and detailed unit costs of drip irrigation in different crops with different spacings are reported under Annexure-VI. The internal rate of return estimated by NABARD varies from 35% in cotton to over 100% in the case of grapes.

3.11 Standardization in Drip Irrigation Systems:

There have been several attempts to standardize the Drip irrigation systems on the lines similar to the standardization brought in Portable Sprinkler Irrigation systems promoted in the country. However, these attempts lose their relevance, as it is nearly



impossible to prepare a standardized package or model, which will suit every farmer's requirement. It is so for the following reasons:

- The location of water source (Tube well/ Open Well/ Canal/ etc) will be different in each case. Accordingly the length of the mainline will differ.
- Quality and Quantity of water will determine the type of filtration unit and their capacity that may be required to be included in the set.
- The availability of electricity ie, duration in a given period, will have a direct bearing on the number of Irrigation Sections to be made and wetted. This will also determine the type and quantity of emitting devices to be used, size of individual irrigation sections, sizes of main and submain pipes, size and capacity of filtration system, etc.
- The cropping pattern, cropping intensity, the crop geometry will also be responsible for type of quality of hardware that will go in building of a drip system.
- The climatological parameters such as Evapotranspiration, Rainfall and their Spatial and Temporal variation will also affect crop water requirement and consequently the selection of emitters.
- The soil type, texture, water holding capacity, the land profile, undulated, rocky, sandy, loamy, clayey, etc will determine the type and number of emitting devices.
- The frequency and quantum of water-soluble fertilizers to be applied will decide the capacity and type of fertigation equipment required to be included in building the set.
- Field Geometry will also have a direct bearing on total hardware as well as pumping requirements and their selection.

All these limitations/peculiarities/nuances/variations/over-tones call for a made-to-fit design, which will differ from farm to farm. It is therefore not possible to standardize or universalize or make uniform sets for every farm. The physical variations do not permit regimented designs or systemized bill of quantities so as to enable prepare a uniform, same-to-same set. Any attempts to standardize, prices or component configuration will ultimately lead to either a sub standard or over qualified mismatch.



Administratively or practically it may be advisable or preferable to go for standardization. However, attempts to bring standardization may defeat the purpose and lead to avoidable distortions. For the limited purposes of subsidy component and loan quantum calculations, broad based unit costs may be determined as guidelines. The final costs will however be based on actual pricing and quantification of system components.

4. SPRINKLER IRRIGATION:

A sprinkler “throws” water through the air in an effort to simulate rainfall whereas the other irrigation methods apply water directly to the soil or root zone, either on or below the surface. A sprinkler system can be composed of one sprinkler or many. When many sprinklers are used they are attached to a pipeline at a predetermined spacing in order to achieve a uniform water application.



Sprinkler type irrigation systems consist of emitting devices, which rotate with the help of water pressure in the system, usually called Sprinklers or Sprinkler heads or Nozzles. These sprinklers have rotating parts and hence are not maintenance-free. Due to rotational motion of the sprinklers, the water can be sprinkled over larger areas depending upon the aperture sizes of their Nozzles, Angle at which the Nozzles are fixed and the water pressure in the system.

The sprinkler or overhead irrigation system consists of conveying water to the field by aluminum or High Density Poly Ethylene (HDPE) pipes and distributing it over the field under pressure through a system of nozzles. For spraying water under pressure, a booster pump or high-speed low discharge pump is necessary. Since the water is conveyed through pipes, the seepage and evaporation losses, which are about 20 per cent in well-irrigated areas to 50 per cent in canal irrigated areas, are eliminated. Further, the system can be designed to distribute the required depth of water uniformly, which is not possible in surface irrigation. Since the water application rate is less than the infiltration rate of the soil, there are no runoff losses in this method of irrigation. Even when the soil is too porous and difficult to distribute water uniformly in the surface



method, a sprinkler system can irrigate it efficiently. This method can be used under most climatic conditions where irrigation is feasible. These systems are suitable for irrigating crops where the plant population in a unit area is very high and hence the adoption of Drip Irrigation Systems would be cost intensive in such crops. Thus, for economic viability, in such high plant population crops such as Cereals, Pulses, Oil Seeds and other field crops, sprinkler irrigation systems are adopted. Depending upon the extent of coverage or diameter of throw, the sprinkler systems can be classified as:

- Low to Medium Range Overhead Sprinkler Systems
- Long Range Rain Gun Sprinklers

Depending upon the type of installation, the sprinkler irrigation systems can be classified as:

- Portable Sprinkler Irrigation Systems
- Semi Portable Sprinkler Irrigation Systems
- Permanent or Solid Set Irrigation Systems
- Center Pivot Sprinkler Irrigation Systems
- Linear Move Sprinkler Irrigation Systems
- Reel Traveler Sprinkler Irrigation Systems

However, the ultimate choice and suitability of a specific microirrigation system depends upon any or few of the following factors:

- Crop
- Soil
- Land Topography
- Water Quality
- Time Available for irrigation
- Water Requirement in different growth stages
- Frequency of irrigation
- Fixed and Maintenance Costs of Irrigation Systems

4.1 Types of Sprinkler Systems:

Sprinkler systems are classified in the following two major types on the basis of the arrangement for spraying or sprinkling water:

- 1) Rotating head or revolving sprinkler system.
- 2) Perforated pipe system.



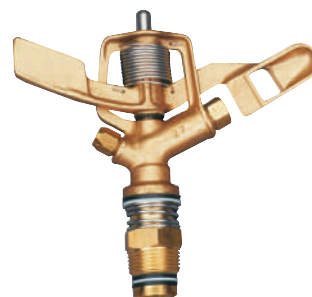
4.1.1 Rotating head or revolving sprinkler system:

This can again be divided into three categories namely:

- a) Conventional system/small rotary sprinklers.
- b) Boom type and self propelled sprinkler system.
- c) Mobile raingun/large rotary sprinklers.

4.1.1.1 Conventional Rotary Sprinkler/ Conventional System:

Small size nozzles are placed on riser pipes fixed at uniform intervals along the length of a lateral pipe. The lateral pipes are usually laid on the surface of the ground. The sprinklers operate at low to medium pressure of 2 to 4 kg/cm² and can wet an area of 9-24 m wide and up to 300 m long at one setting. Application rates vary from 5 to 35 mm per hour. In rotating type of sprinklers the most common device to rotate the sprinkler head is a small hammer actuated by the thrust of the water striking against a vane connected to it. This system using many small rotary sprinklers operating together was the first to make sprinkler irrigation popular in the thirties and it is still the most commonly used system today.



4.1.1.2 Boom Type/Self-Propelled Sprinkler Systems:

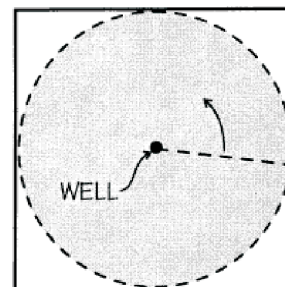
This system employs one boom sprinkler on each lateral. The boom is a pipeline with nozzles fixed at regular intervals. The pipeline slowly rotates and is suspended from a portable tower. Boom sprinklers are moved by towing the towers to the next position along the laterals with a tractor or winch. The large sprinkler irrigates a width of 75 to 100 m depending on nozzle sizes and pressure and is particularly useful for tall crops such as Maize and sugar cane, where space at regular intervals is available for maneuvering the portable towers.

A self-propelled sprinkler consists of a radial pipeline supported at a height of 1.8 to 2.4 m, at intervals of about 30 m on towers mounted on two wheels or a small truck. The radial line is rotated slowly around the first point in the centre of the field by either water pressure actuators or by electric motors at each tower. Conventional sprinklers mounted on the pipe then distribute water to the field, as the pipeline is moving. This system covers about 10 to 100 ha and the total capacity range is from 1500 to 4500 lit/ min. This type of sprinkler system is often used for crops where it is difficult to move sprinkler laterals in the conventional manner.



4.1.1.3 Centre Pivot Systems

This self-propelled sprinkler system rotates around the pivot point and has the lowest labor requirements of all the sprinkler systems. It is constructed using a span of pipe connected to moveable towers. It can irrigate approximately 130 acres out of a square quarter section. Center pivot systems are either electric, water, or oil-drive and can handle slopes up to 15 per cent. Sprinkler packages are available for low to high operating pressures (2.0 kg/cm² to 6 kg/cm² at the pivot point). Sprinklers can be mounted on top of the spans or on drop-tubes, which put them closer to the crop. The water application amount is controlled by the speed of rotation.

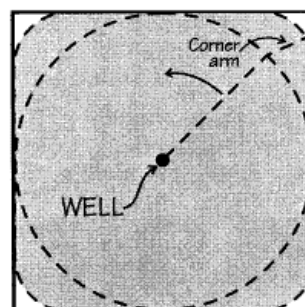


Center pivots are adaptable for any crop-height and are particularly suited to lighter soils. They are generally not recommended for heavy soils with low infiltration

rates. Deep wheel tracks can be a problem on some soils, but, there are a number of management methods available to control this problem. Electric-drive pivots are the most popular due to flexibility of operation. Computerized control panels allow the operator to specify speed changes at any place in the field, reverse the pivot, turn on auxiliary pumps at a specified time and many other features.

4.1.1.4 Center Pivot With Corner Attachment

Corner attachment systems are available which allow irrigation of most of the corner areas missed by a conventional center pivot system. Depending on the method of corner irrigation, pivot systems with corner attachments will irrigate 145 to 152 acres out of a 160 acre quarter section. The most common method of corner irrigation has an additional span, complete with tower, attached to the end of the center pivot system



mainline, which swings out in the corners. As it swings out, sprinklers are turned on to irrigate the corners. The movement of the moving span is controlled either by a buried wire or a mechanical switch.

Another type of corner system uses several guns mounted on the end of the center pivot system mainline. The guns are activated in sequence from smallest to largest and back again as the machine moves past the corners. A corner span generally costs about half as much as the rest of the pivot, increasing the capital cost per acre on a square 160



acres. However, if the field is rectangular, the corner span can be extended on one or both ends, increasing the amount of irrigated acreage from 170 to 185 acres. High value crops and/or high land value as well as scarcity of irrigable land, etc can only justify additional costs over a “plain” center pivot.

Centre pivot systems are suited to fields where a large area free of obstruction is available. Some operators have a quarter section pivot, of which half or one-quarter of the circle can cover different crops. Shorter centre pivot machines are available, and although the cost per acre is high, they may be a viable alternative for field crops in large areas. Major advantages of pivots are that they require a relatively small amount of labour, have the ability to operate on rough topography and have variable speed, which permits light applications.

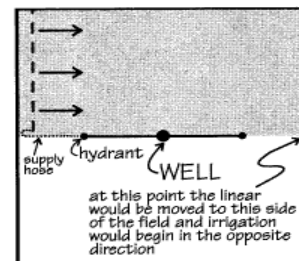
The center pivot system is very adaptable but does not work very well on irregularly shaped fields, long narrow fields and fields that contain some type of obstruction (trees, poles and distribution towers of electricity and/or telecommunication departments, farm structures, depressions or farm ponds, etc.). In these situations other sprinkler systems may be used more effectively.

4.1.1.5 Lateral or Linear Move Systems:

Lateral Move (some times called a linear move) irrigation system is built the same way as a center pivot, with moving towers and spans of pipe connecting the towers. The main difference is that all the towers move at the same speed and in the same



direction. They move linearly and continuously while irrigating. Instead of rotating around a centre point, this type of system moves sideways, irrigating a rectangular area. Water is pumped into either one of the ends or into the center. Water can be supplied to the linear either through a canal, by dragging a supply hose, which is connected to a mainline, or by connecting and disconnecting from hydrants as the linear moves down the field. To gain acreage and make the transition from one side of the field to the other, some linears pivot at the end of the field.



Automation, low energy requirements and uniform water application with a high degree of control are the main advantages. High capital cost is the main disadvantage. The lateral movement makes it difficult to power a linear with electricity. Usually, a diesel motor with a generator is mounted on the main drive tower and supplies the power needed to operate the irrigation system. The primary advantage of the linear is that it can irrigate rectangular fields up to a mile long and a half-mile wide. Due to the high capital investment cost, linears are used on high value crops such as potatoes, vegetables and turf.

4.1.1.6 Raingun/Large Rotary Sprinklers:

This system operates at high pressure to irrigate large areas. The term 'raingun' is used to describe them because of the large size of sprinkler used and its ability to throw a large quantity of water over wide areas. They can irrigate areas up to 4 ha at one setting with an application rate varying from 5 to 35 mm per hour. There are two main types of the system: (i) hose pull system; and (ii) hose reel system.

4.1.1.7 Hose pull system:

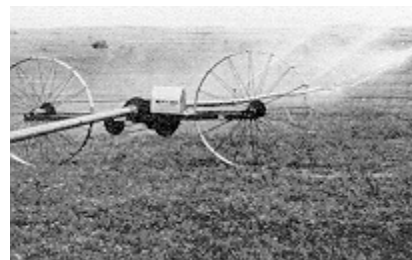
Here the rain gun is mounted on a wheeled carriage. Water is supplied through a flexible hose which is up to 200 m long and 50 to 100 mm in diameter and which is pulled along behind the carriage. The mainline is laid across the centre of the field from the pumping station. A strip up to 400 m long can be irrigated at one setting, although the flexible hose may only be 200 m long. The raingun carriage is moved either by a water motor powered by water supply using a piston, or a turbine drive, or an internal combustion engine. The pressure at the raingun controls the application



rate. The forward speed of the machine controls the application depth of water, which varies with speed from 10 to 50 mm an hour. The faster the machine travels, the smaller is the depth of water applied.

Hose reel system or Wheel Roll or Side Roll Systems:

The side roll (sometimes called a wheel roll) system, as shown, consists of a lateral, usually a 600m or quarter mile long, mounted on four-to ten-foot diameter wheels with the pipe acting as an axle. Common pipe diameters are 4 and 5 inch. The side roll irrigates an area from 18 to 27 m wide. When the desired amount has been



applied to this set area, a petrol/diesel engine located at the center is used to move the side roll to the next set. The sprinklers are generally mounted on weighted, swiveling connectors so that no matter where the side roll is stopped, the sprinklers will always be right side up. This type of system is not recommended for slopes greater than 5 per cent and should be used mainly on flat ground.

Other characteristics include: suitable only to low growing crops, medium labor requirements, moderate initial investment, medium operating pressure (3 to 4 kg/cm² at inlet), generally rectangular field requirements, and each lateral capable of irrigating a maximum of 40 acres. The side roll is better adapted to heavier soils than a continuous moving system. Special wheels must be purchased for moving this system from field to field without disassembly. One variation of the side roll system has trail lines with up to three additional sprinklers on a 18 m spacing. This reduces the number of sets required to irrigate a particular field.

Wheel roll systems are commonly used for several field crops including vegetables in western countries. Four numbers of 400 m laterals per quarter section can be justified by improved yield and quality, rather than the two laterals generally used with conventional field crops. Where surface crusting is a problem or when irrigation for germination is required, the nozzle size of the sprinklers could be reduced. This would result in an increased pressure and finer droplet size. Equipment costs vary depending primarily on the number of laterals that are required. Acreage smaller than a quarter section can also be irrigated with wheel roll systems, but the cost is higher and if the field is not rectangular in shape, the labour requirements are greater.



4.1.1.8 Traveling Big Gun:

The traveling big gun system uses a large capacity nozzle (3/4 to 1 1/2 inches in diameter) and high pressure (6 to 9 kg/cm²) to sprinkler water over the crop (50 to 100 m radius) as it is pulled through an alley in the field. Traveling big guns come in two main configurations: hard hose or flexible hose feed. With the hard hose system, a hard polyethylene hose is wrapped on a reel mounted on a trailer. The trailer is anchored at the end or center of the field. The gun is connected to the end of the hose and is pulled to the end of the field. The gun is pulled across the field by the hose wrapping up on the reel.



With the flexible hose system, the gun is mounted on a four-wheel cart. Water is supplied to the gun by a flexible hose from the mainline. A winch cable on the cart pulls the cart through the field. The cable is anchored at the end of the field. Most traveling big gun systems have their own power unit and cable winch mounted directly on the machine. The power unit may be an internal combustion engine or a water drive. Particularly adaptable to various crop heights, variable travel speeds, odd shaped fields, and rough terrain, the big gun requires a moderate initial investment, more labor and higher operating pressures than center pivots and linears. One 400 m (quarter-mile) long set usually covers 8 to 10 acres, but many variations are available using different water quantities and operating pressures. Irrigated crop land is lost because the alley required for the reel travelers is generally two rows wide. Most big gun systems are used on a maximum of 80 to 100 acres per gun.

4.1.2 Perforated pipe system:

This method consists of drilled holes or nozzles along the length of a pipe through which water is sprayed under pressure. The simple perforated pipe systems are usually designed for relatively low operating pressure (1 kg/sq. cm), however larger spray pipe systems sometimes need higher operating pressures to the extent of 4 to 6 kg/cm². The application rate



ranges from 1.25 to 5 cm per hour for various pressures and spacings. It is therefore limited to use in soils having fairly high intake rates. There are types of spraying systems: (a) Stationary, (b) Oscillating, and (c) Rotating.

4.1.2.1 Stationary System:

They consist of lightweight portable laterals 50 to 100 mm diameter connected with quick couplers. Small holes of 1 to 2 mm diameter are drilled into the topside of the pipe, so that water sprays in all directions wetting a rectangular area. This operates at pressures between 1.5 and 5 kg/cm² and can irrigate an area of land 5 to 15 m wide and up to 200 m long at one setting. The rate of application varies from 10 to 30 mm/hour. While irrigating, the mainlines and laterals are laid out and operated in a manner similar to the portable system using rotary sprinklers. Laterals are moved to the field in the same way. This is used for crops such as vegetables and for nurseries and often for delicate seedlings and plants.

4.1.2.2 Oscillating System:

This is also used mainly for small sized farms. It consists of lightweight portable laterals 25 to 50 mm diameter with nozzles 1 to 2 mm diameter spaced out along the top of the pipe 0.6 to 1.5 m apart. The lateral is supported above the crop on stands, which allow it to be rotated from side to side through approximately 100° to irrigate a rectangular field on either side of the pipe. It operates at pressures similar to the stationary type and irrigates similar area at one setting. Here the pipes are joined together with special rigid couplers so that the whole lateral can be rotated from one place. Rotation can be done by hand or by an automatic oscillator.

4.1.2.3 Rotating System:

The system is sometimes termed either 'rotary irrigators' or 'boom sprinklers'. The main feature is a pipe boom with an overall length up to 80 m pivoted at the centre. It has nozzles varying from 4 to 8 mm diameter spaced out along its length to provide an even distribution of water as it rotates. A ranger nozzle fitted into each end of the boom increases the area that can be irrigated at one setting. The boom is mounted on a wheeled carriage powered by an internal combustion engine or through the take-off point in a tractor. It is supported from the centre by steel cables. Water is supplied from the mainline through a swivel joint to the boom and to the nozzles.

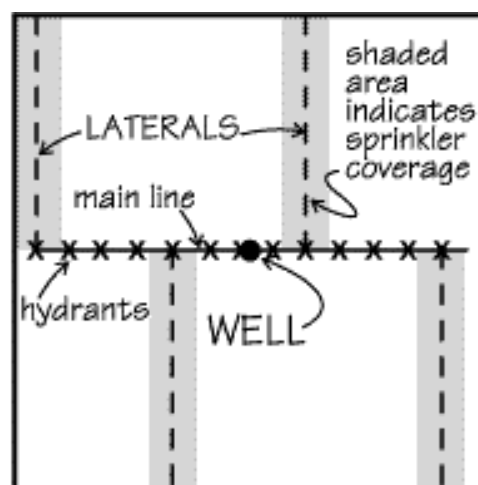


4.2 In addition to the above classification of sprinkler systems, the systems are also classified based on the portability, into the following types:

- Portable system.
- Solid set or permanent system.
- Semi-permanent system.

4.2.1 Portable system or Hand Move System:

Systems where part or all of the equipments are hand moved regularly, are called portable systems. The simplest portable system designed is to be moved by hand. It consists of a pump, mainline lateral and rotary sprinklers spaced 9 to 24 m apart. The lateral is usually between 50 mm to 100 mm in diameter so that it can be moved easily. It remains in position until irrigation is complete. The pump is then stopped and the lateral disconnected from the mainline and allowed to drain. It is then dismantled and moved



manually to the next point on the mainline and reassembled. As the lateral is connected to the end of the mainline it is necessary to disconnect sections of the mainline. Usually the lateral is moved between one and four times each day depending on the set time. It is gradually moved around the field until the entire field is irrigated.

In some cases to irrigate large areas, two to three laterals are used. They are connected to the mainline using valve couplers. This allows irrigation to continue while one of the laterals is being moved. In the system described, only the laterals are moved during irrigation while the mainline remains permanently in the same place. In some cases, the entire system including pump and the mainline is moved from field to field. Portable systems are the most popular and are used to irrigate a wide range of field and orchard crops, for which capital investment is comparatively low and they are simple to use. As the equipment is to be moved often, labour is required. The equipment is therefore well suited to Indian conditions.



4.2.2 Solid set or permanent system:

When sufficient laterals and sprinklers are provided to cover the entire area to be irrigated, there is no need for moving the equipment from place to place. This system is termed “solid set or permanent system”. This type is used on permanently irrigated areas and for relatively high value crops such as orchards, vine yards, pastures and nurseries. The purpose of this system is to reduce labour costs and eliminate moving of lateral lines especially where tree foliage is heavy and/or sensitive. Fully permanent systems are not many, because of the relatively high installation costs, even though in many cases, these costs would be more than offset by saving in labour costs. The most commonly used pipes are plastic and aluminum alloy pipe.

Most solid and permanent systems have only a part of the system irrigating at one time. This depends on the size of the pipes and the amount of water available. Hydrants and valves divert flow from one part of the system to another. For special conditions such as crop cooling or frost protection, it is essential to operate the entire system at one time. Irrigation equipment like this is particularly suited to automation and is useful in areas where labour is inaccessible or is very expensive.

4.2.3 Semi Permanent system

Many new sprinkler systems have been developed in the recent years with the advantage of being both portable and solid set equipment by reducing capital costs and labour requirements. These are known as semi-permanent systems and the following systems are the most commonly used: (a) Sprinkler hop, (b) Pipe grid, and (c) Hose pull.

a) Sprinkler Hop System:

This is similar in many ways to portable systems, but sprinklers are placed only at alternate positions along the lateral. When sufficient water has been applied the sprinklers are disconnected and moved or hopped along to the next position where they irrigate for a similar period. This is done without stopping the flow in the lateral. Each sprinkler connection is fitted with a special valve, which automatically stops the flow when the sprinkler is removed. This lateral is moved to the next position and the hoping process repeated.



b) Pipe Grid System:

This is similar to the solid set or permanent system. Small diameter laterals about 25 mm are used to keep system costs low. The pipes are laid out over the entire field and they remain in place throughout the irrigation season, thus eliminating movements of pipes. Two sprinklers are connected to each lateral, one near the top, the other half way down. When sufficient water has been applied each sprinkler is disconnected and moved along the lateral to the next position. This is repeated until the whole field has been irrigated.

c) Hose Pull System:

This is used for under-tree irrigation for orchard crops and other row crops. The mainline and laterals are usually permanently installed either on or below the ground surface. Small diameter plastic hoses supply water from the lateral to one or two rotary sprinklers. The hose length is about 50 m because of friction losses in the pipe. This reduces a number of laterals and provides great flexibility in irrigation. A sprinkler can be easily moved where it is needed and can be adjusted to compensate for the distortion of spray patterns caused by wind. It is cheap, but problems can arise with plastic hoses.

The type of sprinkler system mostly in use in India is Portable Small Field Sprinkler System consisting of fixed number of medium range sprinklers (10 to 12 m radius) and HDPE Quick Release Type Pipes. The various Central and State government schemes which offer subsidy are all for such Portable Small Field Sprinkler Sets only, as they are ideally suitable for small field sizes in the Country. Farmers use these sets for irrigating their fields by shifting the set of sprinklers and pipes time to time depending upon the crop water requirements and Water/Power availability.

As explained above, there are several types of sprinkler systems depending upon the sprinkler used such as simple Overhead sprinkler systems, Raingun Sprinkler systems, etc. Similarly depending upon the type of pipes used they are classified as Aluminum Pipe based Sprinkler Systems and HDPE Pipe based sprinkler systems, out of which the Aluminum Pipe based Sprinkler Systems, were in use in early days of promotional efforts in the country. However, due to inherent problems associated with the Aluminum pipes such as easy damage to the pipes, leakages in joints and cost of Aluminum raw

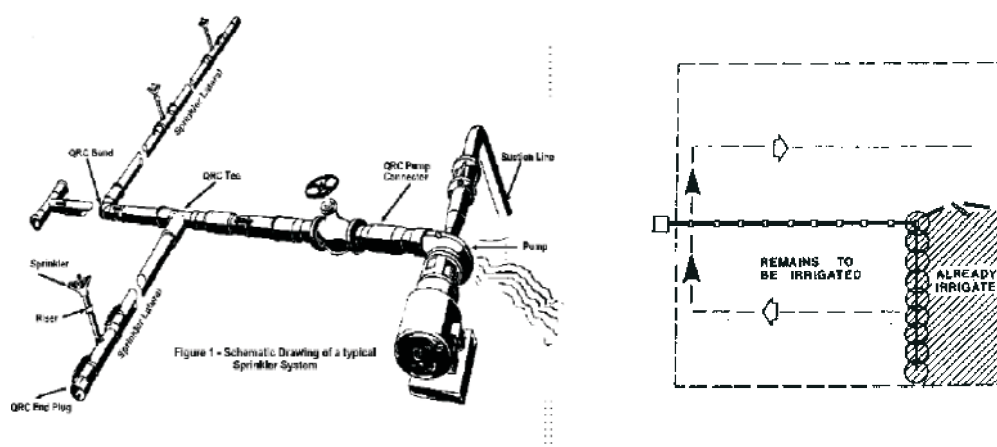


material, the Aluminum Pipe based systems lost their relevance after the advent of Plastic Pipes especially HDPE pipes.

In the Portable Sprinkler Systems that are most popular in the country, the Main/Submain/Lateral pipes are shiftable and can be moved around the field based on irrigation requirements of crops and frequency of irrigation cycles, unlike in a Fixed Sprinkler System where the entire network of pipes and the sprinkler heads are installed permanently.

Fig. 4.3 explains the layout of a typical Portable Sprinkler System.

Fig-4.3: Typical Portable Sprinkler Set



Presently in India, Portable Sprinkler Systems using HDPE pipes are widely in use. The HDPE pipes of uniform lengths (usually 6m or 3m) are fixed with Quick Release Couplers (QRCs). These QRC type pipe ends enable quick joining and separation of the pipes from one another whereby the pipes can be easily shifted from place to place, all over the field.

In each shift the sprinklers are run for a calculated amount of time based on crop water requirements and frequency of irrigation. At the end of each shift the entire set of sprinkler is shifted to the next position for covering the remaining area.

Various components in a typical portable sprinkler system promoted by various States are detailed as given below.



4.3 Sprinkler Irrigation Systems – Hardware:

The typical components in a sprinkler system are:

- Sprinkler or Nozzle
- Lateral, Submain or Mainline Pipes
- Pipe fittings such as Bends, Tees, Saddles, End Plugs, Pump Connectors, riser pipes, etc.,
- Pumping unit

Sprinklers are the components, which spread water into spray form. Hence the performance of the sprinklers will have a major impact on the success of the sprinkler system as a whole. The unique design and construction of sprinklers result in uniform distribution of water droplets over the wetted area. The various components of a typical impact sprinkler and the typical Quick Release Coupling (QRC) pipes are shown in the Fig.4.4.

The various QRC fittings in a portable sprinkler system are described as given below:

- QRC Tee consists of two QRC female ended couplers and one male end arranged in the form of T. This fitting is required to take out branches along a pipeline.
- The QRC bend is a typical short radius bend connected with QRC male and female ends at each of its ends. This is useful in taking out a single perpendicular branch from a QRC pipeline.
- QRC Pump connector is a typical fitting required to connect any threaded component to the QRC pipes. One end of the connector consists of a GI pipe nipple with suitable threads. The other end of GI pipe nipple is inserted into the QRC Female coupler. The GI pipe nipple is firmly fixed into the HDPE end with the help of either a Clamp with a Nut bolt arrangement. Additionally, a GI socket can be welded on GI pipe portion for enabling fixing of a pressure gauge or any other device for pressure or flow measurement



Fig-4.4: QRC HDPE Sprinkler Pipes and Fittings



- Sprinkler base is a component consisting of a service saddle arrangement in order to take threaded GI riser pipe into its female socket. Male and female QRC couplers are attached on either side for enabling connection to other QRC pipes. The no. of sprinkler bases required in a system will be equal to the no. of sprinkler heads in the system.
- The QRC end plug is useful in closing a pipeline. It consists of a male ended QRC coupler which is closed on one end.
- Sprinklers can be of different types such as simple impact driven sprinklers, rainguns, floppy sprinklers, etc. Each of these sprinklers are available in different materials of construction, different nozzles sizes, different coverage patterns (part circle, full circle, etc) and scores of other features depending upon the specific crop, soil and operational requirements.



4.4 Development of Sprinkler Irrigation:

Though it is more than 75 years since the development of sprinkler irrigation technology in the world took place, little of this method was known or talked about till 1980s in our country.

4.4.1 World-wide development:

The sprinkler system became more popular only after the second World War and with the introduction of light weight portable aluminum pipes. Simultaneously there were technological developments in the sprinklers, quick couplers etc that facilitated convenient uncoupling and re-coupling of the pipes. As per the available data at the world level 21 million hectares are under sprinkler and the highest hectarages are in USA with 8.5 million hectares (as on 1980) followed by the then USSR (as on 1980) with a hectarage of 6 million.

Sprinkler irrigation in other countries of the world is under varying degrees of development. A number of installations have been made with more planning in Tunisia, Libya and Turkey. Experimental units were installed in Taiwan in 1952 for irrigating sugar cane with encouraging results. In Greece and Italy, sprinkler irrigation is widely adopted. Australia has introduced sprinkler irrigation on a large scale in their orchards and for fodder crops in about 50,000 ha. It was estimated in the year 1970, that sprinkler irrigation was adopted in an area of about 6 M ha in the world, which is significant not only from the standpoint of the gain in the world food production, but also because it was accomplished almost entirely by individual farmers with their own financial resources.

4.4.2 Development of sprinkler Irrigation in India

Though sprinkler system is known since 1946, yet the farmers started adopting it in large scale only since 1980s. In India sprinkler system has been introduced mainly on account of inevitable factors and not as a realization of its inherent advantages. Thus, it started in the hilly areas of Western ghats in the states of Kerala, Tamil Nadu and Karnataka and in the North eastern states mainly for then plantation crops like Coffee, Tea Cardamom, Rubber etc. Slowly it spread to the water scarcity and light soil states of Rajasthan and Haryana in addition to the black soil area of Madhya Pradesh.

Apart from soil and water constraint conditions, the erratic rainfall also played a significant role for the adoption of sprinkler in these states. One important aspect of sprinkler adoption is that in Haryana, this system is very successfully employed in



canal command areas. The extent of adoption of sprinkler in different states indicates that Madhya Pradesh with an hectarage of 1.5 lakhs contributes to almost 25 per cent of the total area under sprinkler in the country (6.7 lakh hectares). This is followed by West Bengal, Assam, Haryana and Rajasthan. The scarcity of water was realized in States like Tamil Nadu, Karnataka, Haryana, Gujarat and Maharashtra, and hence large-scale adoption of this method is in progress. Further, the Government of India to conserve water has taken an initiative to give subsidy to the farmers to an extent of 20 % to 50 % in order to popularize this water-saving device.

Though detailed statistics are not available, it is estimated that the total gross area under sprinkler irrigation was about 0.23 M ha in India by 1985. Indigenous manufacture of the systems started during 1960s using foreign designs and technology. Subsequently with research and development, the equipment and production techniques have been modified and adapted to suit Indian conditions, especially in the areas of strength and durability, operating economy and reduced cost for the users. Development work on sprinkler systems has been mainly to reduced the cost of equipment, but not at the expense of durability and to save energy by the introduction of smaller, low pressure sprinklers. Till recently, the most popular piping material has been aluminium but High Density Poly Ethylene (HDPE) pipes were introduced in early 1980s in India. This is much stronger than aluminium and available at a lower cost to the farmer.

The spread and popularization of the sprinkler systems among the farmers has received significant support from the various schemes involving subsidy of the Central and State Governments. The following are some of them:

- Integrated Rural Development Programme: In the centrally financed (SFDA, DPAP) – various rates of subsidy are available for small/marginal and medium farmers both individually and on a community/cooperative basis for minor irrigation schemes including sprinkler irrigation. Karnataka Government has taken up in an extensive programme providing small farmers with borewell and sprinklers on a community basis.
- Centrally sponsored schemes for encouraging irrigation through sprinklers, solar pumps, etc. The Government of India contributes 50 per cent of the subsidy with the State Government contributing 50 per cent. Subsidy rates used to be 50 per cent for small farmers and 20 per cent for others.
- Centrally sponsored intensive projects and technology Missions for increasing



production of Oil Seeds, Cotton and Pulses also provide subsidy for sprinkler systems. They offer substantial subsidy on the sprinkler system purchased for the irrigation of these crops.

- Haryana operated a highly successful subsidy-cum-loan scheme specifically for sprinkler irrigation since the seventies. The Government provides a 25 per cent subsidy and loans are given to the farmers through land development bank and the same is refinanced by NABARD. This type of scheme has now been taken up in Rajasthan, Gujarat, Maharashtra, and Madhya Pradesh.
- It is stated that about 10,148 sprinkler sets were installed in Haryana State up to 31.3.1983 at a total estimated cost of Rs. 20 crores. This has resulted in providing irrigation to an additional area of 42,000 ha without any extra water. Further, it was revealed that due to introduction of the sprinkler irrigation system, the gross and net irrigated areas increased to an extent of 83.24 and 66.65 per cent respectively.

4.5 Research and Experimental findings:

The following are some of the useful findings available for introducing sprinkler irrigation:

- The Haryana Irrigation Department has reported that saving of water by a sprinkler was seen compared to surface irrigation averaging to 56 per cent in the case of *bajra*, *jowar*, wheat, barley and gram and 29 per cent in the case of cotton.
- The Punjab Agricultural University has reported water saving of 42.7 per cent for wheat and 47.5 per cent for maize. The University of Agricultural Sciences, Bangalore, has found that the net irrigated area and cropping intensity were higher when sprinkler irrigation was introduced in the university farm.
- A comparative study on sprinkler irrigation in respect of cotton (MCU. 5) was undertaken with the basin method of irrigation as control at Coimbatore. The cotton (*kapas*) yield was the highest under sprinkler irrigation (23.3 Q per ha) consuming only 316 mm of water whereas the basin system recorded the lowest yield of 18.5 Q per ha consuming the largest quantity of water (610mm).
- Evaluation of the sprinkler irrigation method on groundnut crop at Bhavanisagar, TN revealed that irrigating the crop to a depth of 3 cm at 0.6 IW/CPE ratio recorded significantly higher pod yield (1878 kg per ha) whereas flow irrigation with 5 cm depth of water at 0.6 IW/CPE ratio recorded 1.557 kg of pods per ha.
- Studies on sprinkler irrigation comparing with surface irrigation were made at



Madurai on groundnut revealed that sprinkler irrigation was preferable for both yield betterment and water saving. The reason for better yield under sprinkler irrigation with less quantity of irrigation water was that it provided adequate moisture for plant growth, while keeping the soil structure loose and friable, which was conducive to good aeration, root growth and pod formation.

4.6 Crop Response to Sprinkler:

This system has been reported to be techno economically viable for a wide variety of crops as detailed in Table 4.10. The trials conducted in different parts of the country revealed water saving varying from 16 to 70 per cent over the traditional method with yield increase variation of 3 to as high as 57 in different crops and agro climatic conditions

Table 4.10: Response of different crops to sprinkler irrigation

CROPS	WATER SAVING, %	YIELD INCREASE, %
Bajra	56	19
Barley	56	16
Bhindi (Okra)	28	23
Cabbage	40	3
Cauliflower	35	12
Chillies	33	24
Cotton	36	50
Cowpea	19	3
Fenugreek	29	35
Garlic	28	6
Gram	69	57
Groundnut	20	40
Jowar	55	34
Lucerne	16	27
Maize	41	36
Onion	33	23
Potato	46	4
Sunflower	33	20
Wheat	35	24

Source: INCID (1998) adapted from Table 6.5



4.7 Selecting the Most Appropriate Sprinkler Systems:

While selecting a sprinkler system, the most important *physical* parameters to be considered are:

1. The crop or crops to be cultivated.
2. The shape and size (acres) of the field.
3. The topography of the field.
4. The amount of time and labor required to operate the system.

4.7.1 Selection of Sprinkler System Capacity:

A sprinkler system must be designed to apply water uniformly without runoff or erosion. **The application rate of the sprinkler system must be matched to the infiltration rate of the most restrictive soil in the field.** If the application rate exceeds the soil intake rate, the water will run off the field or relocate within the field, resulting in over- and underwatered areas. Using tillage that improves surface storage, such as deep cultivation or making basins, will help control runoff. The intake rate of the soils in the field can be found through soil tests.

The sprinkler system capacity is the flow rate needed to adequately irrigate an area and is expressed in litres per minute per acre. The system capacity depends upon the: Peak crop water requirements during the growing season; effective crop rooting depth; texture and infiltration rate of the soil; the available water holding capacity of the soil; pumping capacity of the well or wells (if wells are the water source) and the Water Permissions for pumping rate.

4.8 Economic Viability of Sprinkler:

Average costs of various types of sprinkler systems in USA ranges between 300 to 425 US \$ (Scherer, T, 14988):

Whereas the simple portable sprinkler set in India costs around Rs 15000 to 20000 per set by which the farmer can cover an area not less than 1 ha.

The economic viability of this system for different crops has been studied at different locations. Apart from working out the economics for unit area it has also been worked out for the total quantity of water used. The trials conducted in Gujarat for various crops in the different agro climatic conditions have clearly indicated that, apart from water savings, there has been a nominal increase in the net return on unit area basis ranging from nil to Rs 760 per hectare in different crops. But, economics worked on the basis of the additional area that can be brought under irrigation with the saved water, showed



that the net income could be increased substantially to as high as Rs 32000. (Table 4.11).

Table 4.11: Economic Viability of Sprinkler for Different Crops in Gujarat

Crop	Location	Zone	%Water Saving	%Yield Increase	Net Return, Thou Rs/ha	Possible Addl. Area, ha	Net Profit, Thou Rs
Cabbage	Navsari	South Gujarat	40	3	7.6	0.67	32.6
			35	12	5.6	0.52	32.6
Cauliflower	Navsari	South Gujarat	29	35	1.4	0.41	2.4
Fenugreek	Jagudan	North Gujarat	29	35	1.4	0.41	2.4
Gram	Vyara	South Gujarat	69	57	1.8	2.2	7.1
Gram	S.K.Nagar	North Gujarat	11	31	2.7	0.13	4.1
Groundnut	Anand	Middle Gujarat	21	42	2.9	0.26	5.4
Lucerene	Navsari	South Gujarat	35	4	-	0.54	4.8
Maize	Godhra	Middle Gujarat	41	36	1.3	0.70	3.8
Sugarcane	Navsari	South Gujarat	42	12	3.3	0.73	25.3
Wheat	Vijapur	North	31	18	-	0.45	10.2

Source: INCID (1998); adapted from Table 6.5

4.9 Constraints of Sprinkler Irrigation:

Some of the limitations of sprinkler irrigation are:

- The high wind velocity reduces the effectiveness and uniformity of sprinkling
- Energy requirements are generally high since sprinklers are operated at a water pressure of more than 2.5 kg/cm²
- Adverse soil conditions. The highly impermeable soils are not suitable for sprinkler irrigation.



- Depending upon the climatic conditions, the evaporative losses may become more
- In hilly terrains, the use of sprinkler irrigation results in soil erosion as well as wastage of water due to enormous non-uniformity in water application.

4.10 Standardization in Sprinkler Irrigation Systems:

The sprinkler irrigation systems promoted under various government sponsored/ supported schemes are standardized to contain pre-fixed numbers and sizes of pipes, fittings and sprinkler nozzles/heads. Any variation in the composition of the system is not allowed or not considered for subsidy and/or loan, due to which the farmers are most often supplied with systems or sets that do not exactly suit their requirements. Also, in the absence of any scope for change in composition of the standardized sets, the supplier companies do not perform any technical analysis based on the field geometry and crop requirements and do not prepare any hydraulic designs or irrigation schedules specific to the farmer/crop requirements. Thus, there is no element of design process involved in the present schemes for promoting sprinkler systems in the country.

Hence, the present day standardization in the sprinkler irrigation systems, needs to be reviewed objectively, in order to provide scope for considering the various farm, crop and farmer requirements before supplying the sprinkler sets to the farmers. Such a flexibility will enable the manufacturers to recommend systems that are ideally suitable for their intended performance objective whereby their utility can be improved. In the absence of such flexibility and in the absence of broad utility of the present day sprinkler irrigation sets, these sets are found to be rarely used for crop irrigation. Instead the farmers are mostly found to be using these systems for water conveyance only, defeating the very objectives such as water conservation, yield enhancement, productivity improvement, etc.

5. POTENTIAL FOR MICROIRRIGATION IN INDIA

If we could convert sizeable part of the irrigated areas into modern irrigation systems, considerably more area can be brought under irrigation along with increasing the land and water productivities. The potential for coverage under drip and sprinkler irrigation is estimated to be about 27 and 42.5 million ha respectively as per the following break up given in Table 4.12.



Table 4.12: Theoretical potential area for drip and sprinkler irrigation in India (M ha)

Crop	Area		
	Drip	Sprinkler	Total
Cereals	-	27.6	27.6
Pulses	-	7.6	7.6
Oil seeds	3.8	1.1	4.9
Cotton	7.0	1.8	8.8
Vegetables	3.6	2.4	6.0
Spices and condiments	1.4	1.0	2.4
Flowers and Medicinal and aromatic plants	-	1.0	1.0
Sugarcane	4.3	-	4.3
Fruits	3.9	-	3.9
Coconut & Plantation Crops, Oil Palm	3.0	-	3.0
Total	27.0	42.5	69.5

Source: 1. Agricultural Statistics at a glance 2003, Ministry of Agriculture, New Delhi.

2. Horticulture Database 2002, National Horticulture Board, Ministry of Agriculture, Gurgaon.

The estimated potential is divided into 3 different categories as given in Table 4.13 below:

Table-4.13: Categorization of Estimated Potential Area for Microirrigation

S.No.	Category	Crops	Estimated potential area, m. ha
1	Category-1	Widely Spaced Tree Crops suitable for Drip Irrigation (including Fruit Crops, Nuts, Plantation Crops, Oil Palm, Rubber, Forest Crops)	06.90
2	Category-2	Closely Spaced Crops suitable for Drip Irrigation (including Cotton, Vegetables, Tea, Coffee, Spices, Sugarcane, Tobacco, Vanilla, Mulberry, Medicinal & Aromatic, Flowers, some extent of Oil Seeds and Pulses)	20.10
3	Category-3	Crops suitable for Sprinkler irrigation (including Cereals, some extent of Oil Seeds, Pulses, Vegetables, Tea, Coffee, Spices, Medicinal & Aromatic, Flower and Fodder)	42.50
		Total	69.50



6. QUALITY CONTROL OF MICROIRRIGATION SYSTEM COMPONENTS

The Bureau of Indian Standards was set up after the enactment of the Bureau of Indian Standards Act, 1986. It operates a product certification scheme, and has till date granted more than 30,000 licenses to manufacturers covering a whole lot of industries ranging from agriculture to textiles to electronics. The certification entitles licensees to use the ISI Mark, which is considered the symbol of quality in India.

Indian standards on different facets of microirrigation systems are formulated by Irrigation and Farm Drainage Equipment and System Sectional Committee FAD 54 (erstwhile FAD 35) of BIS. It has formulated a number of Indian Standards on microirrigation systems. The physical components required to apply water by microirrigation system include the emitters, lateral lines, manifold lines, main and sub main lines, filter, chemical injectors flow control station and other necessary items. Most of the Indian Standards on irrigation equipment are based on corresponding International Standards, which have been adopted after suitable modifications to meet indigenous requirements. The most important standards formulated by the Bureau of Indian Standards are given in Annexure VII.

7 CRITICAL ANALYSIS OF FACTORS AFFECTING THE MICROIRRIGATION ADOPTION

It is quiet evident that the drip technology adoption in India is lopsided. Only four to five states contribute to more than 90 per cent of the achievement. A critical analysis of the adoption pattern showed that many factors are affecting this in an integrated way.

- ▶ An inter state analysis of drip adopting and non-adopting states brings out the fact that wherever the water scarcity is felt, the drip technology adoption is more. For example in the drip adopting states of Maharashtra, Karnataka and Gujarat the net irrigated area varies between 14 and 28 as against the drip non adopting states like Punjab, U.P. Haryana and Orissa where the irrigation percentage vary between 60 and 90.
- ▶ An intra state analysis of the variation between the drip adopting and non-adopting districts also show that in the drip adopting districts the net irrigated area is lower than the other group. One interesting aspect with regard to Andhra Pradesh is that, though, at state level the irrigation percentage is around 40, yet in the districts where drip technology is adopted, the irrigation percentage is only around 20.



- ▶ In the drip adopting states the rainfall is medium to low with deep water table, while in the non-adopting states, the rainfall is comparatively more with assured irrigation, with some exception like Rajasthan.
- ▶ Within the drip adopting state, climatically, the districts where this technology is popular are either arid or semiarid, while the other districts are mostly sub humid to humid or semi arid.
- ▶ Another observation shows that in all the drip adopting states the area under food grain crop varies between 37 and 65% with an average of 55 while in the non drip adopting states (excluding NE states) the area under food grains vary between 66 and 80 with an average of 74.
- ▶ In the drip adopting states the rural population below poverty line 11 and 24 while in the non-adopting states like Madhya Pradesh, Orissa, West Bengal, Uttar Pradesh it varied between 30 and 48%.
- ▶ Higher resource allocation is provided by the government, in these states in their plan budget while the non-adopting states gave lesser emphasis.
- ▶ High level of awareness among the officers as well as farmers coupled with good support for the technology transfer in the drip adopting states.
- ▶ Strong industry infrastructure especially in Maharashtra and Gujarat resulting in better after sales service, training etc.







CHAPTER V

PAST EFFORTS FOR PROMOTING MICROIRRIGATION

1. ORGANIZATIONAL SETUP

A National Committee on Use of Plastics in Agriculture (NCPA) was initially constituted in the Department of Chemicals & Petrochemicals (DCPC) in March 1981 under the Chairmanship of Shri G.V.K. Rao, Former Member, Planning Commission to oversee the development of plasticulture applications in the agriculture sector. The NCPA contributed significantly to the promotion of plasticulture applications in the agriculture sector by initiating various programmes. The NCPA had visualized large-scale plasticulture applications in the agriculture sector including popularization of microirrigation technology. The NCPA submitted three Reports to the Government. One of the major recommendations of the Committee was to set up 22 Plasticulture Development Centres (PDC) in different parts of the country. Consequently, 11 agricultural PDCs, 10 Irrigation PDCs and two industrial PDCs were established. Agricultural PDCs were established through NCPA at State Agricultural Universities (SAUs), irrigation PDCs through Central Board of Irrigation and Power (CBIP) and industrial PDC was established by India Petrochemicals Corporation Ltd (IPCL), Vadodra. Central Institute of Plasticulture Engineering Technology (CIPET) was set up at Chennai to provide services for testing of plasticulture product.

Realised that the agriculture sector is one of the largest consumer of plastics, the NCPA was transferred to the Ministry of Agriculture in the year 1993. But CIPET, which provides support for testing and the Industrial PDC at Vadodra, continued to function under the DCPC. The agricultural PDCs, however, continue to function under the Ministry of Agriculture.

After transfer of NCPA to the Ministry of Agriculture in 1993, it functioned till 1996 under the Chairmanship of Secretary (A&C). However, with a view to give greater thrust to the plasticulture applications and improve the productivity of horticultural crops through plasticulture interventions, the Committee was reconstituted in 1996



under the Chairmanship of Union Minister of Agriculture. Further, with a view to give focused thrust to plasticulture applications in horticulture, the Committee was reconstituted in 2001 as the National Committee on Plasticulture Applications in Horticulture (NCPAH).

The NCPAH secretariat, supported by the persons borrowed from IPCL and headed by Horticulture Commissioner, has been providing support for the promotion of this useful technology. The studies carried out by the PFDCs have resulted in development of regionally differentiated technologies and large number of farmers and representatives of development agencies have been trained. Besides coordinating the plasticulture development programmes & monitoring programmes of PFDC, the NCPAH Secretariat has also been providing national and international linkages for the development of the technology. However, since NCPAH did not have any well-defined legal status and played only an advisory role, it encountered several difficulties in pursuing the programmes vigorously. It had to depend entirely on the state agencies for implementation of the programmes. Decision making process was diffused and proper delegation of powers was virtually impossible. Considering the importance of the plasticulture in promotion of horticulture and need to have a central body to supervise the promotional and developmental activities, a properly constituted body with a defined legal status appears to be a must. The past experiences of NCPAH indicate that it should be an autonomous body.

2.0 TECHNOLOGICAL BACKUP FOR MICROIRRIGATION

2.1 Support from ICAR :

The Indian Council of Agricultural Research (ICAR) has an All India Coordinated Research Project on Plasticulture under which research studies are being carried out. The ICAR had also launched a DRIPNET project for carrying out research on the microirrigation application in various fruit crops. The objectives of DRIPNET were to Evaluate efficiency of drip irrigation in fruit crops; Determine crop regulation, nutritional properties & wetting pattern; and standardize fertigation techniques at different stages of crop growth. The details of centres and fruit crops covered under DRIPNET are given in Table 5.1



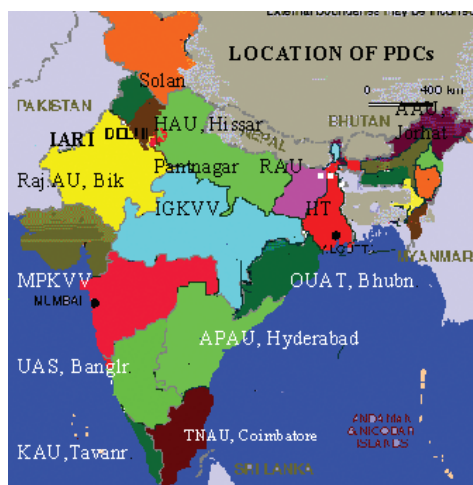
Table 5.1: Centres and Crops Covered Under DRIPNET

S.No.	Institute	Crops
1.	Central Institute of Horticultural Research, Lucknow	Mango, Guava
2.	National Research Centre (NRC) for Citrus, Nagpur	Citrus
3.	NRC for Banana, Trichy	Banana
4.	Mahatma Phule Krishi Vishwa Vidyalaya, Rahuri	Pomegranate, Ber
5.	NRC for Grapes	Grapes
6.	NRC for Arid Horticulture, Bikaner	Arid fruits
7.	NRC Oil Palm, West Godavari	Oil Palm

Besides, research on microirrigation is done under the coordinated projects at different centres on various crop commodities

2.2 SUPPORT FROM NCPAH

One of the major mandates of the NCPAH was to conduct applied research on plasticulture technology and disseminate it to the farmers and field functionaries. The Plasticulture Development Centres played a key role in this regard. The NCPAH was responsible for establishing the PDCs in different parts of the country, which conducted R & D on various plasticulture interventions such as drip irrigation, protected cultivation, mulching and other applications. The location and year of establishment of these PDCs are given in Annexure VIII.



Over the years, these PDCs have emerged as hub centres for plasticulture research. The NCPAH has been organising periodic interaction between the PDCs, State Implementing Agencies, industry and farmers besides conducting annual review meetings. Experiments conducted by these PDCs have helped to establish the advantages of plasticulture applications in terms of crop yield improvement, quality improvement, saving of resources like water, fertilizer, energy, and manpower etc for a variety of horticultural crops.

The PDCs have also been able to optimize design for microirrigation for reducing the



system cost through crop geometry modification. Another added feature is the assessment of crop water requirement under microirrigation at different locations in the country. The PDCs have also helped in designing green houses suitable for different agro climatic regions of the country. The NCPAH has also published literature on Green House design. The PDCs have evaluated the performance of plastic mulching on horticultural crops like banana, kinnow, lemon, pineapple, colocasia, ginger, turmeric, brinjal, chilli, tomato, okra, cabbage, cauliflower, coconut, etc. Besides, trials have been conducted for testing the efficacy of plastic mulching on non-horticultural crops also like cotton and maize. Trials have also been conducted on low tunnel cultivation, particularly on aspects like year round cultivation of mushroom, raising of seedlings and root cuttings, raising softwood cuttings of flowers like carnation and rooting of jasmine. The summary results of some of the studies conducted on microirrigation is given in the Table-5.2 below:

Table 5.2: Result of Studies on Microirrigation by PFDCs

SL NO.	CROP	YIELD (Q/ha)		IRRIGATION (cm)		WUE (q/ha/cm)		ADVANTAGE OF MI (%)	
		Surface	Drip	Surface	Drip	Surface	Drip	Saving	Increase in yield
1	Beet	5.70	8.90	86.00	18.00	0.07	0.50	79.10	56.10
2	Bitter Gourd	32.00	43.00	76.00	33.00	0.42	1.30	56.60	34.40
3	Brinjal	91.00	148.00	168.00	64.00	0.55	2.30	61.90	62.60
4	Broccoli	140.00	195.00	70.00	60.00	2.00	3.25	14.30	39.30
5	Cauliflower	171.00	274.00	27.00	18.00	6.3.0	15.20	33.30	60.20
6	Chilly	42.30	60.90	109.00	41.70	0.39	1.50	61.70	44.00
7	Cucumber	155.00	225.00	54.00	24.00	2.90	9.40	55.60	45.20
8	Lady's Finger	100.00	113.10	53.50	8.60	1.87	13.20	84.00	13.10
9	Onion	284.00	342.00	52.00	26.00	5.50	13.20	50.00	20.40
10	Potato	172.00	291.00	60.00	27.50	2.90	10.60	54.20	69.20
11	Radish	10.50	11.90	46.00	11.00	0.23	1.10	76.10	13.30
12	Sweet Potato	42.40	58.90	63.00	25.00	0.67	2.40	60.30	38.90
13	Tomato	61.80	88.70	49.80	10.70	1.24	8.28	78.50	43.50
14	Banana	575.00	875.00	176.00	97.00	3.27	9.00	45.00	52.20
15	Grapes	264.00	325.00	53.00	28.00	5.00	11.60	47.20	23.10
16	Papaya	130.00	230.00	228.00	73.00	0.60	3.20	67.90	76.90
17	Pomegranate	34.00	67.00	21.00	16.00	1.62	4.20	23.80	97.00
18	Water Melon	82.10	504.00	72.00	25.00	5.90	20.20	65.30	513.9



Keeping in view the impressive role of precision farming for improving productivity of horticulture crops through efficient use of resources, the PDCs were given the mandate of taking up applied research work on precision farming. Accordingly, during 2001-02, the PDCs were renamed as Precision Farming Development Centre (PFDC).

3. CONTRIBUTIONS BY RESEARCH SCIENTISTS AND INSTITUTIONS:

In the case of field R&D trials, studies and evaluation as well as data collection and presentation various institutions and research scientists have made significant contributions. The earliest work in this endeavor was from Dr.R.K.Sivanappan and his associates from the Tamilnadu Agricultural University who in the early 70s tried to develop the microirrigation system with perforated pipes or with micro tubes attached to the laterals. They got very encouraging results both from the point of view of water saving and increase in the productivity of crops. Almost in the same period the scientists at the Central Arid Zone Research Institute at Jodhpur also started working on the technical feasibility of the microirrigation in vegetable crops grown in the arid climate of Rajasthan. Though there was some attempts by the different SAUs and ICAR institutes on the evaluation of the techno economic feasibility of microirrigation in different crops, the technology did not take off due to the high initial system cost and lack of appropriate location specific technology for the different agro-climatic regions of the country and want of quality materials for the system. The Ministry of Petroleum, Chemicals and Fertilizers of the Government of India constituted a National Committee on the Use of Plastics in Agriculture (NCPA) under the Chairmanship of Dr. G.V.K. Rao, the former Member of The Planning Commission, GOI, with members from different Government and educational institutes and some of the drip manufacturers. The formation of this committee during 1981 may be termed as the first milestone for the development of microirrigation in India and the contribution from the different members of this committee led a long way for the development of drip technology for different crops in the different agro climatic conditions of the country. The NCPA (which was subsequently named as NCPAH due to the prominent role plasticulture plays in the productivity of horticultural crops) through the 17 different Plasticulture Development Centers, situated in the different agro climatic regions of the country, played a very important in the technological development of the microirrigation in India apart from recommending steps to be taken and support to be provided by the Government. It also played a pivotal role in the popularization of the microirrigation through arrangement of number of seminars on



microirrigation at state, national and international levels. Dr. H. P. Singh, the present Horticulture Commissioner, who is also the Member Secretary of NCPAH, with his long years of expertise in the field of water management of horticultural crops, left no leaves unturned in popularizing the microirrigation technology among the Indian farmers through using his good offices to convince the planners and policy makers for supporting this system for the overall development of the economy of the farmers. Dr. S.S. Magar, Dr. A. Narayanamoorthy Dr. S. Raman have also made notable contributions.

4. CAPACITY BUILDING:

The PFDCs have conducted 188 training programmes for the benefit of 5753 farmers and 152 programmes for training 2960 field functionaries thus covering 8713 participants. The NCPAH with a view to create awareness about the importance of microirrigation in the country has been conducting many seminars and workshops on this aspect and to cite a few

- ▶ National Seminar on Drip Irrigation 1982
- ▶ National Seminar on Use of Plastics in Agriculture in 1987
- ▶ International Congress on Use of Plastics in Agriculture 1990
- ▶ National Conference on Plastics in Agriculture 1993
- ▶ National Seminar on Microirrigation 1999
- ▶ International Conference on Microirrigation 2000
- ▶ National Seminar on Hitech Horticulture 2000

The private sector has also played significantly important role in capacity building of not only the farmers but also all other stakeholder as far as promotion of Microirrigation is concerned. Jain Irrigation Systems Ltd., Jalgaon has been playing a pioneering role since its inception in 1989 for promoting microirrigation.

5. FINANCIAL SUPPORT:

5.1 Assistance for drip irrigation

The Centrally Sponsored Scheme on Use of Plastics in Agriculture was launched during the VIII Plan with an outlay of Rs.250 crores. Water being a critical input for agriculture and keeping in view the increasing demand on the same from various sectors, an amount of Rs.200 crores was earmarked for promoting efficient method of irrigation



through drip/microirrigation in the country. Till the year 1999-2000, the Government of India provided assistance for drip installation for horticultural crops @ 90% of the cost of the system or Rs.25000 per ha, whichever is less for small & marginal, SC/ST and women farmers and 70% of the total cost or Rs.25000 per ha, whichever is less for other category of farmers. Assistance was also provided for drip demonstration @ Rs.22,500 or 75% of the system cost per hectare whichever is less.

The issue regarding assistance for microirrigation was reviewed in the year 1997 by a Cost Committee constituted by the Ministry of Agriculture under the Chairmanship of the then Commissioner Agriculture, Government of Maharashtra. The Cost Committee held extensive consultations and submitted its recommendations to the GOI. The summary details of the recommendations made by the Committee are as under:

- The unit cost of Drip Irrigation System (DIS) would need upward revision to the tune of 15% of the overall unit cost of April, 1994.
- The system cost for different plant spacing has been worked out (Table 5.3)

Table 5.3: Unit Cost of Microirrigation with Reference to 1994 Costs (For Category - A States)

Sl.No	Plant Spacing	Unit cost of Drip System		
		1994	Proposed by Cost Committee in July, 1998	Per cent increase over 1994 level
1.	12 x 12	12700	13039	2.67
2.	10 x 10	13200	14189	7.49
3.	8 x 8	14900	16013	7.47
4.	6 x 6	20400	22857	12.04
5.	5 x 5	21800	24233	11.16
6.	4 x 4	28100	29712	5.74
7.	3 x 3	24800	26818	8.14
8.	3 x 1.5	31600	32320	2.28
9.	2.5 x 2.5	26000	31270	20.27
10.	2 x 2	31300	32331	3.29
11.	1.5 x 1.5	NA	45670	
12.	1 x 1	38600	42633	10.45
	Overall average	23945	27590	15.22



- The unit cost based on less than one ha. norms will be higher as compared to the unit cost for one ha. Therefore, cost based on 0.4 ha 1 ha and 4 ha have also been worked out.
- Components such as sand filter and ventury assembly are to be included as optional items because of its restricted use by the farmers coupled with high cost.
- The price of DIS needs to be charged from the farmers based on free competition as per market forces.
- The cost of DIS will be more for the hilly areas because of higher transportation cost, use of HDPE pipes and other related cost. Therefore, the hilly States need to be categorized separately for computing the system cost. The unit cost for a plant spacing of 1x1 m for different categories of States would be as given in Table 5.4 below :-

Table 5.4: Unit Cost of Microirrigation System

Category of State	Upto 0.4 ha	0.4 to 1.0 ha	1. 0 to 4.0 ha
A. Fully Developed States	49105	45869	39939
B. Less Developed States *	56471	52749	45929
C. Hilly Region **	61381	57336	49923

* Unit cost of 15% over category A States

** Unit Cost of 25% over category A states.

- The assistance needs to be lowered from 90% to 50% for SC/ST, small & marginal and women farmers whereas it may be reduced from 70% to 35% for other category farmers subject to a maximum ceiling of Rs.25,000 per ha.
- The assistance may be restricted for a maximum of 4 ha against the existing unlimited area restriction.
- The registration of companies/manufacturers supplying imported as well as indigenous drip irrigation components needs be done centrally at NCPA.
- Only those companies which manufacture at least 2 components of DIS ie., laterals and emitting devices need be registered.

Based on the recommendations of the Committee, the pattern of assistance for microirrigation was revised during the IX Plan as per the details given in Table 5.5.



Table 5.5. Pattern of assistance for Microirrigation in IX Plan

State Category	Maximum Ceiling for Small, Marginal, SC, ST and Women Farmers (Rs./ha.) (50% of cost) for a crop spacing of 1.5x1.5 m	Maximum Ceiling for other category farmers (Rs./ha.) (35% of cost) for a crop spacing of 1.5x1.5 m.
A*	22,500	16,000
B**	26,000	18,200
C***	28,500	20,000

* Developed States, AP, Gujarat, Karnataka, Kerala, Maharashtra, TN

** Other States other than those in the Himalayan Region

*** All States in the Himalayan Region including NE States

For facilitating the State implementing agencies in adopting the microirrigation technology in a systematic manner, detailed guidelines were issued by the Department of Agriculture & Cooperation. These are placed at Annexure-IX.

The Plasticulture Scheme was amalgamated under the Centrally Sponsored Scheme on Macro Management in Agriculture – Supplementation/Complementation of State Efforts through Work Plans in October 2000. Under this Scheme the State Governments have been given the flexibility to include programmes as per their felt need and requirement. The pattern of assistance as indicated in Table IV was continued till the end of Ninth Plan (2001-02). Thereafter, with effect from 2002-03 during the Tenth Plan, the assistance has been reduced to 25% of the cost of the system to all categories of farmers.

5.2 Assistance for Sprinkler Irrigation

The GOI extended the subsidy programme to installation of sprinkler also since the VII plan. Assistance for sprinkler irrigation was provided under the following schemes: -

1. Integrated Cereals Development Programme for Coarse Cereals
2. Integrated Cereals Development Programme for Wheat
3. Integrated Cereals Development Programme for Rice
4. Oilseeds Production Programme
5. National Pulses Development Programme and
6. Intensive Cotton Development Programme



During the VII plan the pattern of subsidy was 50%, 75% and 25% for small and marginal farmers, SC&ST farmers and other farmers respectively. The assistance continued during the VIII Plan also. It underwent yearly changes and at the end of the VII plan the assistance for sprinkler irrigation was also on par with that of drip irrigation i.e. 90% of the cost to small, marginal, SC, ST and women farmers and 70% of the cost to other category farmers. During the IX Plan, the assistance for sprinkler irrigation was reduced to 50% of the cost subject to a maximum ceiling of Rs. 15,000/- per ha for small, marginal, SC, ST and women farmers and 33% of the cost subject to a maximum ceiling of Rs. 10,000/- per ha to other category farmers. During the Tenth Plan, with effect from 2002-03, the assistance has been further reduced to 25% of the total cost to all categories of farmers.

6. ROLE AND STATUS OF INDUSTRY

The role of industry is significant in promoting the microirrigation programme in the country. A survey conducted by Agricultural Finance Corporation (AFC) revealed the existence of 74 firms, either manufacturing or supplying drip systems in India, with capacity to bring 2,50,000 hectares under drip irrigation per annum. New firms are also being set up continuously. Thus, the domestic drip industry is well established to take care of the domestic demand for drip systems, which has so far been less than 55,000 hectare per year. A drip system mostly involves assembly work. Hence, firms in the drip industry can expand capacity easily. It is stipulated under the present scheme for promotion of drip irrigation that in order to qualify for supplying drip irrigation system to the farmers, the firm should manufacture at least two components, mainly laterals and emitters. This has been made mandatory in the case of GOI Scheme in order to ensure supply of good quality system supported with prompt post installation maintenance.

Presently there are about six drip firms, who have the necessary infrastructure for manufacturing the complete drip system. They are mostly located in Maharashtra, the State, which has promoted drip irrigation on a massive scale. Among these, only three firms can be considered as national operators catering to all-India demand for drip systems with adequate after-sales service. One firm, viz. Jain Irrigation Systems Ltd Jalgaon, Maharashtra have taken lead in terms of R & D work as well as organizing training programmes to the farmers on drip irrigation.



7. CREDIT SUPPORT

Financing institutions viz. Commercial Banks, Cooperative Banks and Regional Rural Banks advance loans for minor irrigation development mainly for wells and pump sets with refinance from NABARD. During the period 1997-2002, financing banks have disbursed Rs. 2656.88 crores for minor irrigation. Refinance from NABARD, which is 90% of the Banks' loan assistance ranges between Rs 550 crores and Rs 800 crores per year. NABARD has disbursed a total cumulative refinance of Rs. 10371.81 crores for minor irrigation until VIII Plan period. Some of this amount has been towards the development of microirrigation. Share of cooperative banks in total financing for minor irrigation was around 58 %, which got reduced to 20-25 % during IX Plan period due to poor loan recovery position. As per GOI /RBI guidelines Commercial Banks have to advance 18% of their total advances for agriculture as priority lending. However these banks are facing serious concern about mounting overdues, NPAs and poor loan recovery. Loan recovery varies between 50 to 80 % for commercial banks. Cooperative banks are the major players in agriculture lending and 80 % of their advances are for agriculture and minor irrigation is a major component. Recovery percentage of these loans is as low as 12 to 15 % and in only a few cases as high as 60 %. Low agriculture production has been cited as the major reason for poor loan recovery, particularly in the cooperative sector. However, with the use of microirrigation systems, the performance is better and the farmers are in a position to pay back the loans within a reasonable period. NABARD has advised banks vide circular No ICD14/97 dated 12-2-1998 and No 01/99 dated 9-4-99, to finance full cost of the system, net of margin money and adjust the subsidy as and when received. Such loans are eligible for 90% refinance by NABARD repayable in 10 years. With the increased demand for microirrigation sets, NABARD has taken initiative to motivate and scintillate the bankers and farmers to adopt microirrigation system through a series of workshops in the States.

While sanctioning loans under Rural Infrastructure Development Fund (RIDF), NABARD stipulates a condition that the State Government should form Water Users' Associations (WUAs) and transfer the distribution of water to these WUAs, which has been accepted and large number WUAs formed in various States. These WUAs could play a leading role in promoting microirrigation also, as in the case of Andhra Pradesh Microirrigation Project.



8. IMPACT OF EFFORTS :

The efforts made by the government of India by way of Institutional development, Strengthening of R&D efforts and financial assistance provided had a significant effect on the adoption of the microirrigation by the farmers and in the front of technological developments.

8.1 Increase in the area under Microirrigation:

The efforts of GOI in promotion of microirrigation have resulted in bringing about three lakh ha under microirrigation (Table 5.6). It is estimated that in all, about 4.5 lakh ha has been covered under microirrigation, which includes the 3.5 lakh ha covered under GOI schemes.

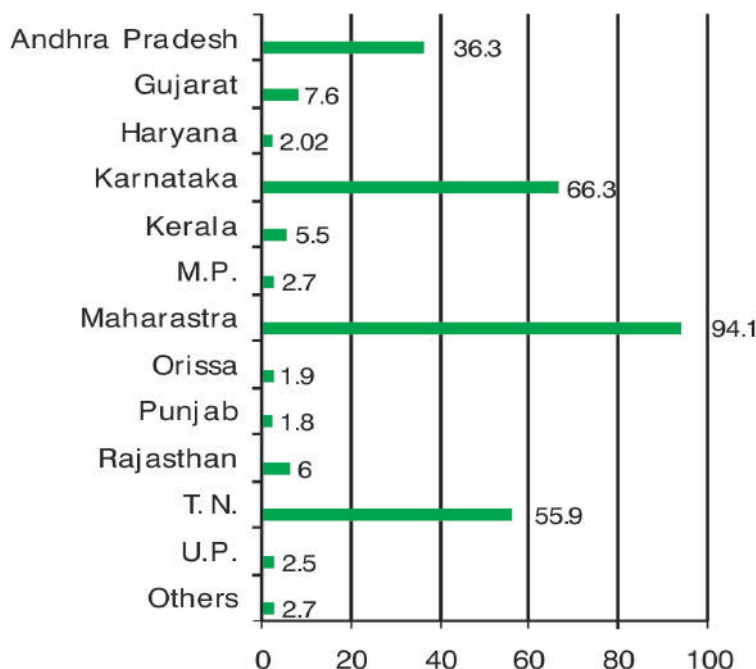
Table 5.6: Annual Coverage of Area under Micro Irrigation in India

Year	Area (000 ha.)
1992-93	13.49
1993-94	14.05
1994-95	14.59
1995-96	39.80
1996-97	46.50
1997-98	45.15
1998-99	53.08
1999-2000	53.19
2000-01	25.44
2001-02	15.20
2002-03	27.10
Total	347.59

Data on area under drip irrigation in the Country as shown in above Table-5.6 is based on the information available with the GoI departments, which have been promoting the subsidy scheme for the same. However, a large number of Institutions, Commercial organizations, Universities, Large Public/Private sector Companies, NGOs, etc have taken up drip irrigation in the country for their farms/crops which do not get reflected in the data available with GOI Departments. Approximately, another 1,00,000 hectares are covered under drip systems by these organizations, whereby



STATE WISE COVERAGE UNDER DRIP IRRIGATION TILL 2000-01



the total area under drip irrigation systems in the country would be about 5,00,000 ha as on March 2003.

Although the programme for promoting drip irrigation was taken up throughout the country, it is seen that maximum coverage has been in States of Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu, accounting for nearly 80% of the coverage of area under drip irrigation in the country. The efforts made by the Government of Maharashtra who were the pioneers in introducing the drip irrigation technology in the country are noteworthy.

8.2 Andhra Pradesh Microirrigation Project (APMIP)

The Govt. of Andhra Pradesh has also taken up steps for promoting micro-irrigation in the State by launching the AP Microirrigation Project. Under the APMIP the Govt. of Andhra Pradesh has introduced a rigorous monitoring system alongwith short-listing of microirrigation system manufactures who will not only provide post installation maintenance for 5 years but also supporting agronomic services for two years. The APMIP has also tapped Rural Infrastructure Development Fund (RIDF) of NABARD to implement the scheme covering an area of 2.5 lakh ha in two years time.



8.3 Crop Coverage

Among the horticultural crops, drip technology is adopted mostly in coconut with a percentage of 19 out of the 3 lakhs hectares (Table 12). This is followed by banana (11%), grapes (10%), mango (9.4%) citrus (7.9%) and pomegranate (6.2%). All others individually contribute to less than 5 per cent of the area under drip. The minimum hectareage was under vegetables.

Table 5.7 Crop wise area under drip in India (lakh ha)

CROP	AREA ('000HA)
Coconut	36.0
Grapes	36.0
Sugarcane	22.5
Banana	22.5
Citrus	21.0
Mango	19.5
Pomegranate	13.5
Sapota	6.0
Ber	6.0
Guava	4.5
Arecanut	4.5
Vegetables	3.0
Others	30.0
Total	225.0

8.4 Impact Assessment

On the request of the Ministry of Agriculture GOI, the Agricultural Finance Corporation, Mumbai, has made comprehensive study on the technological changes in Indian irrigated agriculture, particularly on diffusion of water economizing technologies and practices. and concluded that drip irrigation technology is not only water saving but also increases crop yields and their adoption by Indian farmers holds the promise of Second Green Revolution.. The Study covered about 3900 farmers spread over 26 districts in the States of Andhra Pradesh, Haryana, Karnataka, Maharashtra, Orissa and Tamil Nadu. The Study revealed that the area under drip irrigation went up from 1500 ha. in 1985 to 1.86 lakh ha. by April, 1998. In all, about three lakh ha have been brought under drip irrigation including the





area covered under the State Sector Scheme on Drip Irrigation in Maharashtra. The study also revealed that the beneficiary farmers invariably introduced high value horticultural crops like grapes, banana, mango, cashew nut and coconut after installing the drip system. There was yield increment for crops like banana, grapes, citrus, and pomegranate. The percentage increase in yield over the state average ranged between 41% (grapes) to 141% (Pomegranate) over the state average yield. Economic analysis of 695 beneficiary farmers and 76 non-beneficiary (who installed drip system without any Govt. subsidy) farmers



indicated that the cost (inclusive of subsidy) was recovered in a period of less than three seasons in majority of the cases. The study further indicated that in Andhra Pradesh the coverage of area under drip irrigation was concentrated in the districts of Ananthapur, Chittoor, Rangareddy, Medak, Mahboob Nagar and Nalgonda. In the case of Karnataka the coverage is largely in the districts of Shimoga, Chitradurga, Tumkur and Bijapur while in Tamil Nadu almost 65% of the coverage under drip irrigation was in the districts of Chengalpattu-MGR, Dindigul, Coimbatore and Periyar. Some of the major recommendations of the study are as follows:

- To achieve regional balance in coverage under drip irrigation, there is need to shift the focus of the scheme to States other than those presently classified as Category A (Viz. Maharashtra).
- Financial assistance to the farmer should not exceed 60% of the total cost for all the category of farmers. The cost norm should be reviewed periodically.
- The ceiling of one ha under drip demonstration need to be removed.
- Plasticulture Development Centres (PDC) need to be established to represent different agro-climatic regions.
- The interest on subsidy portion of the loan advanced by the NABARD should either be waived or borne by the Government.
- The Drip manufacturer/supplier should set up a dedicated servicing and farmer-training centre in a district where more than 300 ha have been covered under drip irrigation.
- A Five Year Plan for drip irrigation needs to be taken up to increase the coverage by one million ha.
- The financial assistance to the farmers should be channelised through NABARD instead being distributed through Government Departments.
- About 12.5% of the allocations under the scheme should be earmarked for research, extension, training, survey of installed systems, evaluation and strengthening of in-house monitoring.

The study also revealed that the majority of the farmers are able to recover their investments on drip system within a period of three seasons and the Benefit: Cost Ratio was more than 2.5:1 for most of the cases.



In another Study reported in September 2003 by the Gokhale Institute of Politics and Economics, Pune on the Economics of Drip Irrigation in Banana and Grape Cultivation in Maharashtra the analysis revealed that farmers using drip irrigation operate less number of hours of pump sets and hence consume less amount of electrical energy. The annual saving in electricity amounted to 2430 kwh/ha for banana and 1470 kwh/ha for grapes and the money saved worked out to Rs.1217 and Rs.738 per ha in the case of banana and grapes respectively. Their study confirmed that microirrigation not only contributes to water saving and additional irrigation benefits but also reduces the cost of cultivation and increases crop productivity as compared to conventional irrigation methods. Similar study conducted by the same Institute for sugarcane in Maharashtra revealed that while the yield increase through microirrigation was to the tune of 23 per cent, there was saving of water by 44 per cent due to which an additional area of 0.80 ha could be irrigated. Besides, on an average farmers could save 1059 kwh/ha of electricity per annum through microirrigation thereby reducing the electricity bill to the tune of Rs.1589/ha.

Farmers' Views : The NCPAH centers make field survey to find out the farmers' experience on the adoption of drip. One such survey conducted by the Navsari center in Gujarat has shown that drip was adopted more in horticultural crops and cotton. Though all the farmers opined that drip helped in water saving and increased the crop productivity, nearing 50 per cent of the farmers felt that the water saving was to the tune of more than 50 per cent and 60 per cent of the farmers felt that the yield level increased by 26 to 50 per cent with drip. Only one third of the farmers surveyed, adopted fertigation and most of them were of the view that 30 to 40 per cent of fertilizer could be saved due to microirrigation. About 55 per cent of the farmers felt that weed control could be effected to the tune of 50 to 75 per cent with drip. Better quality of produce, higher price for the produce and labour savings were the other advantages, the farmers experienced.

9.0 REASONS FOR SLOW EXPANSION :

The progress of microirrigation has been constrained by several factors like non-competitive unit cost in the early Nineties, particularly for supplying BIS standard system, increase in custom and excise duty besides other taxes on the raw material and the product, inadequate allocation of subsidy, enormous delay in sanction and release of subsidy, and inability of the State Governments to share the



proportionate subsidy under the Centrally Sponsored Scheme. The microirrigation system manufacturers have been playing a key role in the development and progress of microirrigation by way of extension service, education to farmers, technology upgradation through research and even sharing bridge finance. Despite these constraints, the manufacturers endeavored to supply and install the system over large areas with a hope that the financial difficulties would soon be overcome. But this did not happen. As a result of delay in sanction and actual release of subsidy, the outstanding receivable subsidy compounded to several crores. This affected the industry in several ways; the financial strength of many companies weakened due to non receipt of subsidy against the systems supplied; restrictions put by Financing institutions affected the production capacity causing under utilization of the installed plant capacity; and the reduction in the production capacity led to further financial constraints leading to an adverse impact on the programme.

The increase in the pattern of assistance to 75-90 % during 1996-97 was without increasing the total allocation for the microirrigation sector. This resulted on the one hand in reducing the role of the banks and reduced enthusiasm by the manufacturers due to existing large outstanding dues for systems installed earlier. This also resulted in the supply of system by non-organized manufacturers and in many cases supply of sub standard material. The assistance was reduced to 50% in 2000-01 it was further reduced to 25% in 2002-03 thereby creating more problems and uncertainty.

Microirrigation manufacturers' approached NABARD who agreeing to these problems advised banks to finance full cost of the system without waiting for subsidy and adjusting it as and when received. However in many cases and in most of the states banks do not sanction full cost and continue to link it to subsidy.

Even though the advantages of the drip irrigation have been scientifically proven, there remain many problems requiring further research so as to increase their applicability to horticultural crops. Realistic methods for predicting the temporal and spatial variation of soil moisture, the minimal and optimal fraction of the soil volume to be wetted, and management system in different horticultural crops under varying weather and soil conditions are not known. Application of nutrients along with water through drip irrigation (termed as Fertigation) can help in enhancing the production



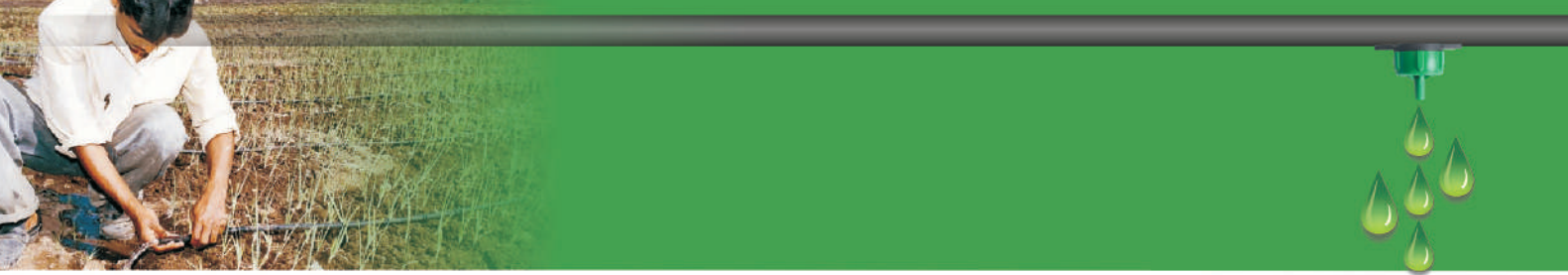
and productivity of horticultural crops. However, fertigation is yet to be adopted in large scale due to non-availability of soluble fertilizers, apart from high cost of imported fertilizers.

The unbalanced growth of drip irrigation limiting mainly to the Southern Peninsular States is yet another area of concern. Some of the reasons for the uneven and slow expansion of the drip technology are:

- Lack of awareness on the full potentiality of the microirrigation systems
- Farmers' misconception of no need of microirrigation, in areas of assured rain fall and irrigation
- Cumbersome procedure for availing the subsidy programme
- Shortage of localized experts for guiding the farmers
- Failure stories of some farmers due to faulty designing of the system coupled with poor after sales service
- Lack of appropriate system for differentiated farmers and situations
- Under exploitation of microirrigation potentiality for problem areas and use of poor quality water
- Lack of emphasis on the use of microirrigation in canal command areas
- Lack of popularization of low cost and low energy requiring systems
- Non availability of spares uniformly all over the country
- Concentration of the industry only in a few states
- Extension gap
- Non identification of hardware and software technology for inter cropping system
- Absence of appropriate cropping pattern based technology as presently the techno economic viability is made based on single crop response only and not for the optimum cropping pattern
- Inadequate credit facility







CHAPTER VI

AGRICULTURAL MARKETING AND CONTRACT FARMING

1. Reform in agricultural marketing

Agricultural Markets in most parts of the country are established and regulated under the State Agricultural Produce Marketing Committee (APMC) Acts. The whole geographical area in the State is divided and declared as a market area wherein the markets are managed by the Market Committee, constituted by the State Governments. Once a particular area is declared as a market area and falls under the jurisdiction of a Market Committee, no person or agency is allowed to freely carry on wholesale marketing activities. The monopoly of Government regulated wholesale markets has prevented development of a competitive marketing system in the country. The system has provided no help to farmers in either direct marketing, or organizing retailing, or in supplying raw material smoothly to agro-processing industries or adopting innovative marketing system and technologies.

An efficient agricultural marketing is essential for the development of the agriculture sector as it provides outlets and incentives for increased production. Such a monopoly marketing system only contributes greatly to the commercialization of subsistence farming. Governments worldwide have recognized the importance of liberalized agriculture markets. Task Force on Agricultural Marketing Reforms set up by the Ministry of Agriculture has suggested promotion of new and competitive Agricultural Market in private and cooperative sectors to encourage direct marketing and contract farming programmes, facilitate industries and large trading companies to undertake procurement of agricultural commodities directly from the farmer's fields and to establish effective linkages between the farm production and retail chains. There is a necessity to integrate farm production with national and international markets to enable farmers to undertake market driven production plan and adoption of modern marketing practices.

If agricultural markets are to be developed in private and cooperative sectors and to be provided a level competitive environment vis-à-vis regulated markets, the existing



framework of State APMC Acts will have to undergo a change. The State has to facilitate varying models of ownership of markets to accelerate investment in the area and enable private investment in owning, establishing and operating markets. Working of existing Government regulated markets also needs to be professionalized by promoting public private partnership in their management. Appropriate legal framework is also required to promote direct marketing and contract farming arrangements as alternative marketing mechanism. Therefore, there is a need to formulate a new model law for agricultural market. The Ministry of Agriculture, accordingly set up a Committee under the Chairmanship of Additional Secretary (S), and formulated a model law on Agricultural Marketing in consultation with the States.

The model legislation titled the state agricultural produce marketing (Development and Regulation) Act, 2003, provides for establishment of private markets/yards, direct purchase centres, consumers/farmers markets for direct sale and promotion of public private partnership in the management and development of agricultural markets in the country. It also provides for separate constitution for special markets for commodities like onions, fruits, vegetables, flowers etc. The Act also envisages legislation to regulate and promote contract farming arrangements in the country. It provides for prohibition of commission agency in any transaction of agricultural commodities with the producers. It redefines the role of present Agricultural Produce Market Committee to promote alternative marketing system, contract farming, direct marketing and farmers/consumers markets. It also redefines the role of State Agricultural Marketing Board to promote standardization, grading, quality certification, market-led extension and training of farmers and market functionaries in marketing related areas. Provision has also been made in the Act for constitution of State Agricultural Produce Marketing Standards Bureau for promotion of grading, standardization and quality certification of agricultural produce. This would facilitate pledge financing, e-trading, direct purchasing, export, forward/future trading and introduction of negotiable warehousing receipt system in respect of agricultural commodities. Enactment of the APM (D&R) Act 2003 would be crucial for enabling the marketing of the produce, which is expected to increase in volume with the adoption of microirrigation on a large scale.

2. Contract Farming Agreement and Model Provision

Contract Farming is an agreement between processing and/or marketing firms, market intermediaries and the farmers for the production and support of agricultural products



under forward agreement, frequently at predetermined prices. The arrangement invariably involves the purchaser in providing a degree of production support to farmers through, for example, the supply of inputs and the provision of technical advice. The basis of such arrangements is a commitment on the part of farmer, purchaser (sponsor) and the registered market intermediaries to support the farmer's production and to purchase the commodity. Contract farming is thus a means of allocating the distribution risk between processor and grower. The latter assumes the risk associated with production while the former assumes the risks of marketing the final produce. An FAO guide "*Contract farming: Partnerships of growth*" argues that well-managed contract farming has proven effective in linking small farm sector to sources of extension advice, mechanization, seeds, fertilizer and credit, and to guaranteed and profitable markets for produce. "It is an approach that can contribute to both increased income for farmers and higher profitability for sponsors". When efficiently organized and managed, contract farming reduces risk and uncertainty for both parties and provides the producer the opportunity to add value to his production.

Merits of contract farming: The prime advantage of contract farming for farmers is that the sponsor will normally undertake to purchase all produce grown, within specified quality and quantity parameters, often at pre-determined prices. Contracts can provide farmers with access to a wide range of managerial, technical and extension services that otherwise may be unobtainable. Small-scale farmers are frequently reluctant to adopt new technologies because of the possible risks and costs involved. In contract farming, private agribusiness will usually offer improved methods and technologies because it has a direct economic interest in improving farmers' production to meet its needs. In many instances, the larger companies provide their own extension support to contracting farmers to ensure that production is according to specification. Skills the farmer learns through contract farming may include record keeping, improved methods of applying chemicals and fertilizers and knowledge of the importance of quality and of the demands of export markets. The returns that farmers receive for their crops on the open market depend on prevailing prices and their ability to negotiate with buyers but contract farming can, to a certain extent, overcome this price uncertainty. Frequently, sponsors indicate in advance the prices to be paid and these are specified in the agreement.



Risk Factors in Contract Farming: For farmers, there is the uncertainty involved in growing new, unfamiliar crops and producing for markets that might not always live up to their expectations – or their sponsors' forecasts. Inefficient management can lead to overproduction, and in some cases sponsors “may be tempted to manipulate quality standards in order to reduce purchases”. One of the biggest risks for farmers is debt which can be caused by production problems, poor technical advice, significant changes in market conditions, or a company's failure to honour contracts. On the sponsor's side, in market conditions, risks can arise when dealing with farmers who, in turn, may have negotiated use of the land with traditional owners. Before entering into contracts, the sponsors need to ensure that access to land is secured, at least for the term of the agreement. But a more serious problem is when farmers break the contract and sell their produce in alternative markets, sometimes encouraged by rival sponsors or at ruling higher prices in open market.

2.1 Managing Contract Farming Relationships: The contract farming system has to be seen as a partnership between agribusiness and farmers. Good service delivery by the sponsor is a precondition for successful contract farming. Sponsors must therefore take responsibility for coordinating production and marketing activities well. Managers must ensure the transparency of all interactions with the farmers and they must ensure that farmers understand both their own obligations and those of the sponsor. Farmer's default in contract farming arrangements can be reduced by following interventions:

- Organizing Farmers' Associations: Peer pressure within the group screens out potential defaulters and can reduce the risk of default. In addition, economies of scale can be realized in the delivery of services, thereby reducing costs. Farmers will also benefit by having a stronger hand in negotiations with companies.
- Good communication and close monitoring of farmers: Good communications help to foster good company–farmer relations and a sense of trust, which has a positive effect by reducing default. Group members can monitor each other where there is a need to ensure quality and traceability of produce, and to prove due diligence throughout the chain.



- Range and quality of services offered: The better and broader the range of services offered, the closer the relationship between farmer and the business, and the more the farmer stands to lose by breaking the relationship.

2.2 Types of Contract Farming: Contract farming agreements can be classified into three, not mutually exclusive, categories: i) market – specification, ii) resource provision, and iii) production management. Market specification contracts are pre-harvest agreements that bind the firm and grower to a particular set of conditions governing the sale of the crop. These conditions often specify price, quality and timing. Resource provision contracts oblige the processor to supply crop inputs, extension, or credit, in exchange for marketing agreement. Production management contracts bind the farmer to follow a particular production method or input regime, usually in exchange for a marketing agreement or resource provision. In various combinations, these contract forms permit firms to influence the production technology and respond to missing markets without having to operate their own plantations. Eaton and Shepherd in their book titled ‘Contract Farming – Partnership for Growth’ (FAO – 2001) have presented five organizational models for contract farming.

- Centralised Model: The sponsor purchases crops from farmers for processing, and markets the product. Quotas are distributed at the beginning of each growing season and quality is tightly controlled. This model is generally associated with tobacco, cotton, sugarcane, banana, coffee, tea, cocoa and rubber crops.
- Nucleus Estate Model: The sponsor owns and manages a plantation, usually close to a processing plant, and introduces technology and management techniques to farmers (sometimes called “satellite” growers). Mainly used for tree crops, but has also been applied to dairy production.
- Multipartite Model: Usually involves statutory bodies and private companies jointly participating with farmers. Common in China, where government departments, township committees and foreign companies have entered into contracts with villages and individual farmers.
- Informal, or individual developed Model: Individual entrepreneurs or small companies make simple, informal production contracts with farmers on a seasonal basis, particularly for fresh vegetables and tropical fruits. Supermarkets frequently purchase fresh produce through individual developers.



- **Intermediary Model:** Formal subcontracting of crop production to intermediaries is common in Southeast Asia. In Thailand, large food processing companies purchase crops from individual “collectors” or farmer committees, who make their own informal arrangements with farmers.

2.3 Contract Farming Agreement: Contents of a contract farming agreement depend on a number of factors such as the nature of the product, the primary processing required, if any, and the demands of the market in terms of supply reliability. Quality incentives, repayment arrangements, the level of control the sponsor wants to have over the production process also influence the nature of the agreement, and the extent to which the parties have capital tied up in the contract. A contract covering, for example, oil palm, tea or sugar, where significant long – term investment is required from all parties, will be different from a contract covering annual crops such as fruits and vegetables for local supermarkets may not be the on pesticide use and product quality as well as higher presentation and packaging standards. Although corporate bodies, government agencies and individual developers are of necessity the catalysts of the contract, farmers and their representatives must be given the opportunity to contribute to the drafting of the agreement and assist in the wording of specification in terms farmers can understand. Management must ensure that agreements are fully understood by all farmers. The terms and conditions entered into must be written down for independent examination and copies given to the farmers’ representatives. Copies should also be available to relevant government agencies.

The legal framework of the Agreement should comply with the minimum legal requirements of the Indian Contract Act, local practice must be taken into account and arrangements for arbitration must be addressed. Arrangements, in the form of a written contract, usually cover the responsibilities and obligations of each party, the manner in which the agreement can be enforced and the remedies to be taken if the contract breaks down. In most cases, agreements are made between the sponsor and the farmer, although in the case of multipartite arrangements, the contracts can be between the sponsor and farmer associations or cooperatives.

2.4 The Provisions: Within the broad categories of market-specification, resource-providing, and produce-management contracts, firms must specify terms that include:



- a) Marketing: How much of the product will be purchased, when, and at what price for what quality? Must the grower deliver all of this product, a share, or set amount?
- b) Inputs and technical assistance: How will inputs and technical assistance be delivered, how much, and at what price and quantity?
- c) Credit: Will the grower receive credit in cash or kind? How much will he receive, at what interest rate? What will be the collateral?
- d) Production management: What technological procedures must the grower follow? How will the grower be monitored or determined?
- e) Delivery and grading: Who will transport the harvest to the processor and how will quality be graded or determined?
- f) The duration of the contract;
- g) The way in which the price is to be calculated using:
 - i. Prices fixed at the beginning of each season.
 - ii. Flexible prices based on world or local market prices.
 - iii. Spot-market prices.
 - iv. Consignment prices, when payment to the farmer is not known until the raw or processed product has been sold, or
 - v. Split pricing, when the farmer receives an agreed base price together with a final price when the sponsor has sold the product.
- h) Procedures for paying farmers and reclaiming credit advances;
- i) Arrangements, if any, covering insurance;
- j) Registration of Contract Farming Agreement with the notified Government Agency and Dispute resolution mechanism.

The emerging trend in respect of contract farming appears to be a tripartite agreement



amongst the sponsor, the farmer and the banker. Under such an agreement sponsor undertakes, in addition to his usual functions elaborated above, to deduct the due installment and interest from the total amount payable to the farmer and to deposit it directly with the banker. The farmer agrees to give an undertaking to the banker and the sponsor for such an arrangement. It may be mentioned that such a tripartite agreement is not more productive and fool-proof from the view point of all the stakeholders. The farmer gets assured, adequate and timely credit. The sponsor is able to collect his bills directly from the bankers against delivery of inputs to the farmer and the banker gets the sponsor to assist the bank in recovery of the dues without any additional cost to the bank. The banker further gets one more channel of information to him regarding the activities of the farmer in respect of the condition of his farm and the crop-health. The presence of the banker also helps in facilitating resolution of dispute, if any, between the farmer and the sponsor.

Microirrigation, which is a holistic approach for improving the production and productivity, shall be guided by the efficient marketing system which ensures remunerative price to farmers when, production and productivity is expected to increase with the adoption of microirrigation. Marketing alongwith contract farming will be a key factor. Thus, these issues are required to be addressed appropriately.





CHAPTER - VII

FINDINGS AND RECOMMENDATIONS

The Task Force recognized that agriculture and allied sectors including horticulture will continue to be prime mover for the growth and prosperity of the nation. However, there are a number of challenges, which are confronting the growth of the sector. By 2010, agricultural production, including horticulture production, will have to be doubled in the face of dwindling land and water resources. Hence, approaches have to be knowledge based, technology-driven and farmer centered to achieve sustainability. In the quest for sufficient utilization of resources for achieving vertical growth in agricultural production, water is the most critical input.

Indian Agriculture still continues to be a gamble on monsoon. Only 18% of precipitation is used while the rest is lost through surface runoff, which aggravates the problem of soil erosion. Therefore, harvesting the rainwater, checking soil erosion through various methods, and efficiently utilizing the harvested/conserved water, needs to be integrated in order to justify the huge investments on high cost irrigation projects. In the absence of large-scale adoption of efficient modern irrigation technologies such as drip and sprinkler irrigation, the present irrigation efficiency in the country is only 30-40 per cent.

Results of various studies carried out clearly demonstrate that microirrigation has a macro future in India. Microirrigation reduces cost of cultivation, weed problems, soil erosion and increases water use efficiency as well as electricity and fertilizer use efficiency, besides serving as an useful means for reducing the over-exploitation of available water resources including groundwater. Since the initial investments on microirrigation systems are generally high, these investments can be justified on these grounds besides achieving higher productivity.

Past efforts in promoting Microirrigation technologies have been rewarding and they did bring vertical growth in their adoption. However, their adoption has remained limited with slow progress, particularly due to the following reasons:



- The initial cost of establishing microirrigation system is high, hence generally out of the reach of resource-poor farmers.
- Microirrigation technology was not integrated with farm irrigation management systems, as they were generally viewed in isolation.
- Adequate credit facilities to the farmers, trained human resources, appropriate technical know-how and infrastructure for training of farmers were lacking.
- Microirrigation is generally perceived as technology intensive, hence its acceptance by farmers needed much persuasion.
- There was a lack of information on temporal and spatial variation in soil moisture, the optimal fraction of soil to be wetted, location specific and crop-specific irrigation and fertigation scheduling and lack of availability of low cost water soluble fertilizers and other agro chemicals.

These issues will have to be addressed for accelerated adoption of microirrigation technologies in the country. Viewed as an integral part of comprehensive water management strategy, focus on enhancing water use efficiency and reaching water to the un-reached areas with the objective of improving productivity of all the resources employed in agriculture, must be the guiding principles for the promotion of microirrigation. The approach must be to produce more with less water. This concept should be integrated with the national policies on irrigation infrastructure, Water management, fertilizer and electricity utilization. The investment and funding options should consider microirrigation as an important infra-structural element in the country for working towards poverty alleviation, food security and environmental sustainability.

1.1 Policy Issues:

- Large scale adoption of microirrigation technologies needs to be encouraged as a key Government Policy in order to take complete advantage of the benefits offered by these technologies.
- Microirrigation should not be viewed as an end in itself. It needs to be promoted in a holistic manner having end-to-end approach with integration of agronomic practices and linkages for marketing.



- Microirrigation technologies should be viewed as total plant support systems instead of just considering them as water conservation measures, as these technologies help in improving the individual and combined efficiency of all other agricultural inputs such as fertilizers, energy, plant protection measures, etc
- While framing policies for the promotion of microirrigation, all stakeholders, which include governments, farmers, bankers and industry, should be involved so that the policy will have support from all of them.
- Wasteland Development policies involving agro-forestry should include and rely upon microirrigation for its benefits such as better establishment of plants, cultivation of inter-crops in between the rows of trees, suitability of microirrigation for the hilly, undulated areas, sandy, salt-affected soils/terrains and carbon sequestration through increased tree cover.

1.2 Sectorial issues

Microirrigation Technologies can substantially impact the performance of several other related sectors. The immense impact of microirrigation technologies will enhance the returns on investments made by each of these sectors for their individual inputs to Indian agriculture. The state funding and/or subsidized provision of resources to the farmers under each of these sectors will have larger impact and meaning if such funding and/or assistance are integrated with microirrigation. Some of the sectors whose performance can be immensely improved by the microirrigation technologies or whose future can be impacted substantially are:

- Irrigation & Water Resource Sector
- Fertilizer Sector
- Power Sector
- Banking Sector
- Agriculture Sector
- Forest & Environment Sector
- Petroleum Sector
- Petrochemicals Sector



In order to reap the advantages of microirrigation specific to each of the above sectors, the following sector specific recommendations have been evolved:

1.2.1 Irrigation and Water Resource Sector:

- The current irrigation policy pertaining to Canal/Reservoir systems is based on availability of reservoir water and is oriented for the limited purpose of crop protection. The future irrigation policy should be based on water use efficiency comprehensively directed towards modernizing agriculture for higher value addition to GNP. This can be achieved with the help of microirrigation technologies as they conserve water with increased yields. Hence microirrigation Technologies ought to be promoted in all canal commands to the maximum extent. Thus, there is a need to integrate the planning process of construction of dams/reservoirs with the microirrigation system to increase the irrigated area and also to increase the water use efficiency.
- The future irrigation policy is required to be tailored to encourage commercial agriculture with greater social equity with the help of crop diversification in irrigated areas and with conjunctive use of canal/reservoir waters, rain water harvesting measures and groundwater management.
- It is accepted that Major & Medium irrigation projects have created islands of prosperity amidst surrounding poverty. This is because, the upstream population as well as population beyond the tail end of the canal have been deprived of the project benefits. The deprived lot has also lost even what they once received as their natural share in the water flowing through the river. Farmers on upstream and beyond tail-end have no option but to resort to cost intensive lift irrigation schemes. Even here, inefficient use of water through conventional methods results in prohibitive water and energy costs rendering the scheme uneconomical. If the government adopts the policy of making MIT mandatory for all commercial crops under both canal and lift irrigation system, it will provide/ensure larger benefits to greater number of farmers with same volume of water. This will obviously lead to greater equity.
- Appraisals of all the future proposals for irrigation dams should insist upon due inclusion of modern irrigation methods while deciding the cropping patterns, irrigable areas, techno-economic feasibility, etc.



- Interlinking of rivers for enabling increase in irrigation potential, power generation etc is on the agenda of the Government. Efficient use of such costly water through microirrigation should receive attention right from the planning stage of the river link projects.
- Ensure equitable and efficient groundwater management: For the country as a whole about 56% of the irrigation is currently provided by underground water sources (Dug, Tube and Bore wells). It is well established that grain productivity/ yield with groundwater is 1.5 to 2.0 times more than the canal irrigated water sources. In quite a number of areas, the ground water levels are fast depleting because more water is pumped out than natural recharge. Groundwater in 877 blocks (17%) in the country is overexploited or nearly overexploited and new areas are being added to the list every year. This has not only reduced the irrigation potential but has caused drinking water scarcity, problem of water quality and land degradation. Punjab, Gujarat and Tamil Nadu are explicit examples. To remedy the situation, government may have to consider the use of microirrigation as far as possible, compulsory in all such critical, semi-critical areas. Since subsidised power supply is one of the major reasons for such a situation, preferential connections be given to owner who agrees to use microirrigation and the banks should finance combined loan for pump and microirrigation. Making microirrigation compulsory in agriculture (at least for commercial crops) would release enough water for drinking and save public expenditure on distant supply of piped drinking water schemes.
- Planning Commission could motivate the States to make separate provision/ allocation for (a) Conventional Irrigation Projects (b) Adoption of microirrigation. This will encourage the States to change their irrigation strategy and legal framework, where required. Moreover, if the assistance from the Central Government is made available only for microirrigation, and not for conventional irrigation projects, the States will be induced to go for expansion of areas under microirrigation either for the existing surface water resources and/or for forward linking of their conventional irrigation projects.
- Several International funding agencies have come forward for supporting restructuring of water sector in many States like A.P., M.P., Rajasthan and Maharashtra. Their concern is also for protecting environment. Since microirrigation



system fulfills all these criteria, it should be included as an integral and obligatory component of financial assistance to irrigation projects.

- Microirrigation may or may not fit into conventional text book concept and definition of infrastructure. However, the concept of infrastructure has also become dynamic and broad based. Concepts such as BOT and BOLT were once non-existent. BOO (Build, Own & Operate) comes closer to the concept of the Government providing the start-up assistance for microirrigation to the farmers. This is like government providing land to the builders for construction of road, bridge or a check dam. In case of grants/subsidies for microirrigation, the government is only providing one-time start-up assistance. Thereafter the farmers are supposed to own and operate the MIS sets. Hence there is a ample justification for creating/ accepting microirrigation to be Infrastructure.
- Microirrigation projects, viewed in the correct perspective, are merely a forward integration of the irrigation projects. They should therefore be given same status as the irrigation projects, i.e., they should be considered as infrastructural projects, notwithstanding the fact that the assets created through microirrigation are owned by the farmers and not by the state. Planning Commission has already accepted in principle the proposition to treat microirrigation as infrastructure project.
- Groundwater is the only source of water being used for drip method of irrigation in India. Unlike other countries, in India water from surface sources (dams, reservoirs, etc) is generally not used for drip method of irrigation. Since water use efficiency under surface sources is very low owing to heavy losses through conveyance and distribution, farmers should be encouraged to use water from surface sources for drip method of irrigation. This can be done by allotting certain proportion of water from each irrigation project only for the use by microirrigation.
- Water Users Associations (WUAs) are being promoted in a big way with the support of internal and external agencies in India in recent years. Since one of the main objectives of the WUAs is to improve the water use efficiency, some arrangements need to be made to introduce the microirrigation through WUAs.



1.2.2 Fertilizer Sector:

- Availability and application of irrigation water under conventional system has prompted disproportionately high application of chemical fertilizers. This often leads to groundwater pollution and environmental hazards. The conventional irrigation system cannot control or measure fertiliser dosing. Microirrigation system promotes the application of fertilizers along with irrigation water, i.e., fertigation. Under this system, the microirrigation user can supply measured and controlled quantities, which are directly applied to the root-zone and evenly spread through the desired length of crop growth cycle. MIT, therefore, results in savings of costly chemical fertilisers. Research has confirmed that saving of over 20% of fertiliser dose is possible without impairing productivity and/or yields. This saving in fertilizer will also directly impact and reduce budget allocation for Central Subsidy for fertilizer. Besides, in view of growing emphasis on environmental protection, an attempt to minimize the damage being done by the fertilisers to our soils and groundwater, is also the need of the hour. Microirrigation can help in achieving this objective as well and save the expenditure otherwise required for reclamation/ improvement of soil and water.
- With the possibility of reduction in consumption of fertilizers in the irrigated agriculture with the help of microirrigation technology and consequent reduction in the subsidy burden on fertilizers used, the Fertilizer Sector shall take interest in promoting the use of microirrigation technology. Under these circumstances, a portion of the subsidy expenditure on fertilizers can be earmarked for promoting microirrigation.
- As liquid and water soluble fertilizers are more efficient with microirrigation, the relevant regulations and guidelines in the Acts related to their production, marketing and distribution should be liberalized and simplified to take advantage of integrated use of microirrigation with fertigation.





1.2.3 Power Sector:

It is noteworthy that adoption of microirrigation results in saving of electricity used for pumping of irrigation water. Since only about half the quantity of irrigation water is required for a given area under irrigation, theoretically the energy saving in lifting of water could be to

the tune of 50%. However, under microirrigation, particularly sprinkler irrigation, water is required to be supplied at higher pressure. The combined effect of higher pressure required for water distribution and delivery to the plants/crops and the reduction in quantity of water to be applied, results in overall saving of 25 to 30% in energy required for pumping. This has been well researched and confirmed.

- Since there is shortage of electrical energy in the country, its conservation in the agricultural sector with the help of microirrigation should receive due consideration even in framing future power policy. The power sector could be a partner in promoting microirrigation technology. An example has been already set in Gujarat.
- Since subsidised power supply to the agriculture sector is one of the major reasons for precarious financial situation of State Electricity Boards (SEB) due to mounting losses, SEBs and Power Corporations should consider promotion of microirrigation by earmarking a portion of their investments for funding these technologies and for promoting efficiency of energy use in agricultural irrigation.
- Since microirrigation results in saving of energy including diesel, the State Electricity Boards should be encouraged to provide power connection on fast track basis to those farmers who agree to install microirrigation sets.

1.2.4 Financial and Banking Sector:

- The bankers will have to be given a clear message that, as a national task and to avert the looming water crisis, they should come forward and make the credit delivery for microirrigation system more affordable, tidy and smooth.



- The recovery of loans extended to agriculture sector can be faster when linked with adoption of microirrigation Systems, because microirrigation enhances the productivity of all other inputs employed in agriculture. For example, the loan extended for purchase of pump can be recovered faster when linked with microirrigation and hence Banks should finance combined loan for pump and MIT. Hence Banks should consider relaxing their guidelines while extending loans to these promising technologies.
- Bankers and Financial Institutes will have to play a proactive role in promoting microirrigation technology. They will have to modernize their ways and means for quicker, easier and cheaper deliveries of credit for microirrigation. The concerned staff needs to be reoriented for capacity building of the farmers and appreciating role of microirrigation for higher loan recovery and alleviation of poverty.

1.2.5 Agriculture Sector

- Microirrigation encourages commercial agriculture through crop diversification and motivates the farmers to switch over from conventional cropping pattern to high value commercial crops. It also improves quality of the produce because of timely and uniform nutrient application. It also enables the farmers to cultivate inter-crops in the initial period of their growth, i.e., till such time the trees become shady. Because of better and higher utilization of per unit of land and water, the crop economics improve. The farmers are automatically enthused to adopt such crop diversification measures. In some states, the crop diversification schemes are being independently promoted and incentivised. Introduction of microirrigation technology needs to form an integral part of such crop diversification schemes.
- Efforts are on for launching National Mission on Bamboo with the objectives of covering about two million ha under bamboo during the X Plan. New bamboo plantations need to be promoted with the help of microirrigation systems.



1.2.6 Environment & Forest Sector



- The afforestation measures being undertaken by the Forest Departments can be more productive with adoption of microirrigation in all the newly planted areas. They can combine water harvesting measures and effective utilization of such harvested water resources through microirrigation for protective irrigation. This will improve the success of such afforestation efforts. Higher

green cover will lead to improved environment.

- Microirrigation can be adopted in all the forest nurseries in order to improve the output from these nurseries as well as for reducing costs of producing quality planting materials.

1.2.7 Petroleum Sector

- A large amount of petroleum based fuels such as diesel, petrol and Kerosene are used in pumping water from various types of water sources in the country. The amount of these fuels used for agricultural pumping can be substantially reduced owing to the potential reduction in power consumption in irrigation with the help of microirrigation.
- Petroleum conservation efforts by the petroleum sector can include promotion of MITs in order to bring savings in consumption of these fuels in agriculture and thus reduce the burden of subsidizing the cost of these fuels as well as save foreign exchange required for importing these fuels.
- Petroleum Conservation and Research Association (PCRA) could also play a role in promoting microirrigation.

1.2.8 Petrochemical Sector:

With the Accelerated Promotion of microirrigation, there is going to be an immense demand for the Plastic raw materials, especially PVC, HDPE, LLDPE, LDPE, PP, etc. Thus the Petrochemical industry is going to benefit from the enormous potential



for their raw materials. In the light of boost in demand from MI Industry it is recommended that:

- The petrochemical industry may earmark funds for promoting microirrigation industry.
- The Petrochemical industry can also help in undertaking research on the raw materials required for the microirrigation industry. The research can address the requirements such as good, affordable additives and raw materials for better environmental stress-crack resistance, long term stability and strength of plastics. Such improvements will enhance the useful life of microirrigation systems in the aggressive open field conditions and the corrosive action of fertilizer and chemical solutions.

1.3 Area Specific issues:

Adoption of microirrigation technologies has special relevance in certain areas and topographies and hence focused attempts are necessary in attempting to solve problems associated in these areas by adopting microirrigation. Some of the recommendations pertaining to these special areas of concern are listed below:

- Several programs (such as Watershed Development programmes being implemented by Department of Agriculture and Cooperation, Ministry of Agriculture; the Desert Development Programme, the Integrated Wasteland Programme and Drought Prone Area Programme by the Department of Land Resources in the Ministry of Rural Development, etc.) catering to the irrigation water requirements in rainfed areas need to be integrated with microirrigation. The aspect of efficient utilization of water harvested from the watershed programs is not adequately emphasized. There is need for appropriate policy modulation to enable the inclusion of water saving technologies such as



microirrigation as an integral component of the watershed programmes in order to improve water use efficiency. In fact, installation of microirrigation systems on watershed basis will lead to economies of scale and lower the investment costs for the farmers for switching over to microirrigation.

- Microirrigation must be made an integral component in all the plans, which aim at expansion of horticultural crops in the coastal areas, wastelands, salt affected soils, poor ground water quality areas, hilly and undulating areas, etc.
- Microirrigation should be mandatory in all the lift irrigation schemes, as far as possible. There is need to introduce a national policy of “no lift without drip” as far as possible, which involves the combination of lift irrigation with microirrigation. This will ensure benefits to large number of farmers and improve the commercial viability of these lift irrigation schemes. Due to its energy saving potential, microirrigation can help improve the commercial/economic viability of these lift irrigation schemes. Thus adoption of microirrigation in lift irrigated areas assumes greater importance due to the fact that the cost of pumping in any lift irrigation scheme holds the key for its successful and viable operation over a period of time.

1.4 Crop Specific Issues

Some of the crops are water intensive and are irrigated very extensively creating enormous pressure on the available water resources in a given region/state. All these water intensive crops like sugarcane, banana, etc need to be immediately brought under microirrigation systems.

- Sugar industries always try to increase the area under sugarcane to increase their capacity utilisation in almost all the States including Maharashtra. Since they have close contact with sugarcane cultivators, some kind of target may be fixed for each sugar industry to bring cultivation of sugarcane under drip method of irrigation. Apart from saving of water, this will also help to achieve cultivation of sugarcane in sustainable manner. Despite shortage of water in many States, sugarcane continues to be grown in large areas predominantly under flood method of irrigation. This puts additional pressure on water resources.
- Further, while providing license for new sugar factories in any state, concerned state government may consider that at least one-third of its sugarcane area is irrigated by microirrigation methods.



- Similarly, the Government of India has announced financial assistance for reviving some of the ailing sugar industry. Part of this assistance needs to be earmarked for promoting microirrigation for sugarcane crop. The industry availing the revival package may be directed to invest on microirrigation in at least 50% of the sugarcane area under its command.

1.5 Technological Issues

While adopting microirrigation on a large scale across the country, it is necessary to evaluate the available technological options for their relevance to the small farmer. The choice of technologies shall depend upon, cost effectiveness, ease of operation and maintenance, long useful life, suitability to a wide variety of crops, soils and water qualities, easy availability of spares and replacements.

The following need consideration:

- It needs to be ensured that only good quality microirrigation systems having certification of Bureau of Indian Standards (BIS) are supplied to the farmers.
- There are no BIS Standards for some of the important products such as Fertigation Tanks, Thin-wall tapes, Micro/Mini Sprinklers, Foggers, Misters, Bubblers, Rain Guns, Floppy Sprinklers, Irrigation Pressure Regulators, Plastic Solenoid Valves, Irrigation Controllers, Disc Filters, Quick Coupling Valves, etc. There is an urgent need for developing indigenous BIS Standards for these products.
- BIS specifications were laid down several years back. In recent years there have been rapid advancements and the systems have become more sophisticated. As such, all components of the system have to be precision tailored. There is therefore need for updating the specifications in the standards of various components and to ensure that these are inline and properly integrated/aligned for being assembled as systems.
- There are several anomalies in the existing BIS Standards. There is an urgent need for removing these anomalies so as to bring clarity as well as strict compliance. Details of revisions required under various BIS Standards are enclosed under Annexure –X.
- The Central Institute of Plastics Engineering & Technology (CIPET), Chennai, should be brought under the control of Ministry of Agriculture for ensuring supply of good



quality material to the farmers, who constitute a large proportion of consumer of plastics.

- In order to have proper flow of information it would be necessary to develop a portal on microirrigation containing all the relevant information.
- Facilities for Internet counseling and use of satellite facility for two-way communication between farmers and experts should be created.
- A national TV channel exclusively for agriculture needs to be started for disseminating knowledge of improved agricultural practices including water management. This should be followed by regional channels for agriculture.
- Effective use of microirrigation needs knowledge and calculation of water requirements of different crops in different agro climatic zones of the country. For such calculations, there is a need for location specific evapotranspiration data, for which a wide network of automated weather stations needs to be created across the country. Dissemination of weather data through Internet and other means is very much essential so that the irrigation scheduling can be more meaningful, logical and effective. Such practices are already very common in advanced countries.
- The network of 17 Precision Farming Development Centres (PFDC) has enabled to develop regionally differentiated technologies on microirrigation besides imparting training to a large number of farmers and departmental staff. These Centres need to be strengthened and selected Centres should be converted into Centres of Excellence. Some of the PFDCs should be equipped to function as quality testing centres.
- Funding of R&D and extension activities of the network of PFDCs needs to be enhanced so that they do not suffer from financial constraints in carrying out their research mandates.
- Besides, R&D farms in the private sector with a good record of consistent research effort on hardware and software aspects of microirrigation and also on its economic

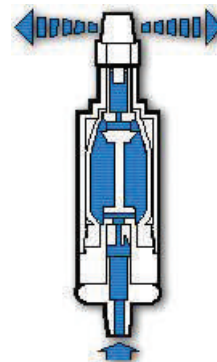


viability across regions and crops should also be recognized as PFDCs and supported suitably.

- New investments for technological advancement and participatory approaches in the context of optimizing water use by adoption of microirrigation technology should be given high priority.
- The major concern or obstacle in the expansion of the microirrigation among the farmers is the high initial investment needed. In spite of governmental support, many farmers are finding it difficult to invest in the microirrigation systems. To reduce the cost, there is need to look into the technological options of which the crop geometry modification is most important one. Instead of adopting traditional spacing, adoption of paired row planting has been found to reduce the cost of the system by 40 per cent in many crops including tomato, brinjal, okra, sugarcane, etc.
- Out of the two microirrigation technologies, i.e., drip and sprinkler irrigation, drip technology needs to be promoted on a larger scale as it irrigates the crop root zone directly as against the complete wetting of land by sprinkler irrigation. Sprinkler irrigation can be promoted only when the drip irrigation systems are not cost effective in closely spaced crops such as wheat, minor millets, and other low value field crops whose returns are not commensurate with the cost of drip irrigation systems.
- Online type of drip irrigation could be adapted in general to the extent possible in comparison with the inline type drip systems. This is because, in the event of clogging due to precipitation of salts, etc the online drip systems can be de-clogged easily whereas the inline drip systems cannot be de-clogged with ease.
- Clogging of drippers due to poor water quality is an inherent problem which is acute in some parts of the country where normal acid treatment does not help to mitigate the problem. Studies are needed to devise de-clogging measures in such areas.
- Inline dripper system can be promoted in areas with better water quality and among farmers, who have gained experience in operating and maintaining online drip irrigation systems.



- Precision irrigation involves frequent application of water and has been found to give better productivity and save water. Therefore, even pulse irrigation can also be promoted in water scarce areas after a thorough study of its suitability and cost effectiveness. This will also help in reducing the temperature related stress to crops.
- Technology development has to be in an integrated manner with the involvement of farmers, scientists and system manufacturers.
- Service providers should be created in every block and suitable mechanism should be devised for inflow & outflow of information, which can be state-supported initially and later on it would sustain on its own.
- There is need to develop human resources and entrepreneurship at the village level for regular monitoring of the systems and offering technical know-how of the technology to the farmers as and when needed. The village youths/ agricultural graduates may be given short-term crash courses on the technical and operation and maintenance aspects. They could act as local consultants. They can be provided with Internet facility to enable them provide advice to the farmers in consultation with select panel of experts via the Internet.
- At the grass root level there should be service providers to address the local problems relating to microirrigation. These service providers could be young graduates or well-trained farmers.
- Since “Seeing is Believing”, large-scale demonstration farms show casing utility of different types of microirrigation technologies have to be taken up at strategic locations with the involvement of the local farmers.
- Operational Research Projects may be taken up in each State.
- The microirrigation system manufacturers should be involved in providing advice on agronomic packages to the farmers as integral part of the system.



- Inter-state visits should be arranged for a group of farmers to visit some of the progressive farmers.
- As is seen, the drip technology has gone into comparatively more developed states for cash crops. There is a need for popularizing this technology in the tribal areas, undulating lands, etc.



- In areas where electricity has not reached, cost effective, gravity based microirrigation Systems can be developed wherever the water sources are available at higher elevations than the fields to be irrigated.
- Solar Pumping based microirrigation Systems need to be developed and promoted across the country, most importantly in areas where the electricity is not available.
- Sub-Surface drip irrigation systems, which conserve more water than the surface drip irrigation systems need to be evaluated for their efficacy and suitability to the peculiarities of Indian Agriculture. The sub-surface drip irrigation systems can play a vital role in crops where ratooning is feasible and practiced. Such systems can reduce the water requirement over surface drip irrigation systems by another 10 to 15 per cent by reducing the evaporative losses.
- In India, in about 15 lakhs hectares, farmers are forced to irrigate with saline water, which in long run deteriorates the soil health and ultimately its productivity. Further, in different states 30 to 80 per cent of underground water is saline. Drip coupled with other agro techniques is the best option for sustaining agriculture under these conditions. Extensive research and promotion of microirrigation in saline soils and/or using saline waters is recommended.
- It is estimated that in India about 64 million hectares are categorized as wastelands. It will be possible to sequester millions of tonnes of carbon for the World, if all the wastelands are converted with tree cover using micro-irrigation. These lands can be leased to local entrepreneurs / microirrigation cooperatives. To start with, efforts should be made to use profitably these lands with appropriate horticulture / multipurpose trees through the use of micro-irrigation along with other appropriate agro-techniques like mulching, etc.
- The industry should be encouraged to develop latest technologies and for manufacturing efficient system components through in house R&D and/or joint ventures. Import of technology and components should be subject to the condition that all the latest and proven technologies would be transferred for indigenous manufacture within a period of two years.



- There is need to propagate differentiated systems for socio-economically and geographically differentiated farmers. For example, the feasibility of low cost drip needs to be explored along with the low energy requiring systems in areas, such as the tribal and hilly areas, where electricity has not reached. Differential system of assistance could be administered by categorizing the states as being followed presently.
- It should be made obligatory on all Registered Suppliers under Government schemes to have facilities for training farmers in Operation and Maintenance of the systems and also rendering extension advice. This will include aspects such as crop water requirements, fertigation schedules and periodicity & intensity of application.
- Farmers have inadequate knowledge regarding the usefulness of liquid fertilizers or water-soluble fertilizers. Though a few farmers have used these fertilisers along with water, most of the farmers fear that using liquid fertilisers through water may lead to system clogging. This fear of the farmers should be addressed by organizing demonstrations and regular visits to successful farms.
- Importance of liquid fertilisers in increasing input efficiency and reducing the cost of cultivation should be clearly demonstrated to the farmers by the extension officials.
- Inadequate information about the operation, maintenance and usefulness of drip irrigation is one of the main reasons for its uneven spread across regions. Farmers do not have full knowledge regarding the usefulness of drip irrigation. Even the adopters do not know how much of assistance is available per hectare for different crops. Owing to poor exposure, farmers are reluctant to invest such huge money on drip irrigation. In fact, many farmers do not know the fact that drip irrigation can also be used efficiently and economically for crops like sugarcane, cotton, vegetables etc. These problems can be addressed through ensuring wide publicity and strengthening the existing extension services.
- The state government extension staff will have to undergo 'Refresher Courses' to understand and appreciate the intricacies of microirrigation and enabling role it can play in modernising agriculture by optimising land and water resources. They



will have to recast their roles as combined facilitators for microirrigation manufactures, bankers and farmers.

- Sound infrastructure needs to be created for training of farmers as well as field functionaries. Selected institutes need to be identified and strengthened to offer tailor made training courses on microirrigation. It should be made mandatory on the microirrigation industry to open service centers for every 500 hectares of coverage. Selected insituted need to be idenfitied and strenged to offer training of microirrigation.
- The sprinkler irrigation systems are presently offered as standardized sets consisting of set quantities of individual components without any consideration to their suitability to the varied conditions of farms, soils, crops, water, etc in different areas. Design aspects need to be brought in to enhance adaptability of these systems to varied situations so that they are more suited to the farmers.

1.6 Strategy & Structure:

The enormity and size of potential for adoption of microirrigation Technologies, necessitates strategic measures for coordinated and integrated action. Some of the Strategy oriented recommendations are described hereunder:

- Institutional Mechanism
- Project Approach
- Miscellaneous

1.6.1 Institutional Mechanism:

The Planning Commission while assigning the terms of reference to the Working Group on Horticulture for X Plan had specifically identified hi-tech horticulture as one of the areas, which called for special attention. The Working Group has observed that hi-tech horticulture covering microirrigation, fertigation, green house cultivation, micro propagation, etc. would be necessary to promote precision farming to increase the productivity of horticultural crops. Hi-tech horticulture has been defined as the deployment of modern technology, which is capital intensive, less environment dependent, and has capacity to improve the productivity and quality of produce. Similarly, Precision Farming has been defined as the application of technologies and



principles to manage spatial and temporal variability associated with all aspects of horticulture production for improving crop performance and environment quality. The institutional mechanism in the form of National Committee on Plasticulture Applications in Horticulture (NCPAH) has been instrumental in operationalising the Scheme on Plasticulture in general and in popularizing the microirrigation technology in particular.

A Committee under the Chairmanship of the then Special Secretary went into the aspect of creating an apex body for overseeing the developmental work on plasticulture in the country of which microirrigation is a major component. The Committee was of the view that without the existence of NCPAH, it would not have been possible to achieve the goals of promoting plasticulture technology in the country, which was then something new to the country. However, since NCPAH did not have any well-defined legal status and played only an advisory role, it encountered several difficulties in pursuing the programmes vigorously. It had to depend entirely on the state agencies for implementation of the programmes. Decision making process was diffused and proper delegation of powers was virtually impossible. These factors have been deterrents in delivering the improved technology to the farmers at affordable price. Considering the importance of the plasticulture in promotion of horticulture and need to have a National/Apex body to supervise the development activities, a properly constituted body with a defined legal status appears to be a must.

The Committee considered various options for providing such legal status and concluded that the Apex Body should be registered under the Societies Registration Act 1860. Keeping in view the larger perspective of introducing the hi-tech interventions and precision farming for the development of horticulture, and keeping in view the fact that 17 Precision Farming Development Centres in the country will have to be provided with directions, the Committee recommended that the Body may be named as National Council for Precision Farming (NCPF).

In the light of the call given to the nation by the Honourable Prime Minister on the Independence day (15th August 2003) to double the horticultural production in next five years, the need for the formation of the above mentioned organisational set up becomes all the more important as precision farming through microirrigation will have to play a pivotal role in achieving the above target and put the nation on sound footing in the agriculture and horticulture fronts.



Among various other activities, the NCPF can carry out and update field research and development, evaluate on an ongoing basis the capabilities of MI manufacturers as well as coordinate with the Central & State Governments both for streamlining policy and fund provisioning issues. NCPF may be created with an initial minimum corpus of Rs.100 crores from Gol and with participation and matching contributions from polymer and processing industries as well as State Governments and other National and International Funding Agencies, National and International Financial Institutions, NGOs and Inter Ministerial budgetary allocations. More specifically, contribution for the initial corpus can also be raised from Petroleum Ministry, Petro-Chemical Ministry & Industry, Petroleum Conservation Research Agency (PCRA), Power Ministry, etc.

The main objective of the NCPF will be to promote hi-tech intervention involving plasticulture applications including micro-irrigation and precision farming methods for the development of horticulture as well as other suitable field crops and agro-forestry. The NCPF may have the following objectives:

Objectives of NCPF

1. To facilitate the development of horticulture as well as other suitable crops and agro-forestry in the country through hi-tech interventions and applications covering plasticulture, precision farming and other emerging technologies.
2. To facilitate interfacing amongst industry, end users (farmers) and the Government as promoters of various relevant technologies, more importantly micro-irrigation.
3. To assist the Governments in planning, propagation, implementation and smooth delivery of various programmes, projects and schemes concerning efficient utilization of land and water resources with reference to inclusion of different hi-tech agricultural and horticultural technologies for higher productivity and use efficiency.
4. To channelise the resources and overseeing the overall development of microirrigation in the country.



Structure of NCPF

The NCPF may comprise of members representing the concerned Central Government Ministries, Departments, State Governments, representatives of the industry, Research Organisations and progressive farmers. It is recommended that the Union Agriculture Minister should be the Chairman of the Council.

17 PFDCs together with NCPAH and their assets will merge into proposed NCPF. It is recommended that NCPF be legally autonomous constituted body to be registered under Societies Registration Act, 1860, and also that it should have representatives of Central and State Governments, Scientist, representative of industrialists, farmers and financial institute ie. NABARD.

The Council should be supported by an Executive Committee under the Chairmanship of Secretary (A&C) for carrying out day-to-day work. The NCPF should be a professional body with Government playing the role of facilitator for implementing the promotional schemes.

Areas of Activities of NCPF

The Council could take up the following activities in furtherance of proposed objectives:

- i) To prepare plans for promoting horticulture and other appropriate field crop development through hi-tech applications and precision farming with special emphasis on optimizing the use of water resources and improving production, productivity and quality of the product through adoption of relevant technologies including MITs.
- ii) To recommend suitable policy measures such as fiscal policy, subsidy assistance to farmers, etc. for promotion of hi-tech horticulture applications and precision farming with MITs.
- iii) To promote strategies for propagation and increased adoption of various hi-tech applications like drip irrigation systems, sprinkler irrigation systems, green houses, mulching, packaging, etc.
- iv) To promote Research and Development to build database, to assist in prescribing and updating quality standards for precision farming.



- v) To supervise and monitor effectively the performance of Precision Farming Development Centers (PFDCs) in particular and overall development of precision farming in general in the country.
- vi) To prepare state-wise and crop-wise potential areas for various Plasticulture interventions especially for microirrigation systems, which would be useful to fix the targets to be achieved and also for formulating schemes for promoting these technologies.
- vii) To promote awareness, training, extension, and capacity building of farmers, experts.
- viii) To undertake testing, accreditation, quality certification and standardization of required hardware.
- ix) To evaluate and monitor required basic and support services and assess capacity of individual processors on ongoing basis.
- x) To build National Data Base for capacities, services, crop coverage, crop insurance, etc.
- xi) To promote indigenization and adoption of regionally differentiated technologies at national level.
- xii) To promote and support adoption of project approach for development of MI throughout the country.
- xiii) Any other matter related to promotion of hi-tech modern agriculture in the country.

1.6.2 Project Approach for Development of Microirrigation:

An approach, which takes a global and holistic view for conservation of natural resources and aims at higher per unit productivity of such resources with the help of technological intervention of microirrigation, may be described as a “Project Approach”.

The underlying objective of promotion and development of microirrigation will be to seek socioeconomic development on far more equitable basis in comparatively short span of time and also promote and protect environment. Such an approach will be reduced to writing in the form of a time bound agreement to be signed and executed between the State and the MI manufacturer. Such an agreement will *inter alia*, detail



the roles, responsibilities and functions of each of the stakeholders namely State Government, MI System Manufacturers, the Banker and the Beneficiary Farmers. Microirrigation Project Approach also seeks to address problems, which have plagued the earlier conventional assistance disbursement procedure.

The central and state subsidies for microirrigation were floated as early as 1988-1991. The percentage, the quantum, the eligibility criterion varied with passage of time. So also was the case with the delivery/disbursement procedures and mechanism. These variations gave rise to multiple difficulties and created many distortions. However, the financial assistance/subsidy provided by the government did succeed in enlarging the area under horticultural and plantation crops to some extent. Some of the regionally important cash crops also benefited from the subsidies. One of the outstanding features of area coverage under microirrigation is that states like Maharashtra, Tamil Nadu, Andhra Pradesh and Karnataka together covered about 70% of the total area under microirrigation. In other States Rajasthan, Gujarat although the need was equal but expansion of area under microirrigation remained limited. Progress for adoption of microirrigation in states like Punjab, Haryana, UP is not significant. TFM observed that good scope does exist in all of these States for promotion and adoption of microirrigation. In case of North-Eastern States with hilly and undulated terrain, microirrigation can play a pivotal role in boosting productivity as well as production.

It is possible to do so only if the state governments adopt “Project Approach” for development of agricultural as well as other culturable wasteland. It is therefore imperative that the Central assistance, whether through RIDF or any other Centrally Sponsored Scheme/Plan, is made available to the state preferably for schemes with the “Project Approach”. The State Government may consider introducing microirrigation on priority in drought affected areas and/or gray or dark zones. As far as possible, a district plan for coverage of microirrigation should be prepared and funded out of the central assistance. Such an approach will automatically disburse the benefits of the microirrigation evenly through all the districts of the State and the regional imbalances and/or backlogs will not be allowed to be created and/or continued. The “Project Approach” will thus ensure largest good for the largest number and will be available to the areas, which need them the most. The States may also select crops within the district, which may or may not be included as “Eligible” for assistance. They may also target certain disadvantaged sections of the society as compared to those who are better placed in terms of their economic status. The Project Approach has



many other benefits/advantages. Some of them are elaborated as under:

- It encourages a cluster approach, which finds favour with the bankers. It is so because the credit delivery and the recovery possibility become much easier and far more certain. It also reduces their operating overheads and risk perception. In turn, it would eventually help them increase their reach and meet minimum Priority Sector Lending Norms.
- As for the farmers, this approach offers them lot better services, entitles them to lower system costs, better agronomic, engineering and training support as well as maintenance and other essential services. It is also possible for them to compare the different systems as well as crop performance in each other's fields.
- The "Project Approach" also allows a local dealer network to be developed and trained. They get assured of minimum volume of business and can, therefore, afford to provide required support services and resources for successful implementation of the project. A well-developed, trained dealer distribution network, in the ultimate analysis, is the real guarantee of the performance and the maintenance of the microirrigation system. The dealer is locally available and can act in real time for attending to the problems of the farmers.
- As far as the state is concerned, the "Project Approach" lends itself to smoother implementation, higher concentrated monitoring and administrative ease. The "Project Approach" enables the state to bargain for lower prices against higher volume of business being offered to the MI manufacturers. The state can also choose and focus on development of certain weaker sections and/or chosen crops, which may be more advantageous to the State as a whole, and they can thus use MI as a tool for promoting crop diversification schemes for enhanced soil fertility, higher and better productivity eventually reducing the need and quantum of financial support in the form of compulsory procurement. The water, power and fertilizer savings can be used for bringing additional areas under irrigation and thereby increase production and productivity of both land and water. The water and land use efficiency leads to higher value addition to GDP of the state and enables the state to reduce percentage of population below poverty line.
- Microirrigation manufacturers also stand to benefit from the "Project Approach"



because they can avail of economies of large-scale procurement, production as well as lower overheads resulting from higher turnover. The large area coverage may also lead to lower operating cost in the long run. This helps the MI manufacturers to upgrade and/or expand as well as update their plants, people, and product and improve profits. It also helps them to broaden their knowledge base in terms of concentration of large area of the same crop/s within the limited geographical spread.

- The cluster or the “Project Approach” ultimately results in increased green cover, reduced green house effect and global warming and help conservation of soil and land as well as water. It also reduces pollution. If combined with organic farming, it can indeed help create microclimate and microorganisms, which can lead to sustainable agriculture, which is the need of the hour.

The state government may, however, devise and implement separate state subsidy schemes. These schemes may be region, crop or class specific.

1.7 Microirrigation Industry:

The manufacturing capacity of all the MI manufacturers is presently under-utilized due to lack of interest from farmers on account of low assistance not encouraging resource-poor farmers to invest. However, their present manufacturing capacity may fall short for taking up the targets being envisaged by the Task Force. It has also been assessed that Indian MI Industry, though technically qualified for production of complete range of hardware, may lag in production capacities to meet the emerging demand unless immediate capacity expansion measures are taken up.

Most manufacturers are not geared up for provision of services, which are critical for ultimate success of microirrigation particularly in the Indian context. The industry, in general, would be required to focus on updating and adapting the hardware and concentrate on R&D, training as well as extension activities, i.e., adopt an integrated approach for smooth delivery of the hardware and software package. In view of the present unutilized capacity of the indigenous drip industry and as the quality of indigenous production competes successfully both on quality and cost accounts with that in Developed countries, there is need to phase-out import of complete systems and finished components.



Imports of raw materials should continue to be allowed and made available to the Industry at reasonable and cost effective pricing. The raw materials used in the industry are also used for purposes other than manufacture of microirrigation hardware. A framework therefore needs to be developed by which material is imported at concessional duty rates against advance licenses for specific use in manufacture of Microirrigation Systems, against end use certification by a local authority nominated for the purpose.

The TFM observed that microirrigation set normally consists of about 100 items/components in the Bill of Quantities, which varies from farm to farm. An Integrated MI Manufacturer (IMIM) may be in a position to manufacture all or majority of these items or outsource a few of them. This may happen in the cases where his requirement of a given component /item may be small and may not justify in-house production. Under these conditions, he may benefit if he purchases the same from outside sources who possess the benefit of large-scale production and have developed required skills for manufacture of such items. In such cases, therefore, he may have to give to the outside manufacturer his own design parameters and build in-house arrangements for proper testing and inward quality inspection. However, all the components have to work in tandem and dimension variations or tolerances or allowances in the given components may lead to malfunctioning of the entire system.

It is, therefore, important that a MI manufacturer builds reliable quality assurance procedures and has proper expertise and skilled personnel to oversee such outsourcing function. In addition to having experienced and skilled personnel, it is also critical to have proper and standard testing equipments. Such testing equipments themselves need to be periodically calibrated and maintained in top condition. Any compromise on quality of testing equipments, maintenance of standards and specifications will lead to gross errors in production. Thus, building of quality must begin from testing and inspection of raw materials and/or bought-outs and subsequently pursued at every stage of the production process. The end product must also be subjected to and conform to the sampling and testing plan. Unless and until all these procedures, documentation and controls are in place under the supervision of are competent personnel, quality cannot be built into the product.



An emitter or a dripper i.e. the emission device through which water flows to the plant, acts like a mechanical meter, which applies controlled/measured quantity of water for required time at specified rate of discharge so as to maintain field capacity. If the discharge, say per hour, is lower than specified, then the plant will get less water and suffer from a shock. On the other hand, if the emitting device is faulty and delivers more than specified quantity, it might lead to excessive irrigation, which is equally harmful for growth of the plant. The same proposition applies to the fertilizer applicator. Likewise, if the components/fittings/accessories are loosely fitted, they will involve leakage of water, drop in pressure and lead to lesser quantity of water being applied at the root zone of plants. Such leakages will also give rise to weeds and other diseases arising out of ponding of the area and the crop. In the same manner, if the quality of main-line pipes and/or sub-main line pipes is defective, the fitment of takeoff and other accessories may give rise to frequent problems. The defective main and sub-main pipelines may also not last long and in the ultimate analysis work out to be far more costly. The lateral lines, if not made from virgin, top quality, tested and certified polymers, may lead to field failures on account of environmental stress cracking, weathering and frequent handling and/or slight mechanical damage which may occur during the course of routine farm operations. Hence, there is need to ensure supply of only good quality pipes and microirrigation sets.

The filtration station or head control unit indeed acts as the soul of the MIS. Even for good quality water, filtration is prescribed. Water can get contaminated at any stage prior to delivery. The intensity/capacity of filtration required is directly proportional to the quality and type of the water. The type and quantity of contaminants will determine type of filter to be used. The fertilizers and chemicals used for de-clogging treatments are corrosive in nature. In such cases, filtering equipment have to be resistant to corrosion. Different types of filters such as Hydro-cyclone, Media, Screen and Disc are used separately and/or in combination for removal of physical impurities. Sometimes hydro-cyclone sand separators are also to be used for removal of particles, which are heavier than water. At times, the farmers may need primary as well as secondary filtration. In any case, the material of construction, design of filter and the ease with which it can be flushed or cleaned are some of the most important criteria for evaluation of filtration systems. Selection of proper size, quality and concentration of filter media, where necessary, also play an important role.



1.7.1 Classification of MI Manufacturers:

With soil and climate diversity and lop-sided distribution of rainfall through the length and breadth of the nation, we more often than not, witness 'flood or famine', 'water logging or drought' situations in our country. The competing demand from different sectors is continually reducing the availability of water for agriculture. As such, the need for efficient methods for irrigation, which result in higher water-use-efficiency, can hardly be overemphasized. It is, therefore, natural and desirable that more and more players enter and enlarge the scope and dimension of MI industry. The TFM, therefore, considered it essential to provide illustrative criteria for classification of manufacturers as well as potential entrants in this industry to ensure standard quality system to the farmers. The existing manufacturers have to be rated according to a definite plan and a system on the basis of their individual capabilities and qualifying requirements/criteria. Individual manufacturers who fall within a certain range can be grouped into one of the four classes: Class A, Class B, Class C and Class D.

Classification Procedure/Process: Class-A microirrigation system manufacturers could be projected as an integrated manufacturer who offers more than irrigation products and services covering aspects like hardware for manufacturing different products, quality assurance mechanism, infrastructure for R &D, basic service facilities for post installation maintenance, marketing network, human resource capability & upgradation facilities and financial strength.

In this context, manufacturing capacity & product range could be given higher rating. Marking system will also take into account quality assurance of hardware delivered to the farmer, Farm & Factory R&D Facilities, their absence or availability, while classifying the industry. Capability to provide basic & support Services, like quality and R&D, as well as education and training backup is also essential. and have to find place in evaluation criteria. Financial strength becomes very important for handling large volumes, hence need consideration while evaluating the manufacturers.

In the current fast changing, dynamic technology oriented globalized economy, criteria for classification/evaluation must be kept flexible and reviewed at regular intervals, say, every two years. Manner in which the marks or weightage are given to each criterion may also vary in keeping with requirements of a given project or the priorities



of the promoters of such projects. Government may entrust to accrediting organizations to work out the details and take up the task of accreditation from time to time.

Microirrigation industry must be fully equipped in terms of sound hardware and software for taking up massive programme at the National level. They should be service providers for the farming community and should not remain content as hardware manufacturers and traders. The criteria, indicated for classification of manufacturers, need to be circulated to the existing manufacturers in the country for self-accreditation and as an opportunity for self upgradation and updation. Illustrative criteria, which should be covered by accrediting agency should include product range and manufacturing capacity, quality assurance mechanism, R & D facilities, capability to provide support services, training, financial strength, after sales services network, performance record and recognitions. Using criteria, by giving weightage to these factors, the manufacturing units could be graded .

1.7.2. Encouragement to SSIs:

The small scale and/or medium scale manufacturers should be given opportunity to upgrade their facilities in terms of manufacturing of hardware, provision of services as well as expansion of geographical reach. It is also essential to enforce eligibility criteria for microirrigation system manufacturers to avoid risk of poor quality. In this context, norms of registration need to be followed strictly and assistance could be provided to upgrade the facilities of upcoming units.

1.7.3 Facilitation of Foreign Companies:

To get new technologies and investment in microirrigation, foreign companies who ensure to have their manufacturing unit in the country within 2-3 years should be encouraged.

1.8 Fiscal Recommendations:

The plan of action for promoting microirrigation in the areas identified to be of importance has been evolved for the period 2004-05 to 2011-12 coinciding with the on going X Plan and the ensuing XI plan. The proposed yearly targets recommended by the Task Force are given in Table 7.1



Table 7.1: Summary of Proposed Annual Target for Microirrigation

S.No.	Year	Proposed area for adoption, million ha		
		Drip	Sprinkler	Total
1	2004-05	0.50	0.25	0.75
2	2005-06	0.70	0.35	1.05
3	2006-07	0.80	0.40	1.20
	Xth Plan	2.00	1.00	3.00
4	2007-08	1.00	0.60	1.60
5	2008-09	1.50	0.70	2.20
6	2009-10	2.00	0.80	2.80
7	2010-11	2.50	0.90	3.40
8	2011-12	3.00	1.00	4.00
	XI th Plan	10.00	4.00	14.00
	Total	12.00	5.00	17.00

The Table-7.2 gives the unit costs of microirrigation systems in different Categories of crops.

Table 7.2: Unit Cost of Drip & Sprinkler irrigation systems assumed.

S.No.	Type	Average unit Cost of System, Rs/ha
1	Drip Irrigation	45,000
2	Sprinkler Irrigation	15,000

Based on the above unit costs and as per the yearly plan given in Table-7.1 the yearly cost estimates for adoption of microirrigation systems are calculated and presented in



Table 7.3: Cost Estimates for adopting microirrigation systems

S.No.	Year	Cost Estimate for adopting MI systems as per yearly plan in Table-7.1, Rs crores		
		Drip Irrigation @ Rs 45,000 per ha	Sprinkler Irrigation @ Rs 15,000 per ha	Total
1	2004-05	2250	375	2625
2	2005-06	3150	525	3675
3	2006-07	3600	600	4200
	Xth Plan	9000	1500	10500
4	2007-08	4500	900	5400
5	2008-09	6750	1050	7800
6	2009-10	9000	1200	10200
7	2010-11	11250	1350	12600
8	2011-12	13500	1500	15000
	XI th Plan	45000	6000	5100
	Total	54000	7500	61500

The Task Force proposed that the estimated cost of microirrigation systems be met by the following means:

1. 50% of the cost shall be borne by the beneficiary farmers through their own resources or by availing credit from financial institutions.
2. 40% of the cost shall be borne by the Government of India, which would be raised by availing loan from International agencies like World Bank, International Financing organisations., and/or by levying import cess on import of horticultural products/oil seeds etc. (Ref Strategy for Mobilizing funds for supporting Governmental assistance for microirrigation)
3. 10% of the cost shall be borne by the State Governments, which could be raised by borrowing from Rural Infrastructure Development Fund (RIDF) of NABARD or through State's own resources.

The above pattern is recommended owing to the following facts that the assistance for microirrigation during the initial period of the Eighth Plan was 50% of the cost of the system to all categories of farmers. This was enhanced to 90% of the cost to small, marginal, SC, ST and women farmers and 70 per cent of the cost to other category



farmers during 1996-97. Subsequently, during the Ninth Plan (2000-01), the assistance was again scaled down to 50% of the cost to small, marginal, SC, ST and women farmers and 35 per cent of the cost to other category farmers. However, during the Tenth Plan the assistance was further scaled down to 25 per cent of the cost to all categories of farmers. This scaling down of assistance has adversely affected the take-off in adoption of microirrigation. The Task Force felt that since the initial investment for installing a microirrigation system is high, making it unaffordable by most of the farmers, the assistance should be restored to the level prevalent during the IX Plan, i.e. 50 per cent of the cost of the system, which should be extended to all categories of farmers.

The indirect benefits of adopting microirrigation would accrue to the State and the Governments in the form of:

Saving in water is equal to saving in investment for creating additional water resources; saving in electrical power supplied to the agricultural sector will mean reduction in the subsidy burden on account of power supply to Agriculture; saving in fertilizer consumption will mean reduction in subsidy burden on exchequer due to the Fertilizer Retention Price Scheme; improved efficiency and productivity from various GoI schemes such as Watershed development, Wasteland Development; Crop Diversification, etc; employment generation in the form of microirrigation Industry, technicians for maintenance of systems in rural areas, increased farm activity due to intensive agriculture, handling/transport of additional farm produce, processing industry, etc.



The yearly requirement of funds for assistance from Government of India and State Government is detailed in Table-7.4.

Table 7.4: Funds required at GoI level for adoption of MI Systems

Year	Drip Irrigation		Sprinkler		Total		
	GOI	State	GOI	State	GOI	State	Total
2004-05	900	225	150	37.5	1050	262.5	1312.5
2005-06	1260	315	210	52.5	1470	377.5	1847.5
2006-07	1440	360	240	60.0	1680	420.0	2100.0
Xth Plan	3600	900	600	150.0	4200	1150.0	5350.0
2007-08	1800	450	360	90.0	2160	540.0	2700.0
2008-09	2700	675	420	105.0	3120	780.0	3900.0
2009-10	3600	900	480	120.0	4080	1020.0	5100.0
2010-11	4500	1125	540	135.0	5040	1260.0	6300.0
2011-12	5400	1350	600	150.0	6000	1500.0	7500.0
XIth Plan	18000	4500	2400	600.0	20400	5100.0	25500.0
Total	21600	5400	3000	750.0	24600	6150.0	30750.0

Similarly, the direct benefits of adopting microirrigation which would accrue to the beneficiary farmers are:

Higher crop yields; better utilization of available resources such as land, water and fertilizers; savings in cost of cultivation on account of reduction in fertilizer use; plant protection; inter-cultivation, etc; better price realization on account of improved quality of produce; and higher income on account of all the above.

It has also been well established that the investments on drip & sprinkler have low break-even periods such as 2 to 3 crop seasons, on account of the benefits described above. The farmers shall be educated about the benefits of these proven technologies and their economic viability, so that they can be motivated to invest the 50% of the cost of microirrigation systems.

Assuming that the farmers would seek loans from the banks towards their share of 50% of the cost of microirrigation systems, the estimated requirement of amounts to be made available by the banks under priority sector lending, is given in Table 7.5



Table 7.5: Amounts to be made available by banks as loans to farmers for adopting microirrigation systems

S.No.	Year	Estimated Bank finance towards the 50% cost of MI Systems to be extended as loan to farmers under priority sector lending as per yearly plan in Table-7.1, Rs crores		
		Drip Irrigation @ Rs 22,5400 per ha	Sprinkler Irrigation @ Rs 7500 per ha	Total
1	2004-05	1125	188	1313
2	2005-06	1575	263	1838
3	2006-07	1800	300	2100
	Xth Plan	4500	751	5251
4	2007-08	2250	450	2700
5	2008-09	3375	525	3900
6	2009-10	4500	600	5100
7	2010-11	5625	675	6300
8	2011-12	6750	750	7500
	XI th Plan	22500	3000	25500
	Total	27000	3751	30751

Recommendations regarding fiscal incentives, credit support and administration of these incentives and credit support are detailed below:

- The subsidy assistance should be administered through a transparent system, preferably by way of credit linked back-ended subsidy mode. This assistance could be administered by involving the financial institutions, commercial and cooperative banks. The farmers intending to adopt microirrigation should have easy access to credit.
- Since there has been rapid strides in the field of Information Technology and there is accessibility of computers at the block and district level, it would be appropriate to have an efficient method of disbursal of funds through electronic transfer as being done in the case of AP Microirrigation Project.



Tax Incentives

- Since microirrigation enhances the productivity and increases the farm income, it could be a means for poverty alleviation. However, high taxes such Sales Tax, Trade tax, Purchase tax and local taxes like Octroi, entry tax etc. ranging from 4 to 10 per cent being charged on the system by the various states is a hindrance for its adoption by the farmers. Therefore, there is a case for abolition of taxes on the complete microirrigation systems and components.
- Imposition of Value Added Tax (VAT) is under consideration of the Government. Microirrigation system should be viewed as an infrastructure support for the overall development of agriculture; hence VAT should not be imposed on microirrigation systems right from inception.
- It is estimated that plastic raw material used for microirrigation systems to cover one hectare will be to the tune of 300-500 kgs. The raw material used in the manufacture of MIS are LDPE, LLDPE, HDPE, PE and PVC. These raw materials are available locally but as the capacity of local raw material manufacturers is not fully adequate some quantities are being imported. These raw materials are covered under Chapter 39 of Custom Tariff 2001-02 and attract basic Custom Duty (25%), CVD (16%) and SAD (4%), which work out to 50.80%. The domestic plastic raw materials are usually priced to match the landed cost of the imported raw materials. The MI manufacturers decide to opt for either domestic or imported raw materials based on the landed price for them. It has been observed that about 15% of the total plastic raw material requirement of the MI industry is being imported presently. Therefore, if raw material were exempted/given considerable concession from basic import duty, CVD and SAD as well as the excise duty, the cost of microirrigation system can be further reduced.
- In the present setup it is not possible to allow import of raw materials duty free as they are also used for other purposes than microirrigation and the revenue considerations will not allow it. However it may be possible to work out a framework by which the material is imported duty free against advance licenses for specific use for manufacture of microirrigation systems and the duty liability is extinguished against end use certification by a local authority nominated for such a purpose. Other mechanisms to avoid misuse can also be evolved in consultation with the



respective departments and the industry.

- Task Force recommended that the import duties on plastic raw materials required for the microirrigation industry should be waived off completely, ie., the existing 50.8% import duties be brought down to 0%.
- Similar to the reduction in import duties recommended above, the Task Force also recommends waiver of excise duty on the domestic plastic raw materials required for microirrigation, ie., the existing 16% excise duty be brought down to 0%.
- The manufacturers of microirrigation components usually decide to procure the plastic raw materials either by importing from outside the country or by purchasing from the domestic plastic raw material manufacturers, depending upon the comparative landed cost of raw materials from import sources or from the domestic sources. On an average presently it is likely that the microirrigation industry might import 25% of their raw material requirements and procure remaining 75% of its requirements from the Indian raw material manufacturers. Based on the above assumption of 75% domestic and 25% imported raw materials and based on the reduction in import duties and excise duty to the levels recommended above, the cost of the systems can go down by about Rs. 1300 to 4800 per ha which amounts to about 8% of the cost of the whole system.
- The microirrigation systems as explained in the preceding paragraphs have to be handled in a holistic manner, which will need services on agronomic practices, market support, etc. Taxes on such services will be a burden on the farmers. Hence, pre and post sale services for microirrigation systems should also be kept out side the purview of the service taxes.
- As far as excise duty is concerned, microirrigation system including its components namely, lateral, tubing, main pipeline, sub main pipeline, filtration equipment and its automation, fertigation equipment or any other system used for the purposes of applying fertilizer along with microirrigation and such other accessories and fittings that go as a package along with microirrigation system should be exempted from all taxes.

Thus, by waiving import duties and excise duty on plastic raw materials required for MI industry, the price of MIS would be reduced by about 8 per cent. The cost of the



microirrigation system could be reduced further by about 4 % if the state governments also exempt sales tax, as done by the Government of Gujarat, Andhra Pradesh, etc

Credit Support

Credit support for microirrigation shall be viewed as a national priority considering the need for conservation of water in irrigation and the need to increase the productivity of various inputs into agriculture.

The credit support and delivery to the farmers towards the 50% of the cost of the microirrigation systems in terms of quantum, interest rates, margin, security, etc are all discussed and various recommendations are made as given below:

1) Interest Rate:

A consensus was reached that Bankers will get refinance from NABARD at a rate not more than 6%. In future this is expected to go down further. The Bankers in turn should not add more than 1 to 2% as their spread to cover the overheads. It is quite possible that Bankers may not recover their full cost of operations and may not have any profit margin for keeping the spread as low as 1 to 2%. However the TFM strongly felt that water crisis is looming large and will assume unmanageable proportions if technological interventions such as microirrigation are not consciously encouraged to save water for the agriculture sector. It is accepted that agriculture will continue to be consuming more than about 70% of total water availability. Since microirrigation does save water upto 50%, any saving arising out of agricultural irrigation water can substantially help other sectors such as industry and domestic/urban consumption as well as reduce cost of costly piped drinking water supply schemes to far-flung villages in the rural areas.

It was felt that low interest rates such as 6 to 7% will promote wider application of technology, significantly reduce the risk of such loans going bad and would also dramatically improve recovery of the loan installments as well as interest from the agriculturist to the Banker.

Such a move would further help change 'Risk' perception of the Bankers at large and broaden the base for even Private and Foreign Bankers to step in. They may even like to swap with established nationalized banking sector, which have wider reach in rural areas. Thus, it may be possible for private bankers to buy some portion of the agricultural



credit from the nationalized banks at a small margin to the later. RBI may consider favourably such a move. In this way, between themselves they can meet their obligations of maintaining credit delivery to agriculture priority sector at a minimum of 18% and within that accorded top priority to financing of microirrigation system, which is pivotal for modernizing agriculture, accelerating the agricultural growth and help alleviate poverty of the rural farmers.

As an incentive for timely repayment of the loan 0.5% rebate in the interest amount could be provided at the time of closure of loan.

2) Loan Quantum/Amount:

Presently loans upto Rs. 50,000, and in some cases Rs. 1 lakh, including the margin provided by the farmer, are eligible for concessional rate of interest. Task Force reached a consensus that in view of increased prices of hardware and inclusion of cost of services pertaining to microirrigation technology introduction, in the system cost, the ceiling for microirrigation Term loans including margin to be provided by the farmer, must be increased to Rs 2 Lakh or 1 Lakh of sanctioned loan.

3) Securitisation of Loans:

In some States and in case of some Bankers, mortgage is insisted upon for availing loans even up to Rs. 50,000/-. However, such mortgage is generally in the form of Equitable Mortgage or English Mortgage i.e. by way deposits of original title deeds. Equitable Mortgage is not required to be registered and as such the farmer saves the cost of registration fee and also do not have to go through completion of cumbersome documentation. State governments are recovering stamp duty charges for registered mortgage. It was felt that all State and Central Government taxes, levies, duties, fees, cess, etc. etc. must be fully waived for introductory period of at least 5 years in respect of term loans to be granted to farmers purchasing microirrigation sets. As such, Bank Finance, excluding margin provided by farmers, should be exempt from need for Registration fees, stamp fees and the need to execute mortgage of land as security. Microirrigation set by itself should be considered as adequate security, and no other collateral or mortgage of land, house, etc be insisted upon, at least for a loan amount upto Rs. 1 lakh or redeemable value of hardware of microirrigation system.



4) Credit Delivery:

Different options for routing of credit support from the Central Government to the State Governments were considered. It was felt that the route adopted under APMIP was possibly the ideal method of providing credit delivery from Central Government to the State Government. Under APMIP, the credit assistance to Government of Andhra Pradesh to the tune of 95% of the State Government's contribution has been assured through the RIDF administered by NABARD. There is a need to step up the provisions for RIDF for enabling the flow of more funds to States for microirrigation projects.

The payment of the subsidy/grant from the State Government to the farmer should be in the form of Back-Ended Capital Subsidy payable by the Banker directly to the microirrigation Supplier/Manufacturer after its satisfactory installation. Such a credit delivery mechanism will minimize, if not eliminate, the delay, the leakages and the malpractices in delivery of the credit.

5) Margin Provision

Since 50% of the total loan component is available to the farmer by way of Governmental assistance, no margin should be insisted upon for availing loan amount upto Rs. 1.00 lakh. However, for loans above Rs. 2.00 lakhs towards microirrigation, the banker may insist on suitable margin.

6) Other recommendations connected to Credit support for Microirrigation:

- Bank Loans for microirrigation should be made available for the entire microirrigation system as a whole, which include bore-well/open-well construction, water storage tank, watershed development, etc.
- Since delay in payment of subsidy indirectly affects manufacturers, the financing banks may provide credit assistance to manufacturers equal to their receivable subsidy so that they would be enthused for larger programme. Further, since such loans are for microirrigation the same should be treated as priority advances and should be eligible for interest concessions available to priority sector.
- In many cases, farmers are not eligible for bank loan because of default in loan repayment. There are many reasons for such defaults main reason being poor crop yield due to non-availability or shortage of water, and/or pest/disease



infestation. Since microirrigation increases crop yield even with less water and controls pest and diseases, the farmers need to be motivated to grow more cash crops by adopting microirrigation for getting more income. For this purpose the banks need to relax their lending norms and should finance farmers after taking into account only current dues instead of total outstanding dues. Further, the bankers may not finance 'willful' defaulters. However, farmers who defaulted on account of poor monsoon, natural calamities and/or circumstances beyond his control should be considered "eligible" for loans to purchase MI systems.

- The State Cooperative Banks & Regional Rural Banks should also make credit available to the microirrigation programmes. In order to make them eligible, revitalization programme of the State Cooperative Banks & Regional Rural Banks should receive top priority. The National Cooperative Development Corporation (NCDC) could also function as a financing agency for microirrigation programmes in the country.
- In order to ensure smooth recovery of loans, emphasis should be given for taking up contract farming. This will enable the farmers in putting higher investments, as they would be assured of returns from their investments. Moreover, the supplier would also be a party to the contract farming scheme. This will ensure close monitoring.
- NABARD has established large number of Self Help Groups (SHG) and many of these are linked to banks for credit. The SHGs should be motivated to promote microirrigation and for this purpose banks, if necessary could support the entire credit needs of the SHGs even by increasing their credit limits.
- Presently, loans for microirrigation are mostly on sporadic basis instead of an area development approach, which results in maintaining large number of accounts. The procedure needs to be simplified by involving the system manufacturers who could identify the prospects of microirrigation in a particular area/taluks/district and firm up the targets, which could be discussed and dovetailed with NABARD. Once these are accepted, NABARD may advise these to the District authority to include them in their district annual action plan and the programme could be allocated to different banks by NABARD.



- Due to procedural and administrative reasons, subsidies are unduly delayed in a large number of cases. The industry has to build in margins in costing to set off the losses on account of outstanding subsidies to the detriment of the farmers. To offset such losses the industry should be allowed to raise credit at concessional rates to the extent of 80% of cumulative subsidies over a six-month period. The rate of interest on such credit should be 3% below the commercial rate of lending.

Suggested Pattern and Delivery Mechanism:

It will be necessary to take adequate measures and build a fool-proof method for delivery and disbursement of funds for microirrigation projects through the states. Following are some of the recommendations intended to improve the Delivery Mechanism:

- The assistance for the purpose should be routed through NABARD. The State Government should be vested with the responsibility of sample verification system alongwith the banker. In this manner, there will be a built-in safeguard between the concerned banker and designated State Government officials. The routing of the subsidy through NABARD will also ensure that the funds are not used for other purposes and the appraisal as well as eligibility of the proposal of a given farmer will be the principal responsibility of the banker.
- Routing the subsidy through NABARD and Banking Structure will not only free Government Officials for providing better extension and technical support to farmers but will help in establishing better linkages between credit and subsidy support to farmers for investment in this technology.
- In some of the States, farmers have to wait for at least six months to get the amount of subsidy. In order to encourage the adoption of drip technology, adequate arrangements should be made to disburse the amount to the beneficiaries or the MI Manufacturer as the case may be, immediately.
- Implementing officers and concerned companies/dealers should be made responsible for any intentional malpractices in the field and should be severely dealt with.
- Mechanisms evolved under the recent Andhra Pradesh Microirrigation Project



(APMIP) for delivery of subsidy component and the bank loan need to be emulated with modifications relevant to the respective local conditions. Under APMIP, GoAP has evolved a system for efficient disbursement of subsidies for the microirrigation. The entire transaction is expected to be almost paper-free. Moreover, the banks are expected to electronically transfer the funds to the suppliers of microirrigation. The state government authorities are only involved at one stage of installation and verification of the system. Even this function they are supposed to perform along with the banker. They are therefore not the only authority for inspection and verification. In this manner, there is a built-in safeguard involving the concerned banker and state government official jointly.

- The routing of the subsidy through NABARD on the lines of “On Farm Water Management Programme for Eastern States” also ensures that the states do not divert the funds for other purposes/projects and the appraisal as well as eligibility of the proposal of a given farmer becomes the principal responsibility of the banker. Such policy changes will minimize, if not eliminate, the delays as well as malpractices in delivery of the assistance.

Strategy for mobilizing funds for supporting Governmental assistance for microirrigation:

Adoption of microirrigation on a large scale as proposed by the Task Force with the help of 50% assistance support from Government of India will necessitate investment to the tune of Rs.30,500 crores during the next 8 years until the end of XIth Plan. The investments of this magnitude will be possible only through proper sourcing of funds. It is, therefore, recommended that multipronged strategy may be adopted for generation of the resources by way of the following means

- Providing large funds in the union budget under a single Department viz. Deptt. of Agriculture & Cooperation may pose inter departmental difficulties. However, there are numerous direct and indirect benefits that reap to many other departments like Water Resources (saving of water for irrigation and Command Area Development), Rural Development (assured drinking water supply), Energy (reduced requirement), Environment (prevention of pollution and protection of resources), Petroleum and Chemical fertilizer (saving in fertilizer consumption), Social Welfare (Tribal development, SC/ST). These departments should therefore contribute to the



development of microirrigation, since there will be less expenditure in meeting their targets. Likewise, in the event of launching special programmes related to water, microirrigation should necessarily form an integral component of their respective schemes.

- On the analogy of “Accelerated Irrigation Benefit Programme”, financial provision by way of planned allocation in the Union budget is needed for accelerated growth of microirrigation, to achieve the desired growth rate of 6% in agriculture. Microirrigation is complementary to flow irrigation because it enhances crop productivity and modernises agriculture. The Central Government should earmark for microirrigation 10% of the total financial allocation for Major/Medium/Minor irrigation projects. Currently about Rs. 10,000 crores are being invested annually on major and medium irrigation projects in the country. Ten per cent of this would be Rs. 1000 crores would therefore be available from the irrigation sector projects for microirrigation. Alternatively, the Central Government could make separate annual provision to meet 40% of the cost of targeted programme of microirrigation.
- Imposing an import cess of 5% on the import of items like pulses, oilseeds, oils and horticultural produce. The imports of horticultural products, oilseeds and pulses during 2002-03 have been to the tune of 6.6 million tonnes valued at Rs. 13761.16 crores. (Annexure XI). Import cess of 5% on these items would generate roughly annual revenue to the tune of Rs. 688.00 crores.
- An amount to the tune of 20 per cent of Sugar Development Fund (SDF) can be availed for the development of microirrigation systems in case of sugarcane.
- Similarly, Watershed Development Fund (WDF), which is maintained and operated by NABARD for watershed development programmes could be availed for promoting microirrigation as an integrated activity under watershed management programmes financed by NABARD.
- Aid/Loan from International Funding Agencies such as World Bank, Asian Development Bank, etc may be tapped.
- Recognizing the need for qualitative improvement in the agricultural infrastructural facilities, Gol has proposed to create an Agri-Infrastructure & Credit Fund (AICF) of Rs 50,000 crores in the NABARD in addition to that available under RIDF which



will be available during the next 3 years at lower interest rate than that of RIDF. The fund is proposed to be used for waste lands development, minor irrigation, functioning and viability of co-operatives, grading, certification, storage of agro-products, their processing, cold chains and modern abattoirs. The Task Force recommended that microirrigation should be given priority consideration while allocating funds out of the proposed AICF.

Other Recommendations related to Financial Aspects:

- Since the risk taking capacity of majority small farmers is low, microirrigation should not pose extra risk for agricultural production. Necessary crop insurance measures should be incorporated in the programme.
- Lack of consistency in subsidy support for the microirrigation during the last decade and recent scaling down of assistance have adversely affected the take-off in adoption of microirrigation in the recent years. Therefore, scaling down of subsidy should not be done till the end of XIth Plan or till the time an area of 17 million ha is brought under microirrigation. The level of assistance should be maintained without any change during the next two Plan periods.

1.9 General Recommendations:

- While giving clearance for infrastructure projects requiring rehabilitation of green cover, the new plantations should be raised only with the support of microirrigation for faster tree growth and expenditure should be built in the project cost.
- Microirrigation will help in increasing production and improving quality of the produce. MITs can do this by themselves on Stand-alone basis. However, they can become far more fertile and potent if they are used in conjunction with other frontier technologies such as bio-technology. Microirrigation should be joined and united with provision of superior planting and grafting material, hybrid or high yielding seeds as well as bio-mediums and material for making agriculture more productive on sustainable basis.
- In order to avoid fall in prices of commodities, mainly that of horticulture produce, due to increased production through microirrigation, long-term supportive measures are required for creating and sustaining strong fruit and vegetable processing infrastructure in the country, processing the produce, particularly those which are



perishable. Presently only about 4% of the fruits and vegetables are getting processed. Incentives to the processing industry in terms of capital and reduction in respect of various Central and State Levies will be needed to attract private capital investment for this sector.

- Microirrigation can be made much more meaningful if forwardly linked with Fruit & Vegetable processing for exports and higher value addition on sustained basis.





CHAPTER – VIII

LIKELY IMPACT ON IMPLEMENTATION OF RECOMMENDATIONS

An attempt has been made in this Chapter to quantify the impact in monetary terms on account of adopting the microirrigation programme over an area of 17 M.Ha by the end of the XI Plan. These could be grouped into Categories, viz,

1. **Benefits to the Nation** : involving

- Saving in infrastructural cost on irrigation projects due to savings in water requirements for irrigation
- Savings in subsidized electricity supplied to agriculture sector due to reduction in electricity consumption with microirrigation
- Savings in subsidy support for the fertilizers due to savings in fertilizer consumption by adopting microirrigation
- Employment generation
- Miscellaneous direct/indirect benefits

2. **Benefits to the Farmers due to Increased Yields**

3. **Impact on revenue earnings due to reduced taxes**

BENEFITS TO THE NATION

Saving in Infrastructural Cost on Irrigation Projects due to Savings in Water Requirements for Irrigation:

With the adoption of microirrigation, there would be saving in irrigation water requirements for the crops covered under these technologies. Under the principle of “Water Saved is Water Created”, there would be benefit to the Nation in the form of saving in cost of creating Irrigation Infrastructure for increasing the Irrigated areas and for improving the efficiencies of existing infrastructure in all Major, Medium



and Minor Irrigation projects. Coverage of additional area of 17 million ha under microirrigation by the end of XI Plan will generate water savings to the tune of 59 BCM.

Table 8.1: Potential Water Savings through Implementation of Microirrigation

S. No	Cr op	Area expected to be brought under Micro Irrigation, million ha	Estimated Water Requirement, mm/annum		Estimated Water Requirement, Water, Billion meter/annum		Savings in Billion Cubic meter/ annum
			Without Drip	With Drip	Without Drip	With Drip	
		[1]	[2]	[3]	$[4] = [1] * [2] / 1000$	$[5] = [1] * [3] / 1000$	$[5] - [4]$
1	Widely Spaced Crops suitable for Drip Irrigation	4.440	900	600	40	27	13
2	Closely Spaced Crops suitable for Drip Irrigation	7.560	1700	1200	129	91	38
3	Crops suitable for Sprinkler Irrigation	5.000	500	350	25	18	8
		17.000			193	135	59

Based on the saving in irrigation water as shown in Table 8.1 the total value of the savings which otherwise will have incurred for creating equal amount of irrigation potential works out to the tune of Rs. 45,000 crores. (Table 8.2).



Table 8.2 : Saving in Water required for Irrigation and consequent Indirect Benefit by Saving in Infrastructural Investments on Irrigation Projects, due to adoption of MITs

Sl. No	Year	Proposed area for adoption, million ha				Water Saving, BCM/year				Value of infrastructure investment saved @ Rs 770 Crores/BCM,* Rs Crores
		Widely Spaced Crops suitable for Drip Irrigation	Closely Spaced Crops suitable for Drip Irrigation	Crops suitable for Sprinkler Irrigation	Total	Widely Spaced Crops suitable for Drip Irrigation	Closely Spaced Crops suitable for Drip Irrigation	Crops suitable for Sprinkler Irrigation Total	Total	
1	2004-05	0.190	0.310	0.250	0.75	0.57	1.55	0.38	2.50	1921
2	2005-06	0.260	0.440	0.350	1.05	0.78	2.20	0.53	3.51	2699
3	2006-07	0.300	0.500	0.400	1.20	0.90	2.50	0.60	4.00	3080
	X th Plan	0.750	1.250	1.000	3.000	2.250	6.250	1.500	10.000	7700
4	2007-08	0.370	0.630	0.600	1.60	1.11	3.15	0.90	5.16	3973
5	2008-09	0.550	0.950	0.700	2.20	1.65	4.75	1.05	7.45	5737
6	2009-10	0.740	1.260	0.800	2.80	2.22	6.30	1.20	9.72	7484
7	2010-11	0.930	1.570	0.900	3.40	2.79	7.85	1.35	11.99	9232
8	2011-12	1.110	1.890	1.000	4.00	3.33	9.45	1.50	14.28	10996
	XI th Plan	3.700	6.300	4.000	14.000	11.100	31.500	6.000	48.600	37422
	Total	4.45	7.55	5.00	17.00	13.35	37.75	7.50	58.60	45122

Assumptions:

* Based on the principle of Water Saved is Water Created it is estimated that investment on Major/Medium irrigation projects for creating 1MCM of water potential is Rs 77 lakhs or Rs 770 Crores per BCM

Savings in Subsidized Electricity supplied to Agriculture Sector due to reduction in Electricity consumption with Microirrigation

It has been well established that the adoption of microirrigation saves electricity requirements of irrigated agriculture. Due to the burden of subsidized electricity supply to the agriculture sector mounting day by day, the State Electricity Boards are reeling under losses. Some of states such as Andhra Pradesh and Gujarat have already noticed the potential of microirrigation in reducing the electricity consumption in irrigated agriculture with microirrigation. In Gujarat the Electricity Board has evolved an innovative plan of providing microirrigation system free of cost to the farmers, who accept to pay for the electricity supplied to them on the basis of actual metered power supplied to them.



The Tables 8.3 and 8.4 explain how savings in electricity are feasible with adoption of microirrigation in irrigated agriculture.

Table 8.3: Electricity Savings with Microirrigation vs Flood Irrigation

S.No.	Particulars	Flood	Drip
1	Water requirement, mm	900	600
2	Water requirement, m ³ /ha/annum [= (1) x 10000 m ² /1000]	9000	6000
3	Water requirement, lts. [= (2) x 1000]	9000000	6000000
4	No of irrigation days in a year	200	200
5	No of irrigation hours in a year @ 8 hours/day	1600	1600
6	Average flow per ha, lps [= (3)/[(5)*3600]]	1.56	1.04
7	Average pumping head, m	40	50
8	Average HP per ha based on above flow and head, [=(7)*(6)/(75*0.8*0.75)]	1.4	1.16
9	Average kW per ha, = (8) x 0.75	1.0	0.9
10	Total annual energy kWhr/ha = (9) x (5)	1666.7	1388.9

Table 8.4: Potential Savings in Electricity consumption in different crops due to Micro Irrigation

S. No.	Crop	Average annual irrigation depth, mm		Average annual Energy Requirement, kWhr/ha		
		Flood	Drip/Spr.	Flood	Drip/Spr	Saving
[1]	[2]	[3]	[4]	[5]	[6]	[7] = [5]-[6]
1	Widely Spaced Crops suitable for Drip Irrigation	900	600	1667	1389	278
2	Closely Spaced Crops suitable for Drip Irrigation	1700	1200	3148	2778	370
3	Crops suitable for Sprinkler Irrigation	500	350	926	810	116

Based on the savings in electricity consumption explained in Tables 8.3 and 8.4 and based on the yearly targeted areas of adoption of microirrigation presented in Table 1, the yearly potential savings in electrical power that can be saved with the help of microirrigation have been calculated and presented in Table 8.5, which indicate that the value of electricity saved through microirrigation would be of the order of Rs. 3767 crores.



The potential savings from the areas brought under microirrigation will be accruing every year after the adoption of microirrigation and hence the savings are progressively cumulated in order to perceive their total potential.

Table 8.5 : Saving in Subsidized Electricity supplied to Agriculture Sector due to Adoption of microirrigation

S. No	Year	Proposed area for adoption, million ha				Cost of Electrical Power Saved or Reduction in Loss to SEBs, Rs Crores				Cumulative cost of Electrical Power saved or Cumulative Reduction in Loss to SEBs, Rs Crores			
		Widely Spaced Crops suitable for Drip Irrigation	Closely Spaced Crops suitable for Drip Irrigation	Crops suitable for Sprinkler Irrigation	Total	Widely Spaced Crops suitable for Drip Irrigation	Closely Spaced Crops suitable for Drip Irrigation	Crops suitable for Sprinkler Irrigation	Total	Widely Spaced Crops suitable for Drip Irrigation	Closely Spaced Crops suitable for Drip Irrigation	Crops suitable for Sprinkler Irrigation	Total
1	2004-05	0.190	0.310	0.250	0.75	13	29	7	49	13	29	7	49
2	2005-06	0.260	0.440	0.350	1.05	18	41	10	69	31	69	17	118
3	2006-07	0.300	0.500	0.400	1.20	21	46	12	79	52	116	29	197
4	2007-08	0.370	0.630	0.600	1.60	26	58	17	101	78	174	46	298
5	2008-09	0.550	0.950	0.700	2.20	38	88	20	146	116	262	67	445
6	2009-10	0.740	1.260	0.800	2.80	51	117	23	191	167	378	90	636
7	2010-11	0.930	1.570	0.900	3.40	65	145	26	236	232	524	116	872
8	2011-12	1.110	1.890	1.000	4.00	77	175	29	281	309	698	145	1153
	Total	4.450	7.550	5.000	17.00	309	698	145	1153	999	2250	518	3767

Assumption: Production cost of Electricity is assumed as Rs 2.50/kWhr.

Savings in Subsidy support for the Fertilizers due to savings in Fertilizer consumption by adopting microirrigation:

Microirrigation also save fertilizers required in irrigated agriculture because of improved efficiency in fertilizer delivery to the plants along with irrigation water itself. Such saving having been quantified in several research works in farmers' fields also and it is well established that microirrigation brings fertilizer savings. An average saving of 15% in fertilizer use is considered for the calculations on overall savings. The nation is going to be benefited by such savings in fertilizer



requirements as almost all the fertilizers in the country are made available to the farmers at subsidized prices. Savings in fertilizer consumption will reduce the burden of subsidizing them. Tables 8.6 and 8.7 quantify the potential savings in fertilizer consumption based on the yearly targets for adoption of microirrigation assuming the average subsidy support for the fertilizers by Gol at Rs 5800 per microirrigation.

Table 8.6: Savings in Fertilizer Subsidy due to reduced Fertilizer Consumption with implementation of MITs

Sl. No	Year	Fertilizer Saving, Million MT/year				Amount of Fertilizer Subsidy Saved on account of reduced Fertilizer Consumption due to adoption of MITs @ Rs 5800 per MT, Rs Crores	Cumulative Saving in on account of reduced Fertilizer Consumption, Rs Crores
		Widely Spaced Crops suitable for Drip Irrigation	Closely Spaced Crops suitable for Drip Irrigation	Crops suitable for Sprinkler Irrigation Total	Total		
1	2004-05	0.228	0.140	0.038	0.405	235	235
2	2005-06	0.312	0.198	0.053	0.563	326	561
3	2006-07	0.360	0.225	0.060	0.645	374	935
4	2007-08	0.444	0.284	0.090	0.818	474	1409
5	2008-09	0.660	0.428	0.105	1.193	692	2101
6	2009-10	0.888	0.567	0.120	1.575	914	3015
7	2010-11	1.116	0.707	0.135	1.958	1135	4150
8	2011-12	1.332	0.851	0.150	2.333	1353	5503
	Total	4.008	2.547	0.600	7.155	5503	17909

Table 8.7: Average fertilizer consumption of different categories of crops

Crop Category	Fertilizer consumption with conventional irrigated agriculture, kg/ha/annum
Widely Spaced Crops suitable for Drip Irrigation	800
Closely Spaced Crops suitable for Drip Irrigation	300
Crops suitable for Sprinkler Irrigation	100



Employment Generation Potential:

With the adoption of microirrigation, potential exists for employment generation in the following areas/means:

- For every Rs 100 crores MI Industry size about 500 skilled/unskilled people are required
- For every 100 ha of microirrigation systems 2 semi skilled persons are required for installation and maintenance
- With intensive agriculture being possible with adoption of microirrigation, direct employment in agriculture will be possible at one additional person per every hectare of area brought under microirrigation.
- Indirect employment in allied sectors such as post harvest handling, processing, transportation, etc will also be generated at the rate of one person for every 5 ha of area under microirrigation.

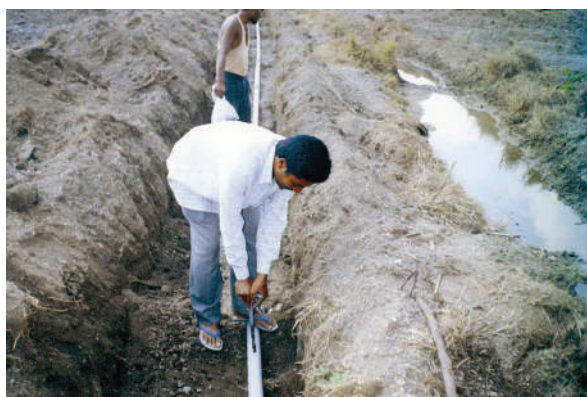


Table 8.8 presents the employment potential on account of adoption of microirrigation in the country as per the yearly targets proposed by the Task Force. It indicates that the employment generation will be to the tune of 21 million mandays.

Table 8.8: Employment potential due to adoption of MITs

Year	Estimated cost of MITs, Rs	Employment Potential, nos				
		Required for Drip	Required for Installation /	Direct employment in intensive	Indirect employment in allied	Total Employment
2004-05	2625	13125	15000	750000	150000	930750
2005-06	3675	18375	21000	1050000	210000	1303050
2006-07	4200	21000	24000	1200000	240000	1489200
2007-08	5400	27000	32000	1600000	320000	1984400
2008-09	7800	39000	44000	2200000	440000	2730800
2009-10	10200	51000	56000	2800000	560000	3477200
2010-11	12600	63000	68000	3400000	680000	4223600
2011-12	15000	75000	80000	4000000	800000	4970000
	58900	307500	340000	17000000	3400000	21109000

BENEFITS TO THE FARMERS DUE TO INCREASED YIELDS

The most important benefit of adoption microirrigation technology in the country is the increase in yields of crops in which these technologies are being adopting. The last two decades of research experience and the experiences of various farmers across the country have convincingly proved that the yields of crops increase due to adoption of microirrigation technology. The benefit of such higher crop yields will accrue to the farmers directly and the National GDP will also go up proportionately. Table 8.9 presents the increase in yields possible on account of adoption of MITs as per the yearly targets proposed.



Table 8.9: Benefit to Farmers due to increase in yield with MITs

S. No	Year	Incremental Revenue to Farmers or Addition to GDP due to increase in yield, Rs Crores				Cumulative Incremental Revenue to Farmers or Addition to GDP due to increase in yield, Rs Crores			
		Widely Spaced Crops suitable for Drip Irrigation	Closely Spaced Crops suitable for Drip Irrigation	Crops suitable for Sprinkler Irrigation Total	Total	Widely Spaced Crops suitable for Drip Irrigation	Closely Spaced Crops suitable for Drip Irrigation	Crops suitable for Sprinkler Irrigation Total	Total
1	2004-05	133	558	141	832	133	558	141	832
2	2005-06	182	792	197	1171	315	1350	338	2003
3	2006-07	210	900	225	1335	525	2250	563	3338
4	2007-08	259	1134	338	1731	784	3384	900	5068
5	2008-09	385	1710	394	2489	1169	5094	1294	7557
6	2009-10	518	2268	450	3236	1687	7362	1744	10793
7	2010-11	651	2826	506	3983	2338	10188	2250	14776
8	2011-12	777	3402	563	4742	3115	13590	2813	19518
	Total	3115	13590	2813	19518	10066	43776	10041	63883

The above incremental revenue calculations are based on the yield and price assumptions made for different categories of crops as given in Table 8.10 below:

Table 8.10: Production and Unit Price

Sl. No	Crop	Average Productivity, MT/ha		Average Price, Rs/MT
		Without drip	With drip	Rs/unit
1	Widely Spaced Crops suitable for Drip Irrigation	4.00	7.50	2000
2	Closely Spaced Fruit Crops suitable for Drip Irrigation	40.00	70.00	600
3	Crops suitable for Sprinkler Irrigation	2.00	2.75	7500

The additional revenue benefit to the farmers can repay the loans on account of 50% cost of the MI systems with 2 crop seasons and later on can add to the individual farm incomes. Thus, the above discussion clearly establishes the immense impact MITs can bring to nation at large and the farming community in particular. The employment generations potential in the rural areas is also very important on account of the need for socio economic improvement.



IMPACT ON REVENUE EARNINGS DUE TO REDUCED TAXES

The Task Force recommends the following with respect to the various duties and taxes being levied on raw materials, finished products, imported components, etc as given below:

- Abolishing various customs duties on import of plastic raw materials required for the MI industry from the existing levels of 50.8%
- Removing Excise duty on domestic plastic raw materials from the existing level of 16%.
- Abolishing Sales Taxes, Service Taxes, Octroi, Entry Taxes, VAT, other local levies and taxes on Micro Irrigation components and systems
- Increase of import duties on finished components of irrigation systems especially the Emitters, Emitting Pipes, Filters, Fertigation Units, Irrigation Lateral pipes, PVC and HDPE pipes, which are presently being manufactured within the country.

The implication of above suggestions pertaining to taxes, duties and levies is analyzed. The quantum of plastic raw materials required in microirrigation systems is summarized in Table 8.11.

Table 8.11: Plastics (Raw Material) Requirement in Drip & Sprinkler Irrigation Systems

S. No.	Crop Type	Plastics Requirement, kg/hectare						
		PVC	HDPE	LLDPE	PP	Nylon	Others	Total
Drip Irrigation Systems								
1	Widely Spaced Tree Crops	90	0	125	5	0.2	0.2	220.4
2	Closely Spaced Crops	120	0	280	29	0.3	0.3	429.6
Sprinkler Irrigation Systems		0	110	0	0	0	0.3	110.3

The present levels of Customs duties on imported raw materials are tabulated in Table 8.12 below.



Table 8.12: Customs Tariff on Imported Plastic Raw Materials of MI Systems

Heading	Description of Material	Basic Customs Duty	C.V.D	S.A.D	Total
3901.10	Polyethylene having a specific gravity less than 0.94 (LDPE)	25%	16%	4%	50.80%
3901.20	Polyethylene having a specific gravity more than 0.94 (HDPE)	25%	16%	4%	50.80%
3902.01	Polypropylene(PP)	25%	16%	4%	50.80%
3904.10	Polyvinyl Chloride not mixed with any other substances	25%	16%	4%	50.80%

Thus the cumulative effect of all the import duties on the plastic raw materials required for the MI Industry works out of 50.80% on the basic price of these materials. The effect of these duties on the cost of raw material required in different categories of MI systems is calculated based on the plastic raw material requirements presented in Table 8.11 and based on the present levels of basic prices of these materials. The cost of plastic raw material component in system cost worked out assuming that the entire material is imported, is presented in Table 8.13.

Table 8.13 Plastic Raw Material Cost of MI Systems with Imported Raw Material at current Duties

Sl. No.	Category	Cost of Plastic Raw Material with prevailing Custom Duties, Rs/hectare						
		PVC @ Rs/kg	HDPE @ Rs/kg	LLDPE @ Rs/kg	PP @ Rs/kg	Nylon @ Rs/kg	Others @ Rs/kg	Total
	Basic Price --->	39.00	45.00	45.00	49.00	100.00	60.00	
	Price including 50.8% Import Duties	58.81	67.86	67.86	73.89	150.80	90.48	
Drip Irrigation Systems								
1	Widely Spaced Fruit Crops	5293	0	8483	369	30	18	14193
2	Closely Spaced Fruit Crops	7057	0	19001	2143	45	27	28273
Sprinkler Irrigation Systems		0	7465	0	0	0	27	7492

Similarly the Table 8.14 gives Plastic raw material cost of MI systems after abolishing the import duties.



Table 8.14 : Plastic Raw Material Cost of MI Systems with Imported Raw Material after abolishing current import duties

Sl. No.	Category	Cost of Plastic Raw Material after abolishing import duties, Rs/hectare						
		PVC @ Rs/kg	HDPE @ Rs/kg	LLDPE @ Rs/kg	PP @ Rs/kg	Nylon @ Rs/kg	Others @ Rs/kg	Total
	Basic Price --->	39.00	45.00	45.00	49.00	100.00	60.00	
	Price including 0% Import Duties	39.00	45.00	45.00	49.00	100.00	60.00	
Drip Irrigation Systems								
1	Widely Spaced Fruit Crops	3591	0	5625	245	20	12	9493
2	Closely Spaced Fruit Crops	4680	0	12600	1421	30	18	18749
Sprinkler Irrigation Systems		0	4950	0	0	0	18	4968

The difference between the costs of MI systems calculated with the cost of imported raw material at the current levels of import duties and at 50% level of the existing import duties is summarized in Table 15. The amount given in the Table 8.15 will thus be the loss of revenue per hectare of various categories of MI systems on account of abolition of import duties.

Table 8.15: Loss of Revenue due to abolishing in Import Duties

S. No	Category	Loss of Revenue due to abolishment of import duties, Rs/hectare						
		PVC	HDPE	LLDPE	PP	Nylon	Others	Total
Drip Irrigation Systems								
1	Widely Spaced Fruit Crops	1702	0	2858	124	10	6	4782
2	Closely Spaced Fruit Crops	2377	0	6400	722	16	10	9524
Sprinkler Irrigation Systems		0	2515	0	0	0	10	2524

It is observed that the microirrigation industry is likely to import 25% of their raw material requirements whenever the international prices are lower than that of the domestic raw materials. For the yearly targeted area of adoption of microirrigation systems as recommended by the Task Force, and assuming that the MI industry will import 25% of its plastic raw material requirements, the yearly loss of revenue on account of abolition of import duties from the existing 50.8% is given in Table 8.16.



**Table 8.16: Total loss of revenue to Government due to abolishing import duties
(for 25% requirement of MI industry)**

S.No.	Category	Total area, M ha	25% area likely to be using imported raw matl., M ha	Rev. loss Rs./ha	Rev. loss, Rs. crores
1.	Drip Irrigation				
	Widely Spaced	4.44	1.11	4782	530
	Closely Spaced	7.56	1.89	9524	1800
2.	Sprinkler Irrigation	5.00	1.25	2524	315
	Total	17.00	4.25		2645

The cost of plastic material at current level of excise and other duties is given in Table 8.17.

Table 8.17: Raw Material price of Microirrigation system with current level of Excise duty

S. No.	Category	Cost of raw material Rs./ha.						
		PVC (Rs./kg.)	HDPE (Rs./kg.)	LLDPE (Rs./kg.)	PP (Rs./kg.)	Nylon (Rs./kg.)	Others (Rs./kg.)	Total
	Basic Price	39.00	45.00	45.00	49.00	100.00	60.00	
	Price including Excise Duties@16%	45.24	52.20	52.20	56.84	116.00	69.60	
Drip Irrigation System								
1	Widely Spaced	4071.6	0	6525	284.20	23.2	13.92	10917
2	Closely Spaced	5428.8	0	14616	1648.36	34.8	20.88	21748
Sprinkler Irrigation System		0	5742	0	0	0	20.88	5762

The cost of plastic material at current level of excise and other duties is given in Table 8.17. The cost of plastic material after reducing the excise duty to 0% is given in Table 8.18, which indicate that the per ha cost of raw material would range from Rs. 4968 to Rs. 18749.



Table 8.18 : Raw Material price of Microirrigation system with current level of Excise duty

S. No.	Category	Cost of raw material Rs./ha.						
		PVC (Rs./kg.)	HDPE (Rs./kg.)	LLDPE (Rs./kg.)	PP (Rs./kg.)	Nylon (Rs./kg.)	Others (Rs./kg.)	Total
	Basic Price	39.00	45.00	45.00	49.00	100.00	60.00	
	Price including Excise Duties @0%	39.00	45.00	45.00	49.00	100.00	60.00	
Drip Irrigation System								
1	Widely Spaced	3510	0	5625	245	20	12	9412
2	Closely Spaced	680	0	12600	1421	30	18	18749
Sprinkler Irrigation System		0	0	4950	0	0	18	4968

The expected loss in revenue due to reduction excise and other duties is indicated in Table 8.19

Table 8.19 : Loss of Revenue due to abolishing of Excise Duties

S. No.	Category	Loss of Revenue due to abolishment of excise duties, Rs/ha.						
		PVC (Rs./kg.)	HDPE (Rs./kg.)	LLDPE (Rs./kg.)	PP (Rs./kg.)	Nylon (Rs./kg.)	Others (Rs./kg.)	Total
Drip Irrigation Systems								
1	Widely Spaced	507	0	900	39	3	2	1451
2	Closely Spaced	748	0	2016	227	4	2	2991
Sprinkler Irrigation System		0	792	0	0	0	2	794

The total revenue loss to the Government on abolishment of excise duty will be to the tune of Rs. 2479.00 crores (Table 8.20).

**Table 8.20 Total loss of revenue to Government due to abolishing excise duty
(for 75% requirement of MI industry)**

S.No.	Category	Total area, (M ha.)	75% area likely to be using domestic raw matl.,mha	Rev. loss (Rs./ha)	Rev. loss (Rs. in crore)
1.	Drip Irrigation				
	Widely Spaced	4.44	3.33	1451	483
	Closely Spaced	7.56	5.67	2997	1699
2.	Sprinkler Irrigation	5.00	3.75	794	297
	Total	17.00	12.75		2479



With the waiver of all the taxes, the cost reduction of microirrigation systems is expected to be of the order of 8 to 10 percent.

BALANCE SHEET ON INVESTMENTS TO COVER 17 M.ha BY XI PLAN

S.No.	Particulars	Amount, Rs. crore
Investments		
1.	Gol Share @ 40% as assistance	24,600.00
2.	Corpus for institutional support, data base, monitoring	600.00
3.	State Govt. share @ 10%	6,150.00
4.	Farmers contribution 50% as Own contribution or bank credit	30,750.00
5.	Sub Total	62,100.00
6.	Loss due to abolishing Excise duty Import duties	2,645.00 2,479.00
7.	Total loss due to abolishing Excise & Import Duties	5,124.00
8.	Total Investments	67,224.00
Benefits		
9.	Value of 59 BCM water saved	45,000.00
10.	Savings in electricity	3,800.00
11.	Savings in fertilizer	18,000.00
12.	Income due to increased Production	63,883.00
13.	Total Benefits	130,683.00
14.	Net Benefits	63,459.00

- Net benefit will be Rs.63,459 crores over a period of 8 years,
- Employment generation for 21 million people during the project period and thereafter employment to 5 million people any annually.
- Substitution of import of oil seeds and pulses.
- Enviromental benifit in terms of less ground water pollution.



CONCLUSION

Microirrigation led agriculture, armed with knowledge and technologies, with farmer as centre point, should be viewed as one of the eco-technological approaches to attain sustained and enhanced agricultural production and productivity. The technology is bound to maximize the synergistic interactions of improved seeds, water and fertilizer – the three components of the Green Revolution. Through microirrigation, the Green Revolution could be transformed into an Evergreen Revolution to ensure the congruence of sustainability, productivity, profitability and equity. Since microirrigation greatly enhances water, fertilizer and energy use efficiency and promotes precision agriculture, the Evergreen Revolution could be achieved without the burden of environmental degradation.





LIST OF ANNEXURE

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ACTION PLAN FOR TASK FORCE ON MICROIRRIGATION

Sr. No.	ACTIVITY	Date	Remarks
1.	Open Web page seeking suggestions to achieve objectives of Task Force	5.8.2003	Web page launched by NIC on 01.08.2003 (http://agricoop.nic.in)
2.	First Meeting of Task force at Delhi (A.P.Bhavan)	21.8.2003	Held as per schedule.
3.	Second Meeting of Task Force at Mumbai	12.9.2003	Meeting could not be held due to preoccupation of Chairman.
4.	Visit Jalgaon	04.09.03	Chairman of TF visited Jalgaon to see progress under microirrigation and interact with farmers and industry.
5.	Visit Israel	15- 18.09.03	Chairman of TF visited Israel during 15-18 Sept., 2003 to see the development made in microirrigation and agriculture exhibition AGRITECH
6.	Second Meeting at Hyderabad	25 .9.2003 & 26.9.2003	● Presentation of views of States by Secretary Hort./Agri all States ● Presentation of views by Agricultural Experts ● Presentation of views by progressive farmers' ● Presentation of views by Industry representatives Meeting was held as per schedule.
7.	3 rd Meeting at Hyderabad	24.11.2003	Discussions with: ● Bankers ● Farmer representatives ● Industry representatives ● Agricultural Experts from Research Institutes/SAU of Maharashtra
8.	Fourth Meeting at Delhi	15.12.2003 Forenoon	Discuss draft report
9.	Consultation with Union Agriculture & Finance Ministers	15.12.2003 Afternoon	
10.	Finalisation of report by Chairman	09.01.2004	
11.	Presentation of Final Report to FM/PM		



**MINUTES OF THE FIRST MEETING TASK FORCE ON MICROIRRIGATION
HELD AT A.P. BHAVAN, NEW DELHI ON 21ST AUGUST, 2003**

The Task Force on Microirrigation constituted under the Chairmanship of Chief Minister N. Chandrababu Naidu to suggest the strategies to increase the coverage of area under microirrigation in the country met on 21.08.2003 at Andhra Pradesh Bhavan, New Delhi.

The meeting commenced with a formal welcome to the Chairman and the Members by Dr. H.P. Singh, Horticulture Commissioner & Member Secretary of the Task Force. The Chairman of Task Force, N. Chandrababu Naidu, honorable Chief Minister traced back the genesis of constitution of Task Force and said that Task Force was constituted based on his discussions with the Hon'ble Prime Minister regarding improving the economic condition of the farmers and achieving higher growth rate in agriculture. Mr. Naidu had mentioned to the Prime Minister that efficient water management assumes a great importance and there is a need to promote efficient means of irrigation, like drip and sprinkler irrigation. The Prime Minister requested him to work out the details for promoting the microirrigation in the country, which he accepted. Mr. Naidu, further mentioned that water is crucial for increasing productivity of crops and all efforts need to be made to use it judiciously for improving the economy of the farmers. The aim should be to achieve an evergreen revolution with integration of post harvest management, value addition and marketing. Since more than 65% of the Indians are dependent on agriculture, their purchasing power needs to be increased by improving their economic condition. He stressed the need for bringing out a report, which is implementable and practical. He sought the views of the Members to achieve the goal of the TF.

Dr. H.P. Singh, HC & MS, in his presentation highlighted the initiatives taken by the Government in promoting microirrigation in the country. He elaborated the benefits of microirrigation for water saving and improving quality of produce. He mentioned that the initiatives taken by the Government has resulted in widespread awareness about the usefulness of the technology. He also highlighted the constraints and problems, which is confronting the accelerated development of the technology in all parts of the country and also stressed the need for integrated efforts having horizontal and vertical integration.



The highlights of his presentation are summarised below:

1. Microirrigation provides the most viable option for economizing water use and improving crop productivity per unit of area as well as time. Hence this technology need to be promoted extensively.
2. Presently, only about 0.50 million ha has been covered under microirrigation against a potential of 27 million ha.
3. The available institutional mechanism in the form of National Committee on Plasticulture Applications in Horticulture (NCPAH) has been instrumental in operationalizing the GOI Scheme on Plasticulture in general and in popularizing the microirrigation technology in particular.
4. The network of 17 Precision Farming Development Centres (PFDC) has enabled to develop regionally differentiated technologies on microirrigation besides imparting training to a large number of farmers and departmental staff.
5. An area of about two million ha could be brought under microirrigation in the country in the next five years.

Dr. S.K. Goel, Commissioner Agriculture, Government of Maharashtra presented the efforts made by the State Government as a result of which they have emerged as the leading State in the adoption of microirrigation technology in the country. He also mentioned that the efforts made by them to take up large projects based on imported technology from Israel did not succeed because it was not attuned to the needs of Indian farmers. He also said that assistance for microirrigation should be treated as investment especially to encourage small and marginal farmers. He also offered suggestions with reference to various Terms of References, which are summarised as follows:

1. Subsidy assistance should be extended to only viable crops.
2. The taxes on drip and sprinkler irrigation components need to be reduced.
3. Microirrigation should be made compulsory in the command areas.
4. Microirrigation should be implemented as an integrated project.
5. Water users societies /federations should be promoted at State and National level.



6. Mechanism and institutional arrangements need to be created for ensuring quality assurance of microirrigation components.
7. Sound infrastructure need to be created for training.
8. Research institutes dealing with microirrigation need to be strengthened.
9. Institutional finance should be extended on priority basis to farmers who adopt microirrigation technology.

Dr. V.P. Jauhari, Principle Secretary, Government of Andhra Pradesh described the efforts made by the State Government in promoting the microirrigation in the state. The presentation was supplemented by Shri J.S.V. Prasad, Commissioner, Horticulture, Government of Andhra Pradesh, who highlighted the efforts made through the Central Government assistance as well as through the Indo-Israeli project in Kuppam. The State Government has introduced an effective mechanism for monitoring the programme for effective delivery of technology. He highlighted that integrated approach is essential instead of focusing on microirrigation in isolation. Some of the highlights of the suggestions are summarised below:

1. Microirrigation should be promoted in an integrated manner by integrating the production technologies also.
2. The microirrigation system manufacturers should also guide the farmers in adopting suitable agronomic practices along with microirrigation.
3. There is need to step up the assistance to the level of 50% of the system cost, particularly for the small & marginal farmers.
4. Efforts should be made to ensure the production and supply of good quality microirrigation system to the farmers by enforcing strict quality control measures.
5. A sound institutional mechanism needs to be created for overseeing the development of microirrigation.

Shri B.H. Jain highlighted the importance of microirrigation for judicious use of water resources and stressed the need for granting infrastructure status to microirrigation industry so that the industry could avail the benefits. The Chairman requested Shri B.H. Jain to give details of some successful projects implemented by them. Mr. Jain



mentioned that projects have been implemented in various parts of the country by adopting integrated approach. He invited the Chairman and Members of the TF to visit Jalgaon to see their farm and the progress made by the farmers in adopting microirrigation technology there. The Chairman accepted the invitation and mentioned that he would visit Jalgaon on the 6th of September, 2003. He also requested the Members of the TF to accompany him during the visit to Jalgaon. Brief highlight of the suggestions made by Shri Jain are as follows:

1. Microirrigation should be granted infrastructure status for enabling the industry to avail institutional financing.
2. Since about 60% of microirrigation is based on wells, attention need to be paid for recharging the ground water.
3. Microirrigation should be made an integral part of all irrigation projects.
4. Taxes, duties, octroi and local taxes on microirrigation systems should be reduced.

Shri Govindrao Adik, Minister of Agriculture, Government of Maharashtra mentioned that water management is the need of the hour because scarcity of water is increasing day by day. Microirrigation is the only solution. Although Maharashtra has taken a lead, much needs to be done. The State is experiencing frequent droughts. He cited the example that one acre coverage of area under the conventional method of irrigation for sugarcane can be extended to 5 acres under microirrigation. He further mentioned that with the promotion of microirrigation, 100% of the area could be brought under irrigation. About 30% of the cost of the microirrigation system is on raw material while 70% of the cost is on other aspects like overhead charges, tanks etc. Ways and means need to be found to reduce the cost of the system to make it affordable to the farmers. After sales service is lacking, which need to be organized. He also suggested to treat microirrigation as infrastructure for agriculture.

Shri J.N.L.Srivastava, Ex Secretary, DAC mentioned that considerable area has come under sprinkler irrigation, particularly for oilseeds and pulses in the States of MP, UP, Rajasthan, Maharashtra and Andhra Pradesh. He suggested the need for having interaction with the farmers. He also suggested for coopting Secretary (A&C) as a Member of Task Force. He emphasised the need for a strong institutional mechanism for overseeing the development of microirrigation in the country. He also mentioned



that treating microirrigation in isolation may not yield the desired benefits. End to end approach with integration of farming systems, post harvest management and marketing is essential. The objective should be to achieve precision farming for deriving best results with judicious use of resources.

Dr. M. Velayutham, MS Swaminathan Foundation, Chennai expressed the need for developing different models for catering to the needs of target groups like resource poor farmers, resource rich farmers, peri urban areas etc. He also suggested the need for extending assistance to the farmers in phases. Shri J.N.L. Srivastava informed that presently under the ongoing Schemes this aspect has been taken care of since the assistance available to the farmers is limited for four ha per beneficiary family.

Shri S.K. Mitra, Executive Director, NABARD mentioned that there is need to mobilise large scale adoption of microirrigation programmes in the country. The Andhra Pradesh Microirrigation Project (APMIC) is a model in which RIDF has been availed. He also supported the need to grant infrastructure status to microirrigation.

The Chairman appreciated the suggestions offered by the Members. He further mentioned that microirrigation technology will have to be promoted extensively for increasing productivity of crops and thus improve the economic condition of farmers. He suggested the need for a sound Institutional mechanism for efficient delivery of microirrigation technology throughout the country. Mr. Naidu further set a deadline of 60 days to finalise the report of the Task Force.

The decisions emerging from the deliberations are summarised below:

1. The Members should give their feed back to the Member secretary in writing within ten days with reference to the TOR. Based on the inputs received from the members, draft report would be prepared and circulated to the Members.
2. The Members of the TFM may hold State / Regional level consultations at different locations to get the views of the farmers and give their feed back during the next meeting of TFM.
3. Chief Minister, Andhra Pradesh would visit Jalgaon on 6th September, 2003 to see the progress of microirrigation there. The Members of TFM may also join during his visit.



4. Minister of Horticulture, Government of Maharashtra would be co-opted as a Special invitee of the TF. Similarly, Secretary (A&C) will also be co-opted as Special invitee.
5. It was resolved to constitute sub-committees to hold detailed discussions and come up with suitable strategies and recommendations for the approval of the Task Force. The sub-committees are
 - (i) Sub-Committee on provision of credit to Microirrigation Sector.
 - Quantum of credit needed for the sector
 - Simplification of procedures
 - Reduce rate of interest including a uniform interest rate across all banks for this sector.
 - (ii) Sub-Committee on Fiscal incentives to MI Sector.
 - Custom duty waiver on raw materials and machinery.
 - Excise duties exemption on raw materials.
 - Sales Tax exemption on MI Systems and components.
 - Granting Infrastructure Industry Status to MI Sector.
 - (iii) Sub-Committee on Technology issues of MI Sector.
 - Use of Fertigation system as an essential component of MI system
 - Fixation of stringent/better standards for MI components manufacturer etc.
6. The Chairman would be visiting Israel on 15.9.2003 to participate in the Agriculture Exhibition there. The Member Secretary of TFM may also accompany him to see the development of microirrigation made by Israel.
7. The Member-Secretary will prepare first draft of the Report incorporating the suggestion in the first meeting and shall communicate to all the Members for comments. The report will be updated periodically as per the progress made by the Task Force.
8. The next meeting of the TF would be held at Mumbai on 12th September, 2003. Commissioner Agriculture, Government of Maharashtra would make the necessary



arrangements for convening the meeting. Representatives of farmers, Industry, State Agricultural Universities, ICAR and other institutions would also be invited to attend this meeting.

9. The third meeting would be convened in the form of a Workshop on 25th & 26th of September, 2003 at Hyderabad wherein Horticulture/Agriculture Ministers, representatives of the State Governments, Agriculture Experts, progressive farmers, industry would be invited.
10. The draft report would be finalised by 9th October, 2003 after having consultations with Agriculture Minister, Finance Minister, Minister of Food Processing Industries. The meeting ended with a vote of thanks to the Chair.



MINUTES OF THE VISIT OF SELECTED MEMBERS OF TASK FORCE ON MICROIRRIGATION TO PLASTIC PARK, JALGAON ON 4TH SEPTEMBER, 2003

The Task Force on Microirrigation constituted under the Chairmanship of Chief Minister Shri N. Chandrababu Naidu to suggest the strategies to increase the coverage of area under microirrigation in the country met on 4 September, 2003 at Jain Hillis, Jalgaon.

The meeting commenced with a formal welcome to the Chairman and the Members by Dr. H.P. Singh, Horticulture Commissioner & Member Secretary of the Task Force. The Chairman of the Task Force accompanied by other Members including Shri J.N.L. Srivastava, Ex. Secretary, Ministry of Agriculture and Dr. H.P. Singh, Member Secretary and Horticulture Commissioner, Shri Satish Chandra, Special Secretary, Government of Andhra Pradesh, Shri V.P. Jauhari, Principal Secretary, Government of Andhra Pradesh, Shri S.K. Goel, Commissioner Agriculture, Government of Maharashtra and J.S.V Prasad, Commissioner of Horticulture, Government of Andhra Pradesh, visited Agri Park, Food Park and Plastic Park and saw the facilities and infrastructure available. Thereafter, the Chairman addressed the press and briefed them about the aims and objectives of the Task Force on Microirrigation. He emphasised the need for judicious use of water for improving the agrarian economy. The Chairman appreciated the efforts made in promoting microirrigation in the region and efforts made for efficient utilisation of water in the arid region of Jalgaon as a result of which the dry tracts have become green belts. He also appreciated the integration of technologies like tissue culture, fertigation, post harvest management and processing. The Chairman mentioned that microirrigation should not be treated in isolation but should be integrated with agronomic practices for deriving maximum benefits and uplifting the agrarian economy. He also briefed and discussed his visit to Jalgaon in the wake of his proposed visit to Israel.

The Chairman expressed his happiness on integration of technologies at the grassroot level which has brought prosperity in the region. He advised that such models should be set up across the country with focused attention on water deficit regions of the country. He declared setting up of two such models in Andhra Pradesh and invited entrepreneurs to take up opportunity and harness the potential that exists.



Dr. H.P. Singh, Member Secretary and Horticulture Commissioner highlighted the initiatives taken by the farmers in the region for promoting microirrigation. He elaborated the benefits of microirrigation for water saving and improving quality of produce. He mentioned that the initiatives taken by the Government has resulted in widespread awareness which has resulted in adoption of the technologies at the grassroot level and thereby higher yield of the horticultural produce.

Shri J.N.L. Srivastava, Ex Secretary, DAC, visited Jain Food Park, Jain Plastic Park and Agri Park and saw the work being carried out. He expressed satisfaction on the initiatives taken by the state government for successful implementation of drip irrigation in the state. He emphasised the need to develop such models for the other parts of the country.

The agriculture minister of Manipur Shri R.K. Thekho, who could not join the Task Force in the morning due to unavailability of connecting flight, also visited the Jain Hills. He was also taken on field visits to near by farms to show the impact of microirrigation on the agrarian economy in the region. He was quite impressed with integration of technologies and suggested that such systems should be created in his state also. He invited the entrepreneurs to setup such microirrigation models in his state.



Annexure IV

Minutes of the Second Meeting of Task Force on Microirrigation held under the Chairmanship of Shri N. Chandrababu Naidu, Chief Minister, Government of Andhra Pradesh on 25th September 2003 at Hyderabad

The second meeting of the Task Force on Microirrigation (TFM), held at Hyderabad on 25th September, 2003 under the Chairmanship of Shri Chandrababu Naidu, had participation of TFM Members, representatives of states, industries and experts. The participants included Agriculture/ Horticulture Ministers from the States of Andhra Pradesh, Gujarat, Karnataka, Manipur, Sikkim and Pondicherry, Vice-Chancellors and Scientists from State Agriculture Universities (SAUs), Indian Council of Agriculture Research (ICAR), representatives of Irrigation Association of India, Presidents of Grower Associations, and Officials of Government of India. The meeting was held both in the forenoon and afternoon. The meeting discussed various issues in three groups and the recommendations of the groups were further discussed to develop recommendations.

The Chairman, in his introductory remarks, gave a brief overview about the decisions taken during the first meeting of TFM on 21.8.2003 and about the visit to Jalgaon and Israel. Mr. Naidu reiterated the need for bringing out recommendations, which are practical, cost effective and implementable. He also reiterated the objectives of the task force and said that the report should contain implementable recommendations for wider adoption of microirrigation by the farmers. Citing the example of Israel, he said that compared to Andhra Pradesh, Israel is a very small country, but they have taken measures for utilizing every drop of water and now they have emerged as world leaders in hi-tech agriculture, although only about 3% of the population depend on agriculture, a sector which contribute only 1% to their GDP. The country has paid focused attention for the development of technologies and microirrigation based agriculture has converted desert into productive zones. In India, with the growth of population and decrease in green cover, the rainfall pattern has become erratic and climate changes are seen. Droughts have become frequent and water sources are declining. In such situations, life saving irrigation can save the crop and the farmers can protect their investment. This is possible only by conserving the water, recharging the sources and utilising the water judiciously. With these remarks, he requested Dr. H.P. Singh to highlight the proceedings of the forenoon discussions.



Dr. H.P. Singh, Horticulture Commissioner and Member Secretary of Task Force presented the brief of the discussions, and the points which emerged during the discussion. Dr. Singh informed that presentation was made covering the need for microirrigation, experience in other countries, visit of Task Force to Israel, and action taken. He also informed about the presentation made by Maharashtra, wherein Dr. Goel informed that non-functional system ranges from 0 to 4 percent attributable to various reasons. Presentation made by Mr. Jauhari, had given details of monitoring system of Andhra Pradesh Micro Irrigation Project (APMIP). The points which emerged from discussion are:

- ❖ The model of monitoring mechanism in the pattern of APMIP for monitoring the scheme could be adopted with suitable modification at the national level, which could be in an interactive mode.
- ❖ Microirrigation should be seen as holistic approach for having horizontal and vertical linkages, for production, value addition and marketing.
- ❖ To make microirrigation adaptable, there is need to reduce the cost of the system by improving the design and also tax concessions. Assistance for microirrigation should be 50% of the cost, as was prevalent during the Ninth Plan.
- ❖ The assistance should be administered through a transparent system, preferably by way of credit linked back-ended subsidy mode.
- ❖ Since, microirrigation is an approach to improve the economy of farmers it should be given infrastructure status.
- ❖ To achieve the objectives of microirrigation, there is need for skill upgradation, monitoring, information support etc., therefore, apex organisation having state level linkages and linkages with farmers through service providers should be set up.
- ❖ The Central Institute of Plasticulture Engineering Technology (CIPET), Chennai, should be brought under the MOA for ensuring supply of good quality material to the farmers, who constitute a large proportion of consumers of plastics.
- ❖ Microirrigation should form a package alongwith water source development and recharge of well s through Watershed Management. The credit support for developing water sources like well/tube well should also be included for support alongwith microirrigation.



- ❖ RIDF loan from NABARD needs to be tapped for covering expenditure on subsidy component of microirrigation by concerned States.
- ❖ The SAUs/PFDCs should convene state level consultations with farmers and stake holders and send feedback to the TFM at the earliest, for consideration in next meeting.
- ❖ The Members and participants of the meeting would send their feedback to TFM at the earliest.

Dr. Singh also informed about action taken report and action plan. It was also proposed to convene the 3rd meeting of the TFM at Mumbai on 21.10.2003 in which the bankers, apart from the Members of TFM would be participating. It was also proposed to submit the final report by 14.11.2003 after the 4th meeting at New Delhi on 4.10.2003.

Shri R.C.A. Jain, Secretary (A&C) in his remarks mentioned that if the entire potential areas of about 69 million ha were to be brought under microirrigation in the country, an investment to the tune of Rs. 2,50,000 crores would be needed, stretching over a period of time. The TFM should keep this aspect in view and recommend a plan of action for sourcing the funds. The best option for extending the assistance to the farmers, based on past experience, is through credit linked back-ended subsidy. This will reduce the transaction cost. Efforts would be needed to make the system affordable to the farmers as in the case of electronic industry. When the scheme for promoting microirrigation was introduced, the subsidy levels were quite high. Currently, the subsidy has been reduced to the level of 25% based on the decisions of the Government while approving the Macro Management Scheme. He also suggested that microirrigation should form a package along with water source development and recharge. Watershed development programmes having water resource conservation and development activities should be dovetailed with microirrigation for best use of the harvested water. Though this may increase the cost, it will be very useful in the dryland areas in the long run. He also suggested the need to have proper marketing linkages of produce preferably by adopting contract farming approach. He also cited the good example of availing RIDF loan under the APMIP for meeting the subsidy component under the project. This experiment could be replicated. He also mentioned that the Cooperative Banks will have to play a major role in promoting microirrigation. There is need to revitalize the Cooperative Banks, which are not in a good shape presently. A Rs.14,000



Crores package is on the anvil for the same. Shri Jain also suggested the need to have a strong institutional mechanism for overseeing the development of microirrigation in the country. He also suggested that Central Institute of Plasticulture Engineering Technology (CIPET), Chennai should be transferred to the MOA for ensuring supply of good quality material to the farmers, who constitute a large proportion of consumers of plastics.

The Chairman, reacting to the remarks of Shri Jain, mentioned that presently investments of the order of Rs. 3000 – Rs. 4000 Crores are being made annually for water resource development. There is need to make best use of the investments being made by judicious use of water. The cost of command area development works out to about Rs. 1.00 lakh/ha. With microirrigation, the investment is only to the tune of Rs. 20,000/ha, hence there is much saving. He suggested to the participants to offer some serious thoughts to such issues by convening State level consultations. The PFDCs/SAUs need also to conduct such consultations with the Stake holders and give feed back to TFM. The chairman observed that funds for support to microirrigation has to be made available and wanted to know the resources. He desired to examine the possibility of levying import cess on pulses, oilseeds and horticultural produce.

Shri J.N.L. Srivastava, Ex Secretary (A&C) briefly highlighted the results of the State level interactions he had with the farmers and officials in the States of Rajasthan, Punjab and Uttar Pradesh. In Punjab and U.P., although the people say that there is abundance of water, the reality is that they are also facing water shortage during critical periods of crop growth. There is a great demand for horticultural crops in these States which respond well to microirrigation in terms of yield enhancement and quality improvement. One of the main features of microirrigation was that it helps to save electricity charges. In Punjab, farmers were facing some technical problems. The horticulture development in the state is being looked after by the Horticulture Department while the microirrigation part is being implemented by the Soil Conservation Department. The staff of Soil Conservation Department needed training on horticultural aspects. He said that while drip irrigation was ideal for horticultural crops, sprinkler irrigation need to be adopted for oil seeds and pulses. He expressed that microirrigation should not be considered in isolation but an integrated approach should be adopted. There should be a strong research backup. The SAUs need to pay more attention on this aspect. There is also a need for smooth flow of credit. Convergence is needed with watershed management



programmes and microirrigation. In Rajasthan, large areas are under sprinkler irrigation and it has helped to increase the productivity of peas and castor in various parts of the State.

In continuation, Shri Srivastava also presented the recommendations of the Sub-Group on Fiscal Incentives for microirrigation, which are as follows:

- ❖ An Integrated Approach for use of microirrigation systems which comprises of hardware and software services would ensure good quality services to the farmer for supply of quality material, regular and proper after sales service at competitive prices. Therefore, efforts should be made for adopting an integrated approach to microirrigation.
- ❖ The burden of Sales Tax, Trade tax, Purchase tax etc of the system amounts to 8-10% per ha. The total burden of sales tax exemption works out to be Rs 3000 to 4000 per ha. Since the system is being promoted in rain fed areas and also as a part of the diversification of agriculture and optimum utilisation of scare resources like water, such exemption is necessary.
- ❖ Whenever the VAT is implemented, this tax should be 0%.
- ❖ The microirrigation system as defined above should also be out side the purview of the service tax. Moreover, local taxes like Octroi, entry tax etc. may also be exempted
- ❖ As far as Excise duty is concerned, microirrigation system including its components namely, lateral, tubing, main pipeline, sub main pipeline, filtration equipment and its automation, fertigation equipment or any other system used for the purposes of applying fertiliser along with microirrigation and such other accessories and fittings that go as a package along with microirrigation system be exempted from taxes. As a package all such items must be exempted from Excise duty.
- ❖ Microirrigation industry should also be declared as an Infrastructure industry so that it can grow to its inherent capacity. It should be ensured that the benefit arising out of tax concessions is passed on to the farmer.
- ❖ Microirrigation equipment should be taken as a prime security for loan purposes and not treated as moveable property. Pledging of land should not be a necessary condition.



- ❖ The present National Committee on Plasticulture Applications in Horticulture (NCPAH) should be converted into an autonomous body or Board with adequate financial support from Government as well as producers of raw material and processors. The corpus from the private sector can be raised by levying a suitable cess on such producers/processors.
- ❖ Such an autonomous body or board would be a professional body with Government playing the role of facilitator. The corpus for it should be about Rs. 100 Crores. It can be named as National Precision Farming Board or National Microirrigation Board.
- ❖ The National Board could also mobilise funds from National, International Financial Institutions, Inter ministerial budgetary allocations, etc for implementing the promotional schemes and for activities such as:
 - a) Promoting awareness, training, extension, capacity building of farmers, experts.
 - b) Testing, accreditation, quality certification and standardization of hardware.
 - c) Evaluation and monitoring of software services and assessment of capacity of individual processors.
 - d) Building National Data Base for capacities, services, crop coverage, etc.
 - e) Promoting indigenisation, adoption of regionally differentiated technologies, at National Level.

Dr. M.R. Sharma, while presenting the recommendations of the Sub-Group on credit to microirrigation highlighted the following:

- Timely availability of the credit is crucial to the farmers, hence this needs to be ensured.
- The interest rate on loans should not be more than 9%.
- Credit should be made available to the microirrigation system as a whole, which includes borewell construction, water storage tank, watershed development etc.
- In order to ensure the proper utilisation of the credit the backended subsidy should be given.
- The Rural Infrastructure Development Fund can also be used to take the loan for the promotion of microirrigation as it has been done in case of Govt. of Andhra Pradesh. This type of model can be replicated by other States.



- Sugar Development Fund (SDF) also can be tapped for the development of microirrigation systems in case of sugarcane.
 - The stamp duty should be waived off in case of land mortgaging by the bankers.
 - The fund should also be made available to the microirrigation system programme by the state Cooperative Bank & Regional Rural Banks. In order to make them eligible revitalization programme should be on top priority.
 - Awareness programme should be made on the lines of Govt. of Andhra Pradesh.
 - The collateral should be taken only on land and there should not be any additional collateral.
 - Augmentation of the technical officers in the banking industry especially in rural areas where there is a scope for microirrigation.
 - In order to ensure the recovery of loans, emphasis should be given to contract farming.
 - Memorandum of Understanding should be signed between Government and equipment suppliers, and working agreement between Bankers, Government, Suppliers & Farmers.
 - Design of the system should be verified by a suitable external agency, to help the bankers to give the required amount of credit.
 - To ensure the smooth flow of credit all the financial transactions such as contribution of margin money, subsidy and sales proceed should be routed through the banking system.
 - Banks should extend credit to the microirrigation systems on priority basis.
- Dr. H.P. Singh, in his presentation on recommendations of the Sub-Group on Technological support for microirrigation summarised the following:
- Technological support should be continued for design upgradation of the system and for crop management in a regionally differentiated manner depending upon crop, soil and climate.
 - Microirrigation has to be adopted for horticulture and row crops whereas sprinkler irrigation could be adopted for pulses and oilseeds.



- Online type of microirrigation could be adopted in general for Horticultural crops and inline dripper system should be recommended to farmers, who have gained experience in microirrigation technology.
- Precision irrigation, specially pulse irrigation should be promoted in water scarce areas.
- Technology development has to be in an integrated manner with the involvement of farmers, scientists and system manufacturers. Service providers should be involved in the districts and suitable mechanism should be devised for inflow & outflow of information, which can be supported initially and later on it would sustain on its own.
- Large scale demonstrations of microirrigation technology have to be taken up at strategic locations with the involvement of the farmers. Operational Research Projects may be taken up in each State.
- Training of farmers should be organized from time to time both about microirrigation and agronomic practices. Training manuals need to be brought out in regional languages.
- The existing PFDCs need to be strengthened and selected PFDCs should function as quality testing centres.
- Standards need to be developed on microirrigation components, which are not existing, and notified.

The Chairman, reacting to the presentation of the Sub-Group, said that interest rate of 9% for loans on microirrigation is too high. It had to be brought down to 6%. He suggested that the bankers including cooperative banks, SBI, RBI, Banking Federation should have discussions on this and suggest their recommendations. The NABARD could take the lead in convening the meeting of bankers. He suggested that the banker should be involved in the meeting to be held at Mumbai.

Shri B.H. Jain, JISL, Jalgaon suggested that possibility of lease financing for microirrigation firms to provide credit support, like in case of cars. However, such leasing firms have to be provided incentives. The Chairman said that this aspect needs to be discussed thoroughly.



Shri Totey, President, Orange Growers Association of India expressed the need for proper after sales services of microirrigation sets. The Chairman mentioned that under APMIP there is a provision for 5 years guarantee and maintenance. Shri Mritujanaya, President, Irrigation Association of India said that there is a need to reduce the cost of the system and interest rate on bank loans for microirrigation. He also said that 50% subsidy assistance to the farmers should be restored. Whenever ground water is being used for irrigation, microirrigation should be made compulsory.

Dr. S.K. Goel, Commissioner Agriculture, Government of Maharashtra said that there is a need to link production with processing and bulk consumers of products through market linkages by the manufacture of microirrigation sets. He also suggested the need for promoting microirrigation systems developed through locally made devices. Responding to the suggestion, the Chairman referred to his discussion, which he had in Israel with Drip manufacturers and said that manufacturer cannot take the responsibility of marketing the produce. He also mentioned about the experiment at Kuppam, which involved a huge investment in the initial stage and now has been brought down considerably in the IIIrd phase. The Chairman also suggested the need for developing a knowledge website on microirrigation. There is also a need for standardising the system design and link it with cost, which should be simple to be understood by the farmers. He also desired to have 10-12 model designs which could fit in varying situation.

Dr. M.R. Sharma, Principal Advisor, NABARD mentioned the need for research in Water Use Efficiency (WUE) by integrating mulching with microirrigation. Dr. Vasantakumar, Director of Horticulture, Karnataka stated that a project approach needs to be followed for promoting microirrigation. Moreover, a mixed cropping pattern should be adopted by the farmers, as large areas brought under microirrigation without ascertaining the capacity of the water source would create problems at a later date. He also suggested the need for trials of soil gels, which can increase the water retaining capacity of the soil. Dr. M. Velayutham, M/s Swaminathan Foundation, Chennai mentioned that existing WALMIs may be entrusted with the responsibility of training on microirrigation technology. Technical graduates could be entrusted with the task of operating microirrigation systems for group of farmers.

On a query by the Chairman about the suitability of the term 'microirrigation' Dr. Ahlawat, Director of Horticulture, Haryana suggested that 'Precision irrigation' could be a more



appropriate word. The Chairman said that more thought need to be given on this term to accommodate drip and sprinkler irrigation methods. He also asked Mr. B.H. Jain, details about other countries where large scale microirrigation projects have been implemented. Shri Jain mentioned that Saudi Arabia has covered above 0.5 million ha. He also mentioned that exhibition is going on in China, where they have put up a stall.

In conclusion, the Chairman thanked all the Ministers and participants. He requested them to give their feed back to the TFM at the earliest so that implementable report could be prepared.

The main decision of the deliberations of the meeting are as follows:

1. Microirrigation need to be promoted in a holistic manner involving good agronomic practices having end-to-end approach. Water source development and recharge of wells through Watershed Management should also form a part of the package. For effective monitoring of the programme APMIP model could be adopted with suitable modification at the National level.
2. Since microirrigation enhances the productivity, improves quality of produce and conserve water it has to be promoted extensively. High initial cost of the microirrigation system makes it unaffordable by most of the farmers. Therefore, the assistance for microirrigation should be restored to the level of 50% of the cost, as was prevalent during the Ninth Plan.
3. The assistance should be administered through a transparent system, preferably by way of credit linked back-ended subsidy mode. The interest on credit for microirrigation should not be more than 6 percent. RIDF loan could be tapped for meeting the expenditure on subsidy component of microirrigation.
4. At the grass root level there should be service providers to address the local problems relating to microirrigation. At the National level an Apex Body need to be constituted for overseeing the development of the microirrigation and related sector which will have the function to oversee the promotion of microirrigation through skill upgradation, information data base and monitoring.
5. Extensive research needs to be conducted for reducing the cost of microirrigation systems by improving the design aspects. The Precision Farming Development



Centres (PFDCs) need to address the issue along with the system manufacturers. Similarly, the PFDCs need to be involved in quality testing of microirrigation products in a regionally differentiated manner. Some of the PFDCs need to be strengthened and equipped for undertaking this task. Besides, the Central Institute of Plasticulture Engineering Technology (CIPET), Chennai, should be brought under the MOA for ensuring quality assurance and designing.

6. For meeting the cost of microirrigation programme, the possibility of levying an import cess for the import of oilseeds, pulses and horticultural produce needs to be explored. The matter needs to be discussed further after getting data on the quantity and value of import of these commodities.
7. There is a need to workout a mechanism for implementation of tax concession, if given, to raw materials of microirrigation systems and components.
8. Appropriate standards for the drip components require to be developed and notified for the certification.
9. In order to have information flow, a portal on microirrigation is required to be launched which should contain all the information.
10. State level consultation may be organised by the PFDCs/SAUs and feed back sent to TFM.
11. The Members should give feedback on the term 'microirrigation'
12. The first draft report of TFM has been circulated to the Members of the TF for their comments. The Members may give their comments, if any, for further updating the report. The Third meeting of the TFM would be held at Mumbai on 21.10.2003. NABARD and Commissionerate of Agriculture, Pune would provide logistic support for the meeting. The 4th meeting of TFM will be held at New Delhi on 4.11.2003 and the final report would be presented by 14.11.2003.

The meeting ended with a vote of Thanks to the Chair.



Minutes of the Third Meeting of Task Force on Microirrigation held at Hyderabad on 24.11.2003

The third meeting of the Task Force on Microirrigation (TFM) held under the Chairmanship of Shri N. Chandrababu Naidu, Chief Minister of Andhra Pradesh at Hyderabad on 24th November, 2003, was attended by the Members of TFM, representatives of Banks, representatives of SAU/ICAR Institutes in Maharashtra and Microirrigation industry. As desired by the Chairman, the Member Secretary requested, Senior Member of TFM Shri J.N.L. Srivastava, to conduct the meeting till Chairman joins the meeting.

In his introductory remarks, Shri Srivastava mentioned about the progress made in developing the recommendations for TFM and this meeting has to discuss modalities for credit support for microirrigation. He requested Dr. H.P. Singh, Horticulture Commissioner & Member Secretary to highlight the current status on the work done by TFM. Dr. H.P. Singh highlighted the action taken on the decisions of the second meeting of TFM held at Hyderabad on 25.9.2003 and mentioned that Task Force has unanimously agreed that large scale adoption of microirrigation is inevitable for reducing risk in agriculture, to achieve improvement in economic status of Indian farmers. A total area of 69 million ha will have to be covered under microirrigation in a phased manner. In X Plan, 3 M ha (2 M ha drip + 1 M ha sprinkler) is proposed to be brought under microirrigation and during XI Plan 6 million ha could be covered. He also mentioned about the action taken on the recommendations of last meeting, and said that credit support would be essential for success in adoption of microirrigation and requested the bankers for their support.

Shri R.C.A. Jain, Secretary (A&C) remarked that while the interest rate on bank loans have been reduced to 9%, a ceiling limit of Rs. 50,000 has been fixed. This limit shall not encourage hi-tech agriculture, which needs high capital investment and requested representative of Banks on the feasibility of increasing this limit, and the scope for reducing the rate of interest further for the microirrigation sector.

Representative from SBI mentioned that the SBI have reduced the interest rate to 8.75% but the ceiling is limited to Rs. 50,000. Representative of ICICI Bank mentioned that there is a high risk factor for repayment of loans for microirrigation, as compared



to housing and car loans. The repayment period for housing and car loans is fairly long and is availed mostly by salaried people who have the paying capacity. The lateral pipes used for microirrigation system are punctured, hence they do not have any resale value. In these circumstances, they have not been in a position to increase the ceiling limit beyond Rs. 50,000 for availing loan at low interest rates.

Dr. V.P. Jauhari, Agricultural Production Commissioner, Government of Andhra Pradesh mentioned that about 3 lakh application were received by the Banks in Andhra Pradesh of which about 50% are eligible. The remaining 50% are not eligible due to rural indebtedness, even after rescheduling of loans. Many of the banks have not been sensitized about microirrigation. Hence policy decision is needed at Government of India level for facilitating loan for microirrigation systems without much hassles by the farmers. He also stated that inline systems are not punctured.

Mr. Totey, President Orange Growers Association of India mentioned that farmers have to face considerable difficulties in availing bank loans. He suggested that assistance for microirrigation should be routed through NABARD. Moreover, mortgaging of property should not be insisted upon.

Shri U.C Sarangi, Secretary-Cooperation, Government of Maharashtra stated that initially drip irrigation was promoted for high value crops in Maharashtra where returns were high in rainfed areas which were well-irrigated. Thus, microirrigation was a part of district credit plan. With increased coverage of area under drip irrigation, all types of crops are being covered and the returns may not be as promising. In this context, availability of credit, both to the farmers as well as the manufacturing Industry is essential. He further, mentioned that since the interest rates have come down, the industry should reduce the cost of the drip system. The Banks should be impressed upon to raise that loan limit to Rs. 1.00 lakh for microirrigation without insisting for mortgage.

Representative of Central Bank mentioned that although many farmers are willing to mortgage their property, the cost involved is high and the procedure is cumbersome. Therefore, he suggested the need for waiving off Stamp Duty for microirrigation related activities.

Shri K. Rajan, Reliance Industries stated that the major cost of microirrigation system



is on pipe lines, thus banks should not have any problem in accepting it as security for loan. There is need to reduce the hassels involved in registration and mortgaging. Procedure for registration deed should be simplified. There is also need to sensitise the importance of microirrigation which will promote larger transaction of volume.

Shri K.L. Khanna, EPC Industries Ltd. highlighted that there is a need for an attitudinal change by the bankers in providing credit to agriculture. For about a decade bankers were having list of restrictions for car loan or house loan. But with attitudinal change the credit has become a reality. Similar attitude is needed so that credit could be available on reasonable interest without limit for mortgaging.

Dr. S.S. Magar, Vice Chancellor, Konkan Krishi Vidyalaya, Dapoli pleaded that the whole issue of microirrigation needs to be looked at in the context of the national economy in which water will play a crucial role in future. In the interest of the development of the country in a scenario when the per capita availability of water is getting reduced every year, and the production having doubled, it will be necessary to make sacrifices and the Banks need to bring in attitudinal change. They should consider providing cheaper credit support without insistence for mortgaging of land. Equipment upto value of asset be taken as security for loan.

Shri Ajit Jain, JISL, Jalgaon mentioned that considerable amount of time is spent by the States in releasing the assistance, as a result of which the manufacturing industry has to suffer losses. If this time lag is reduced, it will have impact in terms of reduction in cost of the system, which otherwise the manufacturers tend to charge on the system. On this, Shri Sarangi mentioned that the delay was mainly due to the proactive role of industry when they exceed the allocated targets fixed by the Government.

Shri B.H. Jain, Chairman, JISL, mentioned that the APMIP model seem to be a better model where eligibility letters are issued and manufacturers are ensured to get the payment within four weeks.

Shri R.C.A. Jain, Secretary (A&C) enquired about the possible level of assistance to be provided by the Government which is currently limited to 25% of the cost. Mr. U.C. Sarangi was of the view that the subsidy assistance should not be high in the interest of the drip industry. If the programme is subsidy driven, the industry will not take any steps to refine the technology through R&D. Mr. Teotey mentioned that the assistance



at the level of 50% of the cost is most appropriate, which should be back ended through NABARD. Mr. K.L. Khanna reiterated that the programme should be technology driven and considering the fact that Indian farmers need support, level of assistance should be 50 percent of the cost. Mr K. Rajan stated that during the initial phase, subsidy of drip irrigation was linked with availability of well which could irrigate 1-1½ ha. As per the existing norms, a small farmer could possess 6 ha in Maharashtra whereas it may be 20 ha in Rajasthan. Hence, it will be appropriate to restrict the assistance to a certain limit of land holding and the assistance should be 50% of the cost.

Managing Director, NCDC expressed that they are a new entrants in the microirrigation field and they will be willing to fund the programme. Hence, NCDC may be included as one of the funding agency in the recommendations of TFM. He also suggested the need for devising some insurance mechanism for enabling the farmers to claim for damages.

Mr. S.S. Magar suggested that an uniform assistance of 50% of the cost will be appropriate. He also said that some fund should be earmarked for R&D. Mr. Sarangi suggested the need for introducing some disincentives for those who do not use microirrigation.

Mr. R.C.A. Jain enquired about the feasibility of covering 2 million ha during the plan period, whether it would be feasible technically. Shri B. H. Jain responded that the available hardware and software in the country is sufficient to cope up with the programme.

Summarising the deliberation till the time of the arrival of CM, Shri J.N.L. Srivastava highlighted the following:

- There has been a consensus that there is need to increase the ceiling limit for availing credit at 9% interest from the level of Rs. 50,000. The RBI needs to be impressed upon to issue necessary guidelines.
- There should not be limit fixed for availing bank loan for microirrigation. RBI may consider raising the limit of Rs. 50,000 loan without mortgage of land to the resale value of asset.
- The procedure for mortgaging the need has to be simplified and stamp duty for registration should not be charged.



- The Bankers need to change their mindset for sanctioning loans in a speedy manner.
- There is need to introduce credit plan for microirrigation at the District level.
- Since the rate of interest has come down, there is scope for reducing the cost of the system by the microirrigation manufacturers.

The Chairman, Shri Chandrababu Naidu welcomed the suggestions. He said that by using microirrigation the farmers will be able to pay back early, as a result of increased income. With this objective, the AP Government has launched the APMIP for covering 2.5 lakh ha in the next two years. The Government of AP will be sharing 50% of the cost while the remaining 50% will be provided by the Bank. He further said that the Government of India has reduced the subsidy limit to 25% of the system cost. Even at this level there is a limit in the amount being sanctioned as a result of which it is not possible to cover large areas. Hence, more funds need to be earmarked by the Government of India for the purpose. He expressed the need for abolishing Sales Tax and Excise Duty. Moreover, there should not be any mortgage requirement for availing loans up to resale value of asset. Other loans should not come in the way for availing fresh loans for microirrigation. Under the APMIP, two years agronomic services have been tied up as a part of the system cost. Seven firms have been shortlisted for supplying the drip system which will create a healthy competition. The manufacturers have to give free maintenance for 5 years. He sought the view of the Bankers as to how they could help in (a) fast processing of loan applications (b) timely availability of credit and (c) further reduction in interest rates?

Representative of SBI mentioned that they will consider further reduction in rates after consultation. Mr. Mitra, NABARD mentioned that they are giving credit at 6% interest irrespective of amount from 1.11.2003. The Chairman requested NABARD to convene a meeting of the Bankers and give their recommendations on the three issues before the next meeting. Dr. M. Velaytham suggested the need for extending loan facility to a group of farmers also.

The decisions which emerged from the deliberations are summarised below:

1. There is need to extend the ceiling limit for availing bank loans for microirrigation without mortgage, from the current level of Rs. 50,000 to enable its adoption by



the farmers. This limit should be applicable for loan amount only. There is also need to reduce the rate of interest by the Banks. The NABARD should convene a meeting with the Bankers and give their recommendations about (a) faster processing of loan applications (b) timely availability of credit and (c) further reduction of interest rate on Bank loans.

2. Assistance for microirrigation should be at the level of 50% of the system cost. The total financial implication on microirrigation could be shared by the GOI and the State Government. The State Government could avail RIDF of NABARD for meeting the State share.
3. Assistance for microirrigation need to be channelised through NABARD as back-ended credit linked subsidy.
4. Wherever mortgaging is insisted, the procedure should be simplified and stamp duty should be waived off for registration purposes.
5. The APMIP model which has built-in provisions for agronomy support for two years, maintenance of system for five years and intensive monitoring through electronic network could be replicated with some modifications at the National level.
6. NCDC may also be identified as one of the funding agency for microirrigation projects.
7. At least one per cent of outlay for development of microirrigation should be earmarked for research and development of microirrigation including its promotion.



Annexure-VI a Statewise and Cropwise Unit cost of Drip Irrigation System (NABARD)

Sr. No	State	Crops-->	Sapota Mango Chikoo Litchi	Sapota Oil palm Mango Orchard	Ber Coconut Orchard	Ber Coconut Sapota	Citrus Almond Apple Guava Cashew Ber Orchard Orange Mosambi	Citrus Ber Plum Apricot Almond	Pomegranate, Coconut Orange, Peach, Custard, Custard A., Kinno, Citrus/ Guava	Lemon Pomegranate	Banana Grape Papaya Coccinia Orchard	Banana Papaya	Banana (Dwarf)	Grape (Thomson seedless)	Rose Banana Veg.	Cotton Jasmine Rose	Rose Mulberry	Date Approved
		Spacing--> (m)	10x10	9x9	8x8	7.5x7.5	6x6	5.5x5.5	5x5	4x4	3x3	2.5x2.5	2x2	1.8x1.2	1.5x1.5	1.2x1.2	0.6x0.6	
1	Andhra Pradesh		18200	20100							35200					81200	36100	Nov.1997
2	Gujarat		20000			20000	20500 (Ber) 25000 (Citrus,Gu)		28000 (Pemo, C.A.) 29000 (Coco D.)									Sept.1998
3	Haryana					13500	16050				28250							Jan.1998
4	Himachal Pradesh		22450					26200	30900									Aug.1997
5	Karnataka		16000	16900			21400			27500				59100		42800	72600	Feb.1999
6	Madhya Pradesh						16600			21200	27700				51400			Sept.1998
7	Maharashtra		16000		17700		20700		21300		37400	41500		58000				July 2000
8	Orissa		17100			19190	22450					34490	41650					Dec.2000
9	Rajasthan			16000	18500		21300				33800							Oct.2000
10	Tamil Nadu			25000		27000			33000									June 1998
11	Uttar Pradesh		11200		12400		15100 (Apple)											Sept.1998
12	West Bengal		22500						32000									Oct.1996



ANNEXURE-VI b COST OF DRIP IRRIGATION SYSTEM FOR ONE HECTARE AREA OF DIFFERENT CROPS (NABARD)

SR. No.	Item	Chikku/Mango/ Tamarind	Banana/Amla	Guava/Sweet Orange/ Flowers/Cashewnut	Custared Apple./ Ber/Anjir/Pomo/ Drum Steak	Papaya/Areacanut Tondli	Grapes							
1	PLANT SPACING	10 Mtr. X 10 Mtr.	7 Mtr. X 7 Mtr.	6 Mtr. X 6 Mtr.	5 Mtr. X 5 Mtr.	3 Mtr. X 3 Mtr.	3 Mtr. X 3 Mtr.							
2	NO. OF PLANTS	100 Nos.	204 Nos.	278 Nos.	400 Nos.	1111 Nos.	2222 Nos.							
3	DISCHARGE CAPACITY	4 L/H	4 L/H	4 L/H	4 L/H	4 L/H	4 L/H LAT							
4.	NO. OF DRIPPER/PLANT	2 Nos.	2 Nos.	2 Nos.	2 Nos.	1 Nos.	1 Nos.							
		Unit	Size	Qty	Amount (Rs)	Size	Qty	Amount (Rs)	Size	Qty	Amount (Rs)			
5	PVC Main (mm)	Mtr.	75	102	4080	75	102	4080	75	102	4080			
6	PVC Sub-Main (mm)	Mtr.	63	144	4032	63	144	4032	63	144	4032			
7	Lateral	Mtr.	12	1000	4600	12	1500	6900	12	3400	15640			
8	Inline	Mtr.	—	—	—	—	—	—	—	—	—			
9	Dripper L/H	No.	4	200	420	4	408	856.8	4	1111	2333.1	4	2222	4666.2
10	Drip Acce. (mm)	LS	12	—	331	12	—	418.5	12	—	496.5	12	—	827.5
11	Screen Filter	No.	25 ³	1	2400	25 ³	1	2400	25 ³	1	2400	25 ³	1	2400
12	Control Valve (mm)	No.	63	2	990	63	2	990	63	2	990	63	1	990
13	Flush Valve (mm)	No.	63	2	180	63	2	180	63	2	180	63	1	180
14	Ventury Assembly	No.	—	1	905	—	1	905	—	1	905	—	1	905
15	Sand Filter	No.	—	One sand ftr can be provided considering the field & water conditions.										
16	Bypass Assembly	No.	—	—	1100	—	—	1100	—	—	1100	—	—	1100
17	PVC Accessories	LS	—	—	1500	—	—	1500	—	—	1500	—	—	1500
	Total			20538	23362.3			24671.1	26651		33987.6			36320.7

One sand filter can be provided considering the field & water conditions.



ANNEXURE-VI c COST OF DRIP IRRIGATION SYSTEM FOR ONE HECTARE AREA OF DIFFERENT CROPS (NABARD)

SR. No.	ITEM	BANANA			BANANA/ STRAWBERI/ COTTON			STRAWBERY VEGITABLES/ FLOWERS/TURMARIC/ GINJER			SUGARCANE/COTTON			SUGARCANE/COTTON (PAIR ROW)			SUGARCANE/COTTON (PAIR ROW)		
		Unit	Size	Qty	Amount (Rs)	Size	Qty	Amount (Rs)	Size	Qty	Amount (Rs)	Size	Qty	Amount (Rs)	Size	Qty	Amount (Rs)	Size	Qty
1	Plant Spacing				1.5 Mtr. X 1.5 Mtr.				1.5 Mtr. X 1.5 Mtr.					1.5 Mtr. X 1.5 Mtr.			2.3 Mtr. X 0.75 Mtr. X 1.5 Mtr.		
2	NO. OF PLANTS				4444 NOS.				4444 NOS.										
3	DISCHARGE CAPACITY				4 L/H				4 L/H					4 L/H			4 L/H		
									LATERAL SAPCING: 1.3 MTR.					LATERAL SAPCING: 1.5 MTR.			LATERAL SAPCING: 2.3 MTR.		
4.	NO. OF DRIPPER/PLANT			1 NO.					DRIPPER SPACING: 0.75 MTR.					DRIPPER SPACING: 0.90 MTR.			DRIPPER SPACING: 0.90 MTR.		
5	PVC Main (mm)	Mtr.	75	102	4080	75	66	2640	75	102	4080	75	102	4080	75	102	4080	75	66
6	PVC Sub-Main (mm)	Mtr.	63	144	4032	63	78	2184	63	144	4032	63	144	4032	63	144	4032	63	78
7	Lateral	Mtr.	12	6600	30360				12	7700	35420	12	6600	30360	12	4400	20240		
8	Inline	Mtr.				16	6600	56100										16	4400
9	Dripper L/H	No.	4	4444	9332.4				4	8555	17965.5	4	7333	15399.3	4	4900	10290		
10	Drip Acce. (mm)	LS	12		1655	16		2410	12		1850	12		1655	12		1061.5	12	
11	Screen Filter	No.	25 ³	1	2400	25 ³	1	2400	25 ³	1	2400	25 ³	1	2400	25 ³	1	2400	25 ³	1
12	Control Valve (mm)	No.	63	2	990	63	1	495	63	2	990	63	2	990	63	2	990	63	1
13	Flush Valve (mm)	No.	63	2	180	63	1	90	63	2	180	63	2	180	63	2	180	63	1
14	Ventury Assembly	No.		1	905		1	905		1	905		1	905		1	905		1
15	Sand Filter	No.																	
16	Bypass Assembly	No.			1100			1100			1100			1100			1100		
17	PVC Accessories	LS			1500			1000			1500			1500			1500		
	Total				56534.4			69324			70422.5			62601.3			46778.5		
																			49734



Annexure-VI d Economic Analysis of Drip Irrigation Investment for Different Plantation/ Horticulture Crops as per NABARD Guidelines

Particulars	Cotton	Sugarcane	Sugarcane Paired row	Sapota	Guava	Mango	Pomegranate	Sweet lime	Grapes	Banana	Ber	Papaya
investment in Drip irrigation system	62600	62600	49730	20538	24670	20538	26650	24670	36320	56500	26650	33987
Area under crop (ha)												
i) Pre-development	1	1	1	1	1	1	1	1	1	1	1	1
ii) Post-development	1	1	1	1	1	1	1	1	1	1	1	1
Yield per (ha) (Quintal)												
i) Pre-development	23	875	875	80	140	130	55	140000	264	575	112	33.33
ii) Post-development	30	1100	1000	104	210	169	90	110000	300	700	225	50
Cost of Cultivation (ha)												
i) Pre-development	26000	36250	36250	3700	2500	3500	7000	10000	22500	25000	2600	8000
ii) Post-development	22100	32000	31000	3810	2610	4000	7300	10500	22500	25930	1370	8200
Price per Quintal	2300	80	80	350	150	400	400	0.4	800	245	250	850
Total output												
i) Pre-development	23	875	875	80	140	130	55	140000	264	575	112	33.33
ii) Post-development	30	1100	1100	104	210	169	90	203000	300	700	225	50
Gross income												
i) Pre-development	52900	70000	70000	28000	21000	52000	22000	56000	211200	140875	28000	28330.5
ii) Post-development	69000	88000	88000	36400	31500	67600	36000	81200	240000	171500	56250	42500
Total cost of cultivation												
i) Pre-development	26000	36250	36250	3700	2500	3500	7000	10000	22500	25000	2600	8000
ii) Post-development	22100	32000	31000	3810	2610	4000	7300	10500	22500	25930	1370	8200
Net income												
i) Pre-development	26900	33750	33750	24300	18500	48500	15000	46000	188700	115875	25400	20330.5
ii) Post-development	46900	56000	57000	32590	28890	63600	28700	70700	217500	145570	54880	34300
Net incremental income	20000	22250	23250	8290	10390	15100	13700	24700	28800	29695	29480	13969.5
Internal rate of return (IPR)	35%	41.30%	60.13%	40.78%	52.13%	>100%	62.16%	>100%	>100%	57%	>100%	50.42%
Repayment period	10	10	7	9	9	4	6	3	4	6	3	9

Note:- 1. Post development investment is for replacement of flow irrigation by drip irrigation.
2. If saving in water after drip is used for some crop, post development income would further increase.
3. Economics is worked out for full investment cost for drip. 50% incremental income is assumed in the first year.
4. Repayment period worked out on the basis of total cost and @ 14% rate of interest. If subsidy is received, the repayment period will be lesser.



Annexure-VI e Statewise cropwise unit cost of drip irrigation system (NABARD)							
Sr. No.	State	Crop	Areawise Unit Cost				
			0.4 ha	1 ha	2 ha	3 ha	64x64m
1	Lucknow (U.P.)	Apple	8,000	15,100	28,600		
		Mango	6,300	11,200	21,000		
		Ber	7,000	12,400	23,500		
		Citrus	8,000	18,100	28,600		
		Grape	10,800	21,900	51,800		
		Rose	19,000	42,100	82,100		
2	Orissa	Mango		17,100	30,480		40,350
		Coconut		19,190	34,570		47,070
		Citrus		25,250	44,160		61,950
		Banana		34,490	63,890		90,010
		Orange		22,450	39,390		53,690
		Vegetables		84,560	163,510		240,300
3	Maharashtra	Mango					9,000
		Coconut					9,600
		Guava/Le					10,900
		Custard A					11,100
		Grapes					17,600
		Banana					19,300
		Sugarcane					30,900
		Cotton					24,900
		Flowers					37,700
4	Karnataka	Grapes	12,000	22,100	36,000		
		Pomegranate	13,900	27,500	50,400		
		Coconut	10,200	18,000	29,700		
		Mango	9,900	16,000	25,500		
		Jasmine	20,400	42,800	76,000		
		Rose	32,000	72,600	137,700		
5	Bhopal (M.P.)	Rose/Veg	22,600	51,400	105,000		
		Pomegranate	10,500	21,200	41,700		
		Citrus/Gu	8,500	16,600	31,500		
		Banana/G	13,400	27,700	57,400		
6	Shimla	Apple	36,200	50,200	74,200		
		Plum	51,000	75,000	105,000		
		Apricot	36,000	75,000	105,000		
		Almond	36,000	51,000	75,000		

Source: Guidelines of NABARD.



List of Standards relevant for micorrirrigation

Sr.	Products	IS Number
1.	uPVC Pipes	IS 4985 – 2000
2.	PVC Fabricated Fittings	IS 10124 – 1988
3.	PVC Moulded Fittings	IS 7834 – 1995
4.	HDPE Pipe	IS 4984 – 1995
5.	Strainer (Screen) Filter	IS 12785 – 1994
6.	Media (Sand) Filter	IS 14606 – 1998
7.	Hydrocyclone Filter	IS 14743 – 1999
8.	Irrigation Laterals (Polytube)	IS 12786 – 1989
9.	Microtube	IS 14333 – 1996
10	Emitting Pipe	IS 13488 – 1992
11	Emitters	IS 13487 – 1992
12	Metal Sprinkler	IS 12232 – 1987
13	PE Pipe for Sprinkler	IS 14151 (I&II)–1999
14	PVC Foot Valve	IS 10805 – 1986
15	Gun Metal Valve	IS 778 – 1984
16	G.I. Pipes	IS 1239 – 1990
17	G.I. Fittings	IS 1879 – 1987
18	Ventury Injector	IS 14483 – 1998
19	C. I. Sluice Valve	IS 780 – 1984
20	C. I. Non Return Valve	IS 5312 – 1969
21	Design & Installation of Drip (Trickle) Irrigation System	IS 10799 – 1984
22	Design of Sprinkler Irrigation System	IS 12232 – 1987
23	Water metres	IS 779 – 1994



**Location of Plasticulture Development Centres or
Precision Farming Development Centres**

Sl. No.	Name & Location of PDC or PFDC	Year of Establishment
1	Indian Agricultural Research Institute, Delhi	1986-87
2	Acharya N.G. Ranga Agricultural University, Hyderabad	1987-88
3	Assam Agricultural University, Jorhat, Assam	1988-89
4	Rajendra Agricultural University, Samastipur, Bihar	1995-96
5	Gujarat Agricultural University, Navsari, Gujarat	1988-89
6	Haryana Agricultural University, Hissar, Haryana	1995-96
7	Y.S. Parmar Univ. of Hort. & Forestry, Solan, H.P	1995-96
8	University of Agricultural Sciences, Bangalore	1986-87
9	Kerala Agricultural University, Tavanur, Kerala	1995-96
10	Mahatma Phule Krishi Vidyapeeth, Rauri, Maharashtra	1986-87
11	Indira Gandhi Krishi Vishva Vidyalyaya, Raipur, M.P.	1995-96
12	Orissa University of Agri. & Technology, Bhubaneswar	1987-88
13	Rajasthan Agri. University, Bikaner, Rajasthan	1987-88
14	Tamil Nadu Agricultural University, Coimbatore, T.N.	1985-86
15	G.B. Pant Univ. of Agri. & Technology, Pantnagar	1987-88
16	Indian Institute of Technology, Kharagpur, W.B.	1985-86
17	Central Instt. Of Sub-tropical Horticulture, Lucknow	2001-02



GUIDELINES FOR IMPLEMENTING THE CENTRALLY SPONSORED SCHEME ON DEVELOPMENT OF HORTICULTURE THROUGH PLASTICULTURE INTERVENTIONS DURING IX PLAN (DRIP IRRIGATION)

I. INTRODUCTION

In the overall development of Agriculture, the horticulture sector, which includes fruits, vegetables, spices, floriculture, coconut, cashewnut, medicinal & aromatic plants etc., has an eminent place in terms of efficient land use for regenerating higher returns, better employment and women employment, above all nutritional security. Past investments have been rewarding in terms of increased production and productivity of horticultural crops, the country emerged as second largest producer of fruits and vegetables, and has credibility for highest productivity in few crops. However, productivity continues to be low in large number of crops necessitating efficient utilisation of natural resources to harness the optimum potential.

2. Plasticulture application has proved beneficial to promote the judicious utilisation of water, sunlight and also reducing the vagaries of climate. In plasticulture, plastic material is used for efficient utilisation of natural resources through various applications resulting in enhanced productivity and sustainability. Plasticulture application includes drip irrigation (microirrigation), plastic mulching, green houses, low tunnels etc. Different grade of plastic material like Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE) pipes for drip irrigation system, Ultra Violet Stabilised films for use as cladding material for green houses, plastic sheets of different thickness for plastic mulch are now available for use. These are light in weight, durable and cost effective.
3. One of the major sectors of plasticulture application is in the area of water management and conservation. Although water is a renewable resource, in recent years there has been considerable stress in the availability of water to meet the growing demand of the rising population. Application of micro irrigation has helped in increasing productivity by 30 to 100 per cent with 50 to 70 percent saving of water. Fertiliser use efficiency is also enhanced when it is applied through drip irrigation. Increased productivity with saving of 30 to 40 per cent of



fertiliser is achieved through fertigation. Thus, drip irrigation is becoming a major component of precision farming. Similarly, green houses / poly-houses have been found to be very successful for raising nursery, off season production of vegetable and flowers, hardening of tissue culture platelets and saving plants from the vagaries of weather. The productivity improvement due to poly-house is by three to four times, depending upon location. Green house grown fruits, vegetables and flowers also excel in quality of produce. Keeping these aspects in view, the Government of India launched a Centrally Sponsored Scheme entitled 'Use of Plastics in Agriculture' during the VIII Plan with an outlay of Rs.250 crores. The scheme involved the components of drip installation, drip demonstration, mulching, construction of green house besides other minor plasticulture applications like shade nets, low tunnels, anti bird / anti hail nets etc. During the IX Plan scheme has been modified and is proposed to implement under the title of Horticulture Development through Plasticulture Interventions since plasticulture intervention is expected to accelerate the production and productivity of horticultural crops in sustainable manner.

II. GUIDELINES FOR IX PLAN

4. The following components would be implemented under the scheme during the IX Plan:

A. Area Coverage

1. Drip Irrigation
2. Sprinkler Irrigation
3. Plastic Mulching
4. Green House
5. Minor Plasticulture Applications

B. Demonstrations

1. Drip Irrigation
2. Green House
3. Mulching

5. The detailed guidelines pertaining to drip irrigation are given hereunder.



DRIP / MICROIRRIGATION:

6. Drip/Micro irrigation is a technology for providing irrigation to plants through network of pipes. It helps for supplying filtered water directly to the root zone of the plant. The term “Drip / Microirrigation” includes emitting water by drippers, micro sprinklers, mini sprinklers, micro-jets, misters, fan jets, micro sprayers foggers, emitting pipes, micro tubes and similar other emitting pipes. The use of different components depends upon the requirement, which may vary due to crop type, water requirement, plant spacing, soil type etc. All types of surface and subsurface irrigation systems are covered under Drip / Microirrigation Technology.
7. The assistance under the scheme is available for all types of microirrigation systems such as on line drip irrigation systems, in line systems, sub surface drip irrigation systems, micro-tube, micro-jets, fan-jets, micro sprinkler, mini sprinklers, misters and similar other low discharge irrigation systems. Micro tubes are less expensive and have been in use for quite some time. However, micro tubes have low water application uniformity and hence should be phased out gradually.
8. The assistance will cover all farmers growing all horticultural crops like fruits, vegetables including potato, onion & other root and tuber crops, spices, medicinal & aromatic plants and plantation crops other than tea, coffee, rubber and oil palm. The scheme will cover all farmers irrespective of the size of land holding. The scheme should be taken up on compact area basis. There is a separate scheme for promoting use of drip irrigation for oil palm under Oil Palm Development Project (OPDP). The pattern of assistance for oil palm crop, however, will be as per the prescribed norms in these guidelines.
9. Only new installations i.e. systems invoiced and installed on or after 1.4.2000 shall be eligible for assistance on the revised pattern. Farmers who have installed Drip Irrigation systems prior to 1.4.2000 without availing themselves of subsidy under the Centrally Sponsored Scheme shall be eligible for assistance for the additional area covered under drip irrigation after 1.4.2000. Pre-existing installations / components or replacement of components in area covered prior to 1.4.2000 shall not be eligible for assistance.
10. The assistance may be extended to farmers’ cooperatives and each member may be considered as a beneficiary. However, it is to be ensured that the



beneficiary covered under a cooperative does not also avail of assistance as an individual.

11. The cost per hectare norm includes expenses towards mains, sub mains, laterals, emitting devices, screen filters, control valve, flush valve and other required accessories, inclusive of installation charges required for efficient functioning of the system. An indicative list of system components required for installing drip system in 0.40 ha, 1.00 ha and 4.00 ha has been provided at Appendix-I, Appendix -II and Appendix -III respectively.
12. The unit cost of Drip Irrigation system varies with respect to plant spacing. Moreover, the cost of the drip system varies from state to state depending upon the existing demand and marketing network. Accordingly, the States have been categorised into three categories, viz. Category “A”, “B”, and “C”. The major States where more than 4000 hectares have been brought under drip irrigation as on 1.4.1998 would come under ‘A’ Category. This would include the States of Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu. All the States except those covered under Category ‘A’ and those falling in the Himalayan belt would come under Category ‘B’. Similarly, all the States falling under the Himalayan belt including all the North Eastern States, Sikkim, Himachal Pradesh, Jammu & Kashmir and Hills of Uttar Pradesh, Darjeeling district of West Bengal would come under Category ‘C’. Keeping in view the level of awareness, proximity to the manufacturing units, distance involved in transportation, potential for drip irrigation the cost of drip system in Category ‘B’ States is estimated to be 15% higher than Category ‘A’ States while for Category ‘C’ States it is estimated to be 25% higher than Category ‘A’ States.
13. The assistance for drip irrigation will be 50% of cost for Small, Marginal, SC, ST and Women Farmers and for other category of farmers the assistance will be 35% of total cost of the prevailing competitive market rate of the system subject to the maximum as indicated in table below. The maximum ceiling would be Rs.28,500/- per ha for Category ‘C’ States for a crop spacing of 1.5x1.5 metres. The assistance will be provided for a maximum area of 4.0 ha per beneficiary family in whose name the land belongs.
14. The pattern of assistance and maximum ceiling for different category of farmers would be as given in Table 1



TABLE 1: COST CEILING FOR DRIP IRRIGATION

State Category	Maximum Ceiling for Small, Marginal, SC, ST and Women Farmers (Rs./ha.)(50% of cost)	Maximum Ceiling for other category Farmers (Rs./ha.) (35% of cost)
A	22,500	16,000
B	26,000	18,200
C	28,500	20,000

15. The maximum limit of assistance for different crop spacing and area coverage will be as given in Table - 2

TABLE 2: COST CEILING FOR DIFFERENT CROP SPACING AND AREA

I. Maximum ceiling for an area of 0.4 ha area

A. SC/ST/S/M/Women Farmers (50% of total cost of system or following whichever is less)

Amount in Rupees

State category	Maximum permissible assistance for different spacing (metre) and State categories												
	12x12	10x10	9x9	8x8	6x6	5x5	4x4	3x3	3x1.5	2.5x2.5	2x2	1.5x1.5	1x1
A	3800	4500	4200	4900	5700	5900	6300	7200	8100	8000	8500	10800	9800
B	4400	5200	4800	5700	6500	6800	7300	8200	9300	9200	9800	10400	10400
C	4800	5600	5200	6200	7100	7300	7900	8900	10100	10000	10700	11400	11400

B. Other Category Farmers (35% of total cost of system or following whichever is less)

Amount in Rupees

State category	Maximum permissible assistance for different spacing (metre) and State categories												
	12x12	10x10	9x9	8x8	6x6	5x5	4x4	3x3	3x1.5	2.5x2.5	2x2	1.5x1.5	1x1
A	2700	3200	2900	3500	4000	4100	4400	5000	5600	5600	6000	7600	6900
B	3100	3600	3300	4000	4500	4700	5100	5800	6500	6500	6900	8700	7900
C	3400	3900	3600	4300	5000	5100	5500	6300	7000	7000	7500	9500	8600



II. Maximum ceiling for an area of one ha

A. SC/ST/S/M/Women Farmers (50% of total cost of system or following whichever is less)

Amount in Rupees

State category	State Maximum permissible assistance for different spacing (metre) and												
	12x12	10x10	9x9	8x8	6x6	5x5	4x4	3x3	3x1.5	2.5x2.5	2x2	1.5x1.5	1x1
A	6500	7100	7400	8000	11400	12100	14800	13400	16200	15600	16200	22500	21300
B	7500	8200	8600	9200	13100	13900	17000	15400	18600	18000	18600	26000	24500
C	8100	8900	9300	10000	14300	15100	18600	16800	20200	19500	20200	28500	26600

B. Other Category Farmers (35% of total cost of system or following whichever is less)

Amount in Rupees

State category	Maximum permissible assistance for different spacing (metre) and State categories												
	12x12	10x10	9x9	8x8	6x6	5x5	4x4	3x3	3x1.5	2.5x2.5	2x2	1.5x1.5	51x1
A	4600	5000	5200	5600	8000	8500	10400	9400	11300	10900	11300	16000	14900
B	5200	5700	6000	6400	9200	9700	12000	10800	13000	12600	13000	18200	17200
C	5700	6200	6500	7000	10000	10600	13000	11700	14100	13700	14100	20000	18600

III. Maximum ceiling for an area of four ha

A. SC/ST/S/M/Women Farmers (50% of total cost of system or following whichever is less)

Amount in Rupees

State category	Maximum permissible assistance for different spacing (metre) and State categories												
	12x12	10x10	9x9	8x8	6x6	5x5	4x4	3x3	3x1.5	2.5x2.5	2x2	1.5x1.5	1x1
A	21200	23800	29700	27600	37100	45900	57100	65400	69700	54800	67000	87400	74500
B	22400	27300	34100	31800	42700	52800	65700	75200	80200	63000	77100	100500	85700
C	26500	29700	37100	34600	46400	57400	71400	81800	87200	68500	83800	109200	93400



B. Other Category Farmers (35% of total cost of system or following whichever is less)

Amount in Rupees

State category	Maximum permissible assistance for different spacing (metre) and State categories												
	12x12	10x10	9x9	8x8	6x6	5x5	4x4	3x3	3x1.5	2.5x2.5	2x2	1.5x1.5	1x1
A	14900	16600	20800	19400	26000	32100	40000	45800	48800	38400	46900	61200	52100
B	17100	19100	23900	22300	29900	37000	46000	52700	56100	44200	54000	70300	60000
C	18600	20800	26000	24200	32500	40200	50000	57200	61000	48000	58700	76400	65200

16. As small farm holdings may not have individual source of water, it would be preferable to encourage a group of farmers to avail the benefits of drip irrigation through a common water source. However, the cost norms for 0.40 ha have been provided with a view not to deprive the marginal farmers from availing the scheme. The cost breakup at Table 2 is indicative of the maximum permissible limits. However, the actual cost will vary depending upon the number of components used in the system, prices of the same charged by different manufacturers as prevailing in each respective state and area covered under drip irrigation. Moreover, for areas not covered in Table 2, the State Implementing Departments should work out the cost norms duly ensuring that the costs are within the limits given in Table 1. A beneficiary cannot avail assistance for 0.40 ha block if more than 0.40 ha has been covered under drip irrigation in his/her holding for any crop. In case of crops with plant spacing other than mentioned in Table 2, the assistance amount should be calculated on pro rata / average basis of the nearest plant spacing assistance amount as per the per unit density of plants.
17. In case of inter-cropping, assistance should be given based on the closest plant spacing followed in the beneficiary's plot for the respective State category. No separate subsidy assistance should be given for more than one crop on the same piece of land for one beneficiary.



ITEMS TO BE VERIFIED WHILE SANCTIONING ASSISTANCE FOR DRIP INSTALLATION

1. Sufficient water and power supply should be available for the proposed installation.
2. Material supplied by the Manufacturer should be of good quality having BIS certification. Moreover, the components installed should conform to the specifications declared by the manufacturer during their registration.
3. Drip lines should be laid as per the recommended crop spacing.
4. The application of water between the first and the last dripper on a lateral should be fairly uniform within 10%.
5. The drip system should be installed and commissioned to the satisfaction of the farmer.

18. A farmer shall be eligible for assistance only if adequate water is available for the area proposed to be brought under Drip irrigation. The installation of Drip Irrigation system and the assistance should be limited to the area for which adequate water is available. For this purpose, assessment of water availability should be made by the District Horticulture Officer/ District Agricultural Officer. The State Government may also nominate accredited trained graduates for verifying the drip installation systems. Sample formats for facilitating collection of basic information before sanctioning the assistance are given in Appendix IV to Appendix X attached to these guidelines. The questionnaire at Appendix IX may be used for assessing water availability in the beneficiary's plot. Methodology for assessing water availability and power requirement are given in Annexure X. The Field Functionaries should collect the data accurately and thereafter an assessment of adequacy should be made on the basis of norms given in these guidelines. In general the following thumb rule may be followed:

- a. **Orchard crops:** Orchard crops may be irrigated with Drip irrigation system if water supply of 1 litre per second / hectare is available for 4 hours per day.
- b. **Vegetables and other closely spaced crops:** Drip Irrigation system may be used if water supply of 3 litres per second / hectare is available for 4 hours per day.

19. Where a farmer proposes to use canal water for drip irrigation, the availability of



adequate overhead storage capacity should be insisted upon as a pre-requisite for installation of drip Irrigation system and sanction of assistance. The storage capacity may be assessed in accordance with the principles laid down in Annexure VI. In general:

- a. For **orchard crops**. storage capacity of 15 cum/ha should be available.
 - b. For **vegetables and closely spaced crops** storage capacity of **45 cum/ha** should be available.
20. All efforts should, however, be made to arrive at the realistic water requirement of the crop for the particular region. Moreover, the drip irrigation system should be designed in such a manner that the required amount of water is made available to the crop depending upon its stage of growth.
21. The availability of electric / diesel power and pumps of adequate capacity should also be insisted upon as a prerequisite to installation of the Drip Irrigation system and sanction of assistance. In general when water is to be lifted from a depth of 15 m to 25 m, the power requirement would be:
- a. 1 H.P./ha for orchard crops
 - b. 3 H.P./ha for vegetables and other closely spaced crops
22. Assistance should not be sanctioned without ensuring adequate power availability. Assistance should be limited to the extent of land for which adequate power is available.

Implementing Agency

23. The scheme is to be implemented preferably through Directorate of Horticulture/ Agriculture as they have the required network / infrastructure. In case, the implementation is entrusted to an agency other than the State Directorate, State Government must give an undertaking to the effect that no service charges shall be levied by these agencies or be debited to this scheme. To avoid any discrepancies and for smooth implementation of the scheme, there should not be more than one implementing agency in the state.
24. In the case of women farmers, the assistance will be admissible only to those



whose names occur on the land revenue records as landholders, and will be restricted to her share in case of her being a joint holder. One or more farmer, who agrees to use the same water source for irrigating their land, may also be permitted to avail himself or herself of assistance as an individual.

25. The cost towards earthwork for making trenches for installation of drip system pipes will be borne by the farmer. The drip system manufacturers are supplying a tailor made system to the farmers. Therefore the installation charges are in built in the system component costs. No separate installation charges should be charged by drip manufacturers from the farmers.
26. State Government should uniformly follow the procedure mentioned in the guidelines. This will enable Government of India for building a uniform system for monitoring the scheme.
27. In order to bring about uniformity, it is suggested that the following procedure may be followed:
 - a. Farmer submits his / her application to Agriculture / Horticulture Development Officer (ADO/ HDO) or any other designated authority through village level worker (VLW).
 - b. After scrutiny of the document, ADO/ HDO or any other designated authority issues eligibility certificate for availing assistance after assessing the availability of water and power for the area, which is proposed to be brought under Drip Irrigation. He also gives a list of the approved drip system manufacturers to the farmer.
 - c. Farmer collects proforma invoice from any of the approved manufacturers directly or from their authorised distributor or dealer.
 - d. Farmer collects pro forma invoice from any of the approved manufacturers/ suppliers. It is to be ensured by the farmer as well as State implementing agency that only components with BIS certificates are installed. In case of imported components it should have the approval of the NCPA/ GOI before installation.
 - e. Farmer hands over a copy of pro forma invoice to ADO/HDO, ADO/HDO scrutinises the pro forma invoice, design, water and soil test report. After



verification, ADO/HDO submits the eligibility document to the District Agriculture/ Horticulture Development Officer / equivalent concerned authority designated by the State Government.

- f. District Agriculture / Horticulture Officer scrutinises the proposal, sanctions the assistance and conveys final approval to the farmer with a copy to the system manufacturer.

If beneficiary pays his own contribution:

- a. He pays his/ her own contribution to the manufacturer/supplier who issues the receipt to the farmer in duplicate for the amount received. The farmer submits a copy of the receipt to ADO/HDO.
- b. The system manufacturer installs system on farmer's field.
- c. Farmer informs ADO of the installation of the system.
- d. ADO verifies and communicates satisfactory installation of the system to DAO.
- e. The assistance amount is released by DAO to the manufacturer through the farmer.
- f. The State Government ensures that the payment of subsidy is made within a month from the date of installation of the system. The applicant should be informed about sanctioning of the system within one month from the date of receipt of his/her application.

If beneficiary takes loan:

- a. The DHO/DAO conveys sanction of subsidy by the State Government and the intention of the farmer to avail loan to the concerned bank and system manufacturer with a copy to the farmer.
- b. The system manufacturer installs the system on the farmer's field.
- c. The performance of the system is verified by the farmer, bank / state Government official or both as per the State norms.
- d. Bank debits the State Government amount and farmer's amount to the extent of subsidy and loan respectively.



In this case also the applicant should be informed about sanctioning of the system within one month from the date of receipt of his/her application.

28. The farmers shall be free to select the manufacturers/suppliers from an approved list of manufacturers/suppliers maintained by the concerned State Governments.

Registration of Manufacturers:

29. Drip irrigation has proved beyond doubt that that high water use efficiency of 90-95% can be achieved with water saving upto 60% and increase in yield by 40-100% under different climatic conditions. However, the benefits can only be harnessed if the right design and good quality components are used. Therefore, the State Governments should register only those companies which have all the facilities to ensure the quality of product and who can provide prompt after sales services. The companies should either manufacture all the major drip components within their factory or in collaboration with specialised manufacturers. The manufacturers should declare the technical details of the components proposed to be manufactured and supplied.
30. In order to ensure the above, while registering the manufacturers, the following aspects should be taken care of:
- i. The Company must manufacture at least laterals and emitting devices (other than micro-tubes) and must provide guarantee of quality assurance of other components which is not manufactured by them.
 - i. The companies supply the BIS marked material only.
 - ii. In case, the company intends to supply imported components, they should have the prior approval of the GOI.
 - iii. The material should be supplied directly by the manufacturers only or their authorised distributor / dealer. In all cases the manufacturers should authenticate the invoices.
 - iv. Each company will have its own pricing system. However, the company would be required to submit the same to the concerned State Government in the beginning of the year and as and when the prices are revised by the manufacturers.



Supply of Imported Components

31. In the case of suppliers, importing systems/components into India, only those may be considered who have a definite intention to manufacture the presently imported systems / components within the country within a period of two years from the date of registration. The intention to manufacturer would be assessed by the National Committee on Plasticulture Applications in Horticulture (NCPAH) with reference to the following factors:
1. The manufacturing facilities and capacities for different components proposed to be set up by the supplier and the time frame within which they are proposed to be set up.
 2. The scale of investment proposed to be made in the manufacturing facilities.
 3. The foreign collaboration agreement, if any, entered into by the supplier for getting up manufacturing facilities. PIPE approval obtained, if applicable.
 4. The reputation and competence of the joint venture partner, if any.
 5. The approvals obtained for setting up of the manufacturing facilities and the appraisal of the project made by a financial institution.
 6. The term loans and working capital tied up for the project from financial institutions.
 7. Steps taken for acquisition of land, provision of utilities and other steps crucial for initiation of the project.
 8. The track record, size, financial health and performance of the promoters or companies with which the promoters are associated.
32. For establishing a supplier's intention to manufacturer systems / components NCPA may call for such information from the supplier as may be appropriate. State Government will also ensure that manufacturing facilities are being proposed for manufacture of the same items which are proposed to be imported in the initial phase.
33. Suppliers importing systems / components into India whose intention to manufacture is established will be included in the list of approved suppliers under



the scheme initially for a period of one year. The following points would be considered while registering these companies for supplying imported components / systems under GoI subsidy scheme:

- a. The imported components carry the quality certification of the national standards institution of the concerned country or of a standards institutions included in the list of such institutions furnished by the BIS. The quality certification should be authenticated by Embassy in India of the exporting country.
 - b. The imported components conform to BIS standards where BIS standards exist. The conformity to BIS standards will be got certified by CIPET (or such other institutions as may be notified) by the Company directly.
 - c. BIS are available for most of the drip components. However, where no BIS standards exist, the imported components should conform to the standards prescribed by the national standards institution of the exporting country included in the list of institutions furnished by BIS. The conformity to the relevant standard will be got certified from the CIPET or other notified institution after the testing of samples.
34. Suppliers of imported systems / components who desire to get themselves included in the approved list of suppliers will first get their intention to manufacture assessed by NCPAH, obtain certificate of conformity to BIS / other relevant standards (as the case may be) from CIPET or other notified institution and then approach the State Governments.
35. The suppliers importing systems/ components into India who fulfill the above conditions will have to get their approval renewed at the end of one year when the quality certification of the national / concerned standards and certification of CIPET regarding conformity to BIS or the relevant standard would have to be produced afresh.
36. Suppliers who have been approved under the scheme based on their proposed manufacturing facilities will be subjected to a review at the end of one year. In the event of the progress in setting up of manufacturing facilities being unsatisfactory at the end of the first year or in the event of the manufacturing facilities not having been established at the end of the second year the approval will be liable to be withdrawn. In the case of suppliers manufacturing certain components in India



and importing certain other components, the guidelines as per indigenous components would apply in respect of components manufactured within the country and guidelines relevant to imported components would apply in respect of imported components.

After Sales Service

37. The manufacturers should have the network for providing after sales service in the area of operation. Operation and maintenance of the system though simple, requires training for maintenance, fertigation, chemigation etc. in the initial stage. Therefore the manufacturers should provide detailed operational and maintenance manuals at the time of installation of the system. The beneficiaries should be made aware to follow the instructions provided by the manufacturers in operation and maintenance of the drip irrigation system.
38. State Government should ensure that drip system manufacturers should open their Regional offices / service centres at the State / Division / District / Block level when a reasonable area has been covered by the company in the respective state as considered appropriate by the state implementing agency in the local conditions. These offices are expected to provide technical guidance to the farmer, supply of spares, maintenance as well as ensuring satisfactory performance of the system.
39. Free after sales service should be provided by the manufacturer/authorised distributor at least for three years. In the event of any system manufacturers failing to abide by his commitments, the same should be brought to the notice of Gol/ NCPA.
40. The manufacturer should take the responsibility in case of any dispute arising from the supply of their product through their Distributor or Dealer.

Sharing between Centre & State Government

41. With effect from the year 2000-01, the ratio of share between Gol & the State Government will be in the ratio of 90:10 for all States excepting the North Eastern states including Sikkim. The State Governments' contribution of 10% of the share for the scheme shall also be furnished along with the progress report.



Revisions required in various BIS Standards

I) IS: 12786-1989 for Polyethylene Pipes for Irrigation Laterals

Clause No 3.1:

- a) The Pressure classes in the existing standard are Class 1, 2 and 3 designating the pressure rating of 0.25 Mpa, 0.40 Mpa and 0.60 Mpa respectively. Due to this the thickness of drip laterals will be considerably high for 0.60 Mpa and hence their cost also is high. In order to reduce the cost of drip laterals, which constitute more than 50% in a typical drip irrigation system cost, for the benefit of farmers, it is necessary to revise the pressure classes as Class 1, 2 and 3 as summarised below:

S.No.	Existing		Proposed Revision	
	Class	Pressure Rating Mpa	Class	Pressure Rating Mpa
1	1	0.25	1	0.20
2	2	0.40	2	0.25
3	3	0.60	3	0.40

The above suggestion is based on the fact that the Class-3 lateral, which can withstand a working pressure of 6 kg/cm² is not at all relevant as the operating pressure of Drip emitters is not beyond 1 to 3 kg/cm² and hence there is no need for a Class with 0.6 Mpa. Instead of a higher pressure class, there should be a lower pressure class of 0.20 Mpa as indicated above. Even after reducing the pressure rating of Class 1 pipes to 0.20 Mpa from 0.25 Mpa, the safety margin of 25 to 40%, in withstanding the pressure inside the laterals is still available.

- b) It is also noted that the wall thickness of drip laterals in different pressure classes over-lap with that of the next higher class, whereby there exists a scope for foul play by the smart manufacturers who designate their products as of higher pressure rating with same or less wall thickness as can be seen from the Table below:



Outer Diameter of lateral pipe	Wall Thickness, mm					
	Class 1 (0.25Mpa)		Class 2 (0.40 Mpa)		Class 3 (0.60Mpa)	
	Min	Max	Min	Max	Min	Max
12	1.0	1.2	1.1	1.3	1.4	1.6
16	1.2	1.4	1.4	1.6	1.8	2.0
20	1.3	1.5	1.5	1.7	2.3	2.5
25	1.4	1.8	1.9	2.3	2.8	3.3
32	1.6	2.1	2.4	2.9	3.6	4.2

A study of the above Table reveals the overlaps such as in 12mm Class 1, the wall thickness is 1.0 to 1.2 whereas the same in Class 2 is 1.1 to 1.3. Thus, a wall thickness of 1.1-1.2 can be categorised as Class 2 and can be priced accordingly for Class-2, thus misleading the customers, even though its wall thickness is of Class 1

- c) Subsequent to the above suggested revision in Pressure ratings, and the need for avoiding over lap in wall thicknesses, the Class wise Wall Thickness for different sizes of drip laterals can be followed as given in the Table below:

Outer Diameter of lateral pipe,mm	Wall Thickness, mm					
	Class 1 (0.20Mpa)		Class 2 (0.25Mpa)		Class 3 (0.40Mpa)	
	Min	Max	Min	Max	Min	Max
12	0.6	0.8	0.9	1.1	1.2	1.4
16	0.8	1.0	1.1	1.3	1.4	1.6
20	0.9	1.1	1.2	1.4	1.5	1.7
25	1.2	1.6	1.7	2.0	2.1	2.4
32	1.5	1.9	2.0	2.4	2.5	2.9

Clause No: 4.3

The existing clause recommends use of 10% of manufacturer's own rework material along with virgin raw material while manufacturing Drip laterals. As use of manufacturer's own rework material does not result in any degradation or deterioration in the final product, as well as to uphold the universal policy of recycling of plastics, it is recommended that the upper limit of 10% for manufacturer's own rework material be withdrawn and it should be insisted upon the manufacturers to declare the actual percentage of their own rework material used. This recommendation is based on the latest revision in the standards for PVC pipes, ie



IS: 4985-2000, Clause 6.2, which has been modified to allow full usage of manufacturer's own rework.

Clause No: 5.1.1

The existing clause recommends that the outside diameter of the pipe shall be average of 4 measurements taken at 45° around the pipe. This is a very cumbersome and time consuming process which has no relevance for the final product quality and hence the same shall be revised as the outside diameter of pipe shall be average of 2 measurements taken at 90° apart.

Clause No: 5.1.1

The clause for tensile strength of pipe and elongation at break at $27 \pm 1^{\circ}\text{C}$ shall be revised as given below:

Particulars	Existing	Proposed
Tensile Strength, Mpa	10	12.5
Testing Speed, mm/min	$100 \pm 10\%$	$100 \pm 10\%$
Elongation at Break, %	350	500

Such upward revision of these strength parameters will reduce the chances of use and/or mixing of lower quality raw materials and to improve the quality of final product.

Clause No: 7.4

This clause recommends tests for verification of the Environmental Stress Crack Resistance (ESCR). The guidelines for such tests are not adequate and are much lower than the prevailing international specifications such as ASAE S-435 as can be seen from the comparison below:

Particulars	Existing	Proposed
% of Igepal (Surface Active Agent)	100%	10%
Test temperature, deg	$C50 \pm 3$	76.7 ± 2.8
Time Duration, hours	0.5	48

ESCR is the most critical property, which decides the durability/performance of laterals in the field when they are exposed to the sunlight. It is also the property of basic resin, which cannot be altered. As India is a tropical country and the temperatures in summer reach as high as 47°C , the surface temperature of the



tubes reaches 80° C as they are black in color, the proposed revision is very significant in ensuring quality and long term durability while exposed to Sun.

Miscellaneous

In addition to the above proposed revisions, the following revisions also are necessary.

Standard/Clause	Particulars	Existing	Proposed
\DOC STI IS 12786/2 1992, Clause 1,2	Frequency of Calibration of testing equipment	Periodic	To be specified as once in or 6 months an year
DOC STI IS 12786/2 1992, Clause 1,2	Dimensional verification at both ends of coil	For each coil	One coil in every 4 hours of producton
DOC STI IS 12786/2, 1992	Frequency of Test for Tensile Strength	Three pieces per control unit	One Piece per control unit

The above revisions were already agreed in the All India Review meeting on Irrigation Equipment Standards held at Mumbai on 7th Aug 1998, however they were not implemented so far.

II) IS: 13488-1992 for Emitting Pipes

Clause No 4.2:

- a) The Pressure classes in the existing standard are Class 1, 2, 3 and 4 designating the pressure rating of 0.10 Mpa, 0.125 Mpa and 0.25 Mpa and 0.4 Mpa respectively. These pressure classes and ratings are different to those in IS:12786 – 1989 for Drip Laterals. Uniformity in pressure classes between Drip Laterals and Emitting pipes will avoid confusion among the manufacturers as well as the farmers.

The revisions proposed are detailed below:

S.No.	Existing		Proposed Revision	
	Class	Pressure Rating, Mpa	Class	Pressure Rating, Mpa
1	1	0.10	1	0.20
2	2	0.125	2	0.25
3	3	0.25	3	0.40
4	4	0.40	--	--



The above suggestion will be in line with the standard for Drip Laterals. Also, the Classification will be more technical/logical than being arbitrary as is the case today.

- b) It is also noted that the wall thickness of emitting pipes in different pressure classes overlap with that of the next higher class, whereby there exists a scope for foul play by the smart manufacturers who designate their products as of higher pressure rating with same or less wall thickness as can be seen from the Table below:

Outer Diameter of lateral pipe,mm	Wall Thickness, as per existing Standard. mm							
	Class 1 (0.10Mpa)		Class 2 (0.125 Mpa)		Class 3 (0.25Mpa)		Class 4 (0.40 Mpa)	
	Min	Max	Min	Max	Min	Max	Min	Max
12	0.5	0.7	0.6	0.8	1.0	1.2	1.1	1.3
16	0.7	0.9	0.8	1.0	1.2	1.4	1.4	1.6
20	0.8	1.0	1.0	1.2	1.3	1.5	1.5	1.7
25	1.0	1.2	1.2	1.4	1.4	1.8	1.9	2.3

A study of the above Table reveals the overlaps such as in 12mm Class 1 the wall thickness is 0.5 to 0.7 whereas the same in Class 2 is 0.6 to 0.8. Thus, a wall thickness of 0.6-0.7 can be categorised and price as Class 2 even though the wall thickness is that of Class 1, thus misleading the customers.

- C) Subsequent to the above suggested revision in Pressure ratings, and the need for avoiding overlap in wall thickness, the Class wise Wall Thickness for different sizes of emitting pipes can be revised as given in the Table below.

Outer Diameter of lateral pipe,mm	Wall Thickness, mm					
	Class 1 (0.20Mpa)		Class 2 (0.25 Mpa)		Class 3 (0.40Mpa)	
	Min	Max	Min	Max	Min	Max
12	0.6	0.8	0.9	1.1	1.2	1.4
16	0.8	1.0	1.1	1.3	1.4	1.6
20	0.9	1.1	1.2	1.4	1.5	1.7
25	1.2	1.6	1.7	2.0	2.1	2.4



Clause No: 6

Diameter of Emitting pipes is presently designated on the basis of Outer diameter, due to which the Internal diameter keeps varying in different pressure classes in same size of emitting pipe. Such variation in internal diameters makes it necessary for the development of different sizes of drip emitters to be inserted into the tube, as well as the fittings of such emitting pipes will have to be of different diameters.

All of these result in increased costs of production due to the requirement of different moulds, tools, for each size and each pressure rating. Thus, there exists a scope for cost reduction by designating the Emissions pipes on Internal diameter (ID) basis by keeping the ID same and varying the thickness, so that the drippers and fittings will be same for all pressure classes in a given size of emitting pipe.

Such a measure will also improve the product performance as the flow through the pipes of different classes of same size will be constant because of constant ID.

Clause No: 8.7

This clause recommends tests for verification of the Environmental Stress Crack Resistance (ESCR). The guidelines for such tests are not adequate and are much lower than the prevailing international specifications such as ASAE S-435. The existing guideline and the recommended guideline are compared below:

Particulars	Existing	Proposed
% of Igepal (Surface Active Agent)	100%	10%
Test temperature, deg C	50 $\pm$ 3	76.7 $\pm$ 2.8
Time Duration, hours	0.5	48

ESCR is the most critical property, which decides the durability/performance of laterals in the field when they are exposed to the sunlight. It is also the property of basic resin, which cannot be altered. As India is a tropical country and the temperatures in summer reach as high as 47⁰ C, the surface temperature of the tubes reaches 80⁰ C as they are black in color, the proposed revision is very significant in ensuring quality and long term durability while exposed to Sun.



Clause No: 8.8 Determination of Emitter Exponent

This clause specifies determination of emitter exponent for regulated emitters (pressure compensated emitters), where as such determination is essential for unregulated emitters (Turbulent flow emitters) also. Such revision will help customers in understanding the Clog resistance of the emitter and the performance with respect to the irrigation uniformity in the field.

Clause No: 6 DOC STI 13488/1 June 1996

This clause stipulates that the dimensions should be checked at both ends of each coil length. As such checking for every coil is cumbersome and not feasible due to high speed of extrusion (100 m/min), it is recommended to revise the frequency to one in every ten coils. Even though this recommendation was accepted in the All India Review meeting on Irrigation during 7th August 1998 at Mumbai, the same is still not ratified by the Standards committee.

Clause No: 6 DOC STI 13488/1 June 1996

The clause specifies that the flow path on the emitting pipe has to be checked once in every two hours of production for 3 samples. This should be amended to once per control unit (production shift), as the dimensional reliability in injection-moulded drip emitters is very high and hence there is no need for very high frequency of verification.

III) IS: 14151 (Part 1) -1999 for PE pipes for Sprinkler Irrigation Systems

Clause No 4.4:

The existing clause recommends use of 10% of manufacturer's own rework material from pipe manufacture along with virgin raw material while manufacturing the pipes. As use of manufacturer's own rework material does not result in any degradation or deterioration in the final product, as well as to uphold the universal policy of recycling of plastics, it is recommended that the upper limit of 10% for manufacturer's own rework material be withdrawn and it should be insisted upon the manufacturers to declare the actual percentage of their own rework material used. This recommendation is based on the latest revision in the standards for PVC pipes, ie IS: 4985-2000, Clause 6.2, which has been modified to allow full usage of manufacturer's own rework.



IV) IS: 13487-1992 for Emitters

Clause No 8.3: Determination of Emitter Exponent

This clause specifies determination of emitter exponent for regulated emitters (pressure compensated emitters), where as such determination is essential for unregulated emitters (Turbulent flow emitters) also. Such revision will help customer in understanding the Clog resistance of the emitter and the performance with respect to the irrigation uniformity in the field.

DOC STI 13487/1 January 1994 – Flow path dimensions

This standard specifies verification of flow path dimensions on the emitters, as 5 samples per cavity per mould per control unit, which is very cumbersome as the emitters are mass produced in lakhs of pieces every day from number of moulds. Also the moulds are usually multi cavity moulds with the number of cavities as high as 32 and beyond.

The frequency of flow path dimensional verification needs to be amended to one sample per cavity per control unit (production shift) or once in a week as the dimensional reliability in injection-moulded drip emitters is very high and hence there is no need for very high frequency of verification.

V) IS: 14483-Part 1 1997 for Ventury Injectors

Clause No 4.4:

This clause mandates provision of metering device on the suction hose of the ventury injector for adjusting flow of chemicals through the suction port. Such a compulsory use of metering device is not necessary because the manufacturer has to declare the performance data for the ventury as per the clause 8.1-c of the same standard. Further control of suction is usually not required and hence the metering device can be made optional instead being mandatory. This will help in further cost reduction in the ventury assembly and make the system/components more affordable.

Similarly, this clause also insists on use of an in-built check valve in the suction line of the ventury, which also needs to be made optional for reducing the cost of ventury assembly.



Clause No 5.2.1:

The clause stipulates the measurement of Motive flow and suction rate with a test liquid prepared by mixing 2 kg of urea in 10 liters of water. It is recommended that the test liquid can be water at ambient temperature for routine tests and a separate chart/table can be prepared to contain suction rates with different liquid densities for a given ventury model.

VI) IS: 12785-1994 for Strainer Type Filter**Clause No 4.1.1:**

The Clause specifies the thickness of powder coating or Galvanising as 70 to 80 microns. It is recommended to fix only the lower limit for the thickness of coating, so that the confusion due to the range and/or upper limit can be avoided. Also some of the locations near welds, etc it is practically not feasible to maintain a proper thickness of coating as at times the thickness of coating at these locations can go up beyond the existing upper limit of 80 micron.

Clause No 4.3.2:

The flange connection for inlet/outlet of strainer type filter is stipulated to be of IS: 6418- 1971 for CI Flanges or IS: 6392-1971 for MS flanges. However, the Flanges as per the dimensions given in Table-D of BS-10 shall also be allowed, as most of the flanges available in the market are as per the dimensions given in the above referred Table.

Clause No 6.1.2:

The standard specifies that the drain valve to be fitted on the Strainer type filter needs to be opened and closed for 100 times to ensure its performance. This requirement can be dropped as valve manufacturer individually tests the valves and hence there is no need for repeating the test once again.

Clause No 6.5:

The clause specifies that the tests should be carried out once in every production shift, which is very cumbersome and time consuming. The frequency shall be revised as once in a week. Such a lower frequency is adequate as the filter elements



are always new and hence there cannot be any variation within each production shift.

VII) IS: 14606-1998 for Media Filters

Clause No 7:

The recommended design flow rates for media filters have been fixed in the Standards as 63 to 76 m³/hr/m² for light (0 to 10 ppm) contamination. This range of design flow rate is quite low and will result in higher filtration area, whereby the cost of the media filters is unaffordable for the small farmers. Hence, it is recommended that the design flow rate be revised to 63 to 100 m³/hr/m², whereby the cost of media filters can be made affordable.

Clause No 4.1.1:

The Clause specifies the thickness of powder coating or Galvanising as 70 to 80 microns. It is recommended to fix only the lower limit for the thickness of coating, so that the confusion due to the range and/or upper limit can be avoided. Also some of the locations near welds, etc it is practically not feasible to maintain a proper thickness of coating as at times the thickness of coating at these locations can go up beyond the existing upper limit of 80 micron.

The clause specifies that the tests should be carried out once in every production shift, which is very cumbersome and time consuming. The frequency shall be revised as once in a week. Such a lower frequency is adequate as the filter elements are always new and hence there cannot be any variation within each production shift.

Clause No 4.3.2:

The flange connection for inlet/outlet of media filter is stipulated to be of IS: 6418-1971 for CI Flanges or IS: 6392-1971 for MS flanges. However, the Flanges as per the dimensions given in Table-D of BS-10 shall also be allowed, as most of the flanges available in the market are as per the dimensions given in the above referred Table.



Clause No 5.3.3:

The clause prescribes that the tests to be conducted on the media filters have to be in the range of 80 % to 125 % of manufacturer's declared design flow rate, in 7 equal incremental steps. The stipulation for 7 incremental steps is too cumbersome and time consuming and hence it can be brought down to 3 equal incremental steps. Such a revision will allow faster verification of the filters whereby the cost on testing and quality control can be brought down making the filters more affordable.

Clause No 3.6:

The clause stipulates use of 30 to 50mm drain ports for the media tanks, which is very high compared to the volume of tanks. Hence it is recommended to revise the clause for 20mm to 50 mm drain ports so that the cost on the same can be brought down.





Annexure XI

Statement showing Import of Agricultural Products from 1998-99 to 2002-03.

Qty. '000' tonnes, value Rs. In crores

Sr. No.	Item	1998-99		1999-2000		2000-01		2001-02		2002-03 (P)	
		Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value
1	Pulses	563.60	708.81	250.77	354.69	349.84	498.47	2217.8	3160.16	1879.52	2562.67
2	Cashew Nuts	243.35	968.76	256.00	1198.26	249.32	960.85	161.79	431.14	401.20	1230.64
3	Fruits & Nuts (exclude. Cashew nuts)		670.39		590.84		797.76		756.76		610.36
4	Spices	61.12	298.58	65.08	294.10	43.87	254.13	86.29	503.87	118.29	568.47
5	Oil Seeds		8.52		15.42		7.21		1.34		11.48
6	Vegetable oils fixed (edible)	2621.85	7588.90	4195.64	8046.05	4177.17	5976.53	4321.8	6464.97	4266.00	8744.88
7	Sugar	900.47	1111.2	1181.18	1110.80	30.40	31.11	25.58	32.60	41.29	32.66
	Total	4390.39	11355	5948.67	11610.20	4850.60	8526.06	6813.26	11350.80	6706.30	13761.20

PRINCIPLES FOR ESTIMATION OF WATER AND POWER REQUIREMENT FOR INSTALLATION OF DRIP IRRIGATION SYSTEM

A. ESTIMATION OF QUANTITY OF WATER

To irrigate an area by drip irrigation system sufficient quantity and rate of water should be made available at the given place. To estimate the minimum quantity of water for meeting the irrigation water requirement of any area, the following steps are required.

Collection of General Information

General information on water source, crops to be grown, topographic conditions, type and texture of soil and climatic data are essential for designing the drip irrigation system.

Layout of the field

The layout of the field by giving the path and lengths of main line, sub main line and lateral lines in metres to connect water source with the existing / planned crop in the area must be worked out.

Crop water requirement

Water requirement of crops (WR) is a function of plants, surface area covered by plants, evapotranspiration rate. Irrigation water requirement has to be calculated for each plant and thereafter for the whole plot based on plant population, for different seasons. The maximum discharge required during any one of the different seasons is adopted for design purposes. The daily water requirement for fully-grown plants can be calculated as under:

$$V = E_p \times K_c \times K_p \times W_p \times S_p$$

The total water requirement of the farm plot would be $V \times \text{No. of plants}$ Where:

V is the Water requirement (liters per day per plant)

E_p is the pan evaporation (mm/day)

K_c is the Crop factor

K_p is the pan factor

W_p is the wetted area (0.3 for widely spaced crops and 0.9 for closely spaced crops)

S_p is the spacing of crops / plant, (m^2)



B. ESTIMATION OF HORSE POWER OF PUMPING UNIT

Power is required to pump the required irrigation water from the source and to develop sufficient pressure to operate the drippers effectively.

The ideal drip irrigation system is one in which all drippers (or orifices) deliver the same volume of water in a given irrigation time. The dripper flow variation caused by water pressure can be controlled by hydraulic design.

Flow carried by each lateral line (de) =

Discharge of dripper x No. of drippers per plant x No. of plants along each lateral.

Flow carried by each sub-main line (ds) = $de \times \text{No. of lateral line per sub main line}$

Flow carried by each main line (dm) = $ds \times \text{No. of sub-mains}$

The friction head loss in mains can be estimated by Hazen-Williams formula given below :

$$hf = 10.68 \times (Q/C)^{1.852} \times D^{-4.87} \times (L + Le)$$

hf = Friction head loss in pipe (m)

Q = Discharge (m^3 / sec)

C = Hazen - William constant (150 for Plastic pipes)

D = Inner dia of pipe (m)

L = Length of pipe (m)

Le = Equivalent length of pipe and accessories

The design of lateral pipe involves selection of pipe size for a given length, which can deliver required quantity of water to the plant or alternatively the maximum length of lateral pipe for a given maximum allowable head-loss

In designing the lateral, the discharge and operating pressure at drippers are required to be known and accordingly, the allowable head loss can be determined by the same formula as the main line.



DESIGN CRITERIA

1. It should be ensured that the head loss in the lateral length between the first and last emitter is within 10 per cent of the head available at the first emitter.
2. The friction head loss in the mainline should not exceed 1m/100m length of the mainline

Friction head loss for various discharges is calculated based on the Hazen-Williams Formula and on the equivalent lengths of straight pipe in metres giving equivalent resistance to flow in pipe fittings.

After finalisation of dimensions of main, sub-mains and laterals the selection of pump consists of the following steps.

Total pressure head drop in metres due to friction (H_f) = Friction head loss of main + Friction head loss of sub-mains + friction head loss of laterals.

Operating pressure head required at the dripper = H_e in metres.

Total static head = H_s in metres

Total Pumping Head (H) = $H_f + H_e + H_s$

Discharge of main = d_m litres / sec

Efficiency (overall), (e) = (60% for electric pump & 40% for diesel engine driven pump)

$$H.P. = \frac{H \times d_m}{75 \times e}$$

Worked Out Example:

A farmer proposes to install drip irrigation system for a new citrus plantation on a 1 ha plot.

Basic Data Analysis

1. No. of Plants

$$\text{Area} = 1 \text{ ha} = 100 \times 100 \text{ m}$$

$$\text{Spacing (m)} = 6 \times 6$$



$$\text{No. of plants} = \frac{100 \times 100}{6 \times 6} = 277$$

2. Estimation of Water Requirement

The irrigation water requirement is determined using IMD pan evaporation data. The average monthly pan evaporation data for the area is given below:

Month	Normal Monthly Pan Evaporation Data, mm
January	99.2
February	119.6
March	176.3
April	210.2
May	245.4
June	198.8
July	145.6
August	134.6
September	134.6
October	144.6
November	112.2
December	94.4
TOTAL	1,815.5

From the above data the seasonwise total pan evaporation as well average pan evaporation is given below

S.N.	Season	Days (Nos)	Total evaporation during the season (mm)	Pan Average Daily Pan evaporation (mm/day)
1	Kharif (15/6 to 15/10)	122	585.8	4.80
2	Rabi (16/10 to 28/2)	136	497.4	3.65
3	Summer (1/3 to 14/6)	107	737.3	6.83



The daily water requirement of plants is given below :

S.No.	Season	Evaporation	Water requirement	
			lpd/plant	m ³ /day/ha
1	Kharif	4.8	36.3	10
2	Rabi	3.65	27.6	7.6
3	Summer	6.83	51.6	14.3

Therefore, the drip irrigation system has to be designed for the maximum requirement of 51.6 litre/day/plant during the summer season. For this the water requirement works out to 14.3m³/day/ha of plantation. If the average working hours of pump set is taken as 4 hours per day, the discharge required would be as below:

$$\begin{aligned}
 \text{Pumping rate} &= 13 \text{ litres / hr/plant} \\
 \text{Pumping rate per ha.} &= 14.3 \text{ m}^3/\text{day/ha} \\
 &= 3.6 \text{ m}^3/\text{hr/ha} \\
 &= 0.97 \text{ lps or day } 1 \text{ lps}
 \end{aligned}$$

Alternatively, a tank of 14.3 m³ capacity can be provided so that uninterrupted irrigation may continue for 4 hours even in areas where power shut offs are frequent.

1. Selection of Drippers

Number of Drippers

Depending upon the type of dripper and discharge required their number can be estimated. For a pressure head of 10 m and discharge at 4 litre / hour the number of drippers required are :

$$\begin{aligned}
 \text{No. of drippers/plant} &= \frac{\text{Rate of pumping / hour / plant}}{\text{Avg. discharge of one dripper}} \\
 &= 13/4 \text{ or } 3.22 \text{ say } 3
 \end{aligned}$$

The plot is square and of 1 ha. As such the mainline would be 100 m long and laterals would also be 100 m in length. A plant spacing is 6 m x 6 m, a total of 17 laterals would be required. Each lateral would serve approximately 16 plants and there would be 3 drippers per plant. Thus, the total number of drippers per lateral would be 16 x 3 = 48 nos.



2. Main Line and Laterals

Main Line

The main line is designed to carry the maximum discharge required for total number of plants in the farm plot.

$$\begin{aligned}\text{Maximum discharge required} &= \text{No. of plants} \times \text{peak discharge per plant} \\ &= 277 \times 13 = 3601 \text{ lph or } 1 \text{ lps}\end{aligned}$$

Friction Head loss in pipes (m)

$$\text{Total length of pipe} = 100.0$$

Equivalent length of

$$17 \text{ straight connections} = 8.5$$

Equivalent length of tee

$$\text{bends, etc} = 6.0$$

$$\text{TOTAL} = 114.5 \text{ or say } 115 \text{ m}$$

From, Hazen William Equation it would be seen that for discharge of 1 LPs through a pipe of say 40 mm diameter, the friction loss would be 2 m per 100 m length of 2.3 m for 115 m equivalent length.

$$\text{Friction head loss} = 2.3 \times 0.88 = 2.02$$

$$\text{Conversion factor} = (0.88)$$

As the proposed system uses multiple openings, the friction loss is taken as 1/3 of the total friction loss i.e. $2.03/3$ i.e. 0.67 m. Thus the loss in mains is within 1.0 m/100 m and a pipe of 40 mm diameter will be ideal in the layout.

4. Laterals

A lateral is so selected that the pressure difference from the proximate end to the last dripper does not exceed 10 per cent of the normal operating head which in the present case is $10 \times 10/100 = 1.0$ for lateral of 100 m length. The land slope is 0.5 m / 100 m. Thus the total friction loss allowable is $1 + 0.5 = 1.5$ m.

In addition to 100 m length of laterals there is additional loss due to connectors. This



is generally taken as 0.1 to 1 m (on an average 0.5) of the equivalent length per dripper. The equivalent length of 48 drippers would thus be $48 \times 0.5 = 24$ m. Thus, total equivalent length for calculation of friction loss in laterals would be 24 m. The total flow in laterals is 192 lph. i.e. $4 \times 3 \times 16$. A perusal of Hazen William Equation shows that for 200 lph flow the friction loss in 13.9 mm inner diameter pipe would be 1.7 m per 100 m length. Therefore, in 124 m length it would be 2.20 m. It is a general practice that friction losses are taken at 1/3 of the total equivalent length of pipes with multiple dripper/connections. Thus the friction loss works out to $1/3 \times 2.2 = 0.74$ m, which is within the maximum permissible limit of 0.9 m. Therefore, 14 mm (OD) lateral pipe of 100 m length is suggested in this scheme.

5. Horse Power of Pump-set

The HP of pump-set required is based upon design discharge and total operating head. The total head is the sum of total static head and friction losses in the system.

Static Head

i) The total static head, m is the sum total of the following

a. Depth to water (borewell)	15
b. Draw-down	3
c. Outlet level above ground level	1
d. Friction loss in pipes, bends, etc	2
	21

ii) The friction loss in the drip unit is as under

a. Friction loss in main pipe	0.67
b. Friction loss in laterals	0.75
c. Minimum head required over drippers	10.00
	11.42



$$\begin{aligned}
 \text{Total Head} &= \text{Static Head} + \text{Friction head loss} \\
 &= 21.00 + 11.42 \\
 &= 32.42 \text{ or say } 33 \text{ m} \\
 \text{Hp of pumpset} &= \frac{Q \times H}{75 \times e} \\
 \text{Where } Q &= \text{Discharge (lps)} \\
 H &= \text{Head (m)} \\
 e &= \text{Pumping efficiency (0.6)} \\
 \text{Hp} &= \frac{1 \times 33}{75 \times 0.6} = 0.73 \text{ or say } 1 \text{ H.P.}
 \end{aligned}$$



ANNEXURE -XIII

FIELD LEVEL QUESTIONNAIRE FOR ASSESSMENT OF WATER AND POWER AVAILABILITY FOR INSTALLATION OF DRIP IRRIGATION SYSTEM

1. NAME OF THE APPLICANT
2. RESIDENTIAL ADDRESS
3. FARM ADDRESS / LOCATION (Survey. No. TO BE INDICATED)
4. TOTAL FARM AREA
5. AREA PROPOSED TO BE IRRIGATION UNDER DRIP

	Plot 1	Plot 2	Plot3	Plot4

CROP

AREA UNDER CROP

ROW TO ROW DISTANCE

TOTAL NO. OF PLANTS

6. TYPE OF SOIL

7. WHAT IS THE WATER SOURCE PROPOSED

TO BE USED BY THE FARMER

8. OPEN WELL

- a. Depth of water table (in metres)
- b. Date and season during which assessment made
- c. Drawdown in metres
- d. Height of outlet above ground level
- e. Assessment of water availability (in litres / second)
- f. Method used for determining water availability
- g. Total duration for which pumping was done



- h. Duration of pumping after which constant water level was obtained
- i. Pump used / Mention make (electric / diesel)
- j. H.P. of pump used
- k. Diameter of outlet pipe

9. TUBEWELL / BOREWELL

- a. Depth of water table (in metres)
- b. Date and season during which assessment made
- c. Drawdown (in metres) (PI refer Annexure VIII)
- d. Height of outlet above ground level
- e. Assessment of water availability (in litres/second)
- f. Method used for determining water availability
- g. Total duration for which pumping was done
- h. Duration of pumping after which constant water level was obtained
- i. Pump used (mentioned make) (electric / diesel)
- j. Horse power of pump
- k. Diameter of outlet pipe

10. SURFACE FLOW / STREAM IN HILLY AREAS

- a. Rate of flow of water (in litres/ second) in the stream during the lean season
- b. Methodology used for assessing the rate of flow of water
- c. Whether storage tank is available ?
- d. If so, capacity of the storage tank ?
- e. Structure used for diversion of water into storage tank



11. STORAGE TANK USING CANAL WATER

- a. Distance of farmer's field from canal delivery point
- b. Whether storage tank has been constructed or is proposed to be constructed by the farmer
- c. If so, capacity of the storage tank?
- d. Elevation of the storage tank above ground level
- e. Availability of water in the canal according to "turn" system (No. of days in a week / fortnight/month)
- f. Pump available with farmer (electric / diesel) to lift water from canal to water storage tank (mention make)
- g. Horsepower of the pump

12. DETAILS OF PUMP

- a. Does the farmer own a pump
- b. If so, of what make?
- c. What is the horsepower of the pump?
- d. In the case of electric pump no. of hours per day for which electric ity is generally available
- e. In the case of diesel pump, name of the nearest diesel station
- f. Does the farmer propose to buy a new pump (if so, specify make and H.P.)
- g. Other farm machinery owned by farmer (eg. tractor, tiller, thresher etc)

13. NEARBY DRIP INSTALLATIONS

- a. How many drip irrigation installation are there in the same village?
- b. What is the approximate area under these installations?
- c. What are the problems faced by the existing drip installations ?

Name, Signature & Designation of Field Officer



14. DISTRICT AGRICULTURE OFFICERS ANALYSIS OF WATER AND POWER AVAILABILITY

- a. Total requirement of water for the area proposed to be covered by farmer under drip irrigation (litres per day/plant x total number of plants or total requirement in litres per ha. x total area)
- b. Total availability of water?
- c. Area recommended to be brought under drip irrigation
- d. Horsepower of pump available
- e. Horsepower of pump required
- f. Recommendation regarding area to be covered under drip irrigation (also give recommendation regarding upgradation of pumping capacity, if required)
- g. Recommendation regarding elevation, capacity and construction of storage tank.

Signature of DAO



METHODOLOGY FOR ASSESSMENT OF WATER AND POWER AVAILABILITY

I. In cases where the water source is an open well or tubewell/ borewell, then for assessment of water availability and pumping power requirement it is necessary to compute the following:

- a. Depth of the water table
- b. Discharge of the well
- c. Total pumping level

1. The depth of water level below the ground level, before pumping begins, is the depth of the water table. It can be measure by a simple procedure using a rope with a stone tied at one end.

2. The discharge of the well / tubewell is measure after running the pump for a period of 30 minutes to 1 hour. It can be measure by adopting volumetric measure. Under this method, the discharge is emptied into a ditch of container of know dimensions for a certain length of time. The rate of discharge is calculated by dividing the total volume of water discharged by the time taken. This method works for low discharge say upto 5 litres per second.

For higher discharges volumetric measurement may be difficult and therefore standard devices like water metre / c.notch/flume may be used. In the case of non-availability of these devices the discharge may be assessed approximately using the co-ordinate method described below:

COORDINATE METHOD:

For measuring the discharge from wells/ tubewells. the outlet pipe should be horizontal. The x and y co-ordinates are measured from the centre of the pipe to the centre of the water jet.

The discharge is computed using the equation



$$Q = \frac{A\sqrt{x} \times g \times X \times (1000)}{\sqrt{(2Y)}}$$

where Q = Discharge in litres / second

A = Cross sectional area of the pipe in m²

X = X co-ordinate in metres

Y = Y co-ordinate in metres

g = Acceleration due to gravity (m /sec²)

3. Total pumping level includes the depth of the water level, draw-down and height of the outlet above the ground level. To measure the draw-down the pump installed over the well/tube-well is run for a period of 30 minutes to 1 hour so that constant water level is attained in the well/tube-well. The new depth of the water level is measured. The difference between the depth and the original depth of the water table is the draw-down. The height of the outlet level above the ground level is also to be measured. Once the total pumping level is determined, the horsepower.

4. Power rating of the pump required can be approximately determined with the reference to the table given below:

POWER REQUIREMENT TO PUMP AND OPERATE DRIP IRRIGATION SYSTEM FOR ORCHARD AND VEGETABLE CROPS

S. No.	Static water depth (m)	Orchard Crop (hp/ha)	Vegetable Crop (hp/ha)
1.	00-10	0.64	1.93
2.	11-20	0.87	2.61
3.	21-30	1.10	3.30
4.	31-40	1.31	3.93
5.	41-50	1.53	4.59
6.	51-60	1.76	5.28
7.	61-70	1.98	5.94
8.	71-80	2.20	6.60
9.	81-90	2.42	7.26
10.	91-100	2.64	7.92



5. In cases where the water source is perennial stream of low discharge generally available in hilly areas), drip irrigation systems can be operated by diverting these streams at a higher elevation to a small storage tank of approximately 2 cubic meter capacity and it can be directly connected to the drip irrigation system for irrigating lands at a lower elevation. If drip irrigation system is being used with drippers then the average elevation difference between tank and area of operation should be 12-15 metres. If micro tube system is used elevation difference of 3 m to 4 m would be sufficient to operate the system. The area proposed to be irrigated should be commensurate with the flow of water in the stream. If flow of 1 litre per second is available it is sufficient to irrigate 1 ha of orchard crops at a time.

The rate of flow of water in the stream can be measured by volumetric measurement or by using other devices mentioned above.



THOSE WHO CONTRIBUTED TO THE WORK OF TASK FORCE ON MICROIRRIGATION

Member of TFM

1. Shri N. Chandrababu Naidu, Chief Minister of Andhra Pradesh, Hyderabad.
2. Shri Govindrao Adik, Minister of Agriculture, Government of Maharashtra, Mumbai.
3. Shri Ajit Pawar, Minister of Horticulture, Government of Maharashtra, Mumbai
4. Dr. M.S. Swaminathan, Chairman, M/s Swaminathan Research Foundation, 3rd Cross Street, Taramani Institutional Area, Chennai– 600113.
5. Shri R.C.A. Jain, Secretary (A&C), Department of Agriculture & Cooperation., Krishi Bhavan, New Delhi
6. Shri J.N.L. Srivastava, Ex Secretary (A&C), C-1/13, Bapanagar, New Delhi – 110 003.
7. Dr. H.P. Singh, Horticulture Commissioner, Krishi Bhavan, New Delhi

Special Invitees

8. Dr. S.K. Goel, Commissioner of Agriculture, Government of Maharashtra, Pune 411005
9. Shri B. H. Jain, Chairman, Jain Irrigation Systems Ltd., Jalgaon, Maharashtra

Ministry of Agriculture

10. Shri Rajnath Singh, Minister of Agriculture, Govt. of India, New Delhi.
11. Shri R.C.A. Jain, Secretary (A&C), Department of Agriculture & Cooperation., Krishi Bhavan, New Delhi
12. Dr. H.P. Singh, Horticulture Commissioner, Krishi Bhavan, New Delhi,
13. Dr. Jose C. Samuel, Deputy Commissioner (SWC-E), Department of Agri. & Cooperation, Horticulture Division, Krishi Bhavan, New Delhi



14. Shri Prashanta Mishra, Joint Secretary, NCPAH, Himalaya House, IInd Floor, 23, K.G. Marg, New Delhi
15. Mr. P.K. Agarawal, Joint Secretary and Agricultural Marketing Advisor, MoA, Krishi Bhavan, New Delhi
16. Mr. Satish Chander, Joint Secretary, Integrated Nutrient Management, Krishi Bhavan, New Delhi
17. Mr. Ashok Jha, The-Then additional Secretary, Dept of Agriculture & Co-operation, Krishi Bhavan, New Delhi

State Governments

18. Shri V.S. Rao, Minister of Agriculture, Government of Andhra Pradesh, Hyderabad
19. Shri P. Narayana Swami Naidu, Minister of Horticulture, Govt. of Andhra Pradesh
20. Shri Bhupendra Sinh Chudasama, Minister of Agriculture, Government of Gujarat, Gandhi Nagar
21. Shri R.K. Thekho, Minister of Horticulture, Govt. of Manipur, Imphal
22. Minister of Agriculture, Sikkim.
23. Dr. Mohan Kanda, Chief Secretary, Govt. of Andhra Pradesh
24. Dr. V.P. Jauhari, IAS, Agriculture, Production Commissioner & Pr. Secretary to Govt. Andhra Pradesh, Hyderabad.
25. Shri J.S. Saharia, Secretary of Agriculture, Govt. of Maharashtra, Mantralaya, Mumbai.
26. Dr. U.C. Sarangi, Commissioner for Cooperatives & Registrar of Coop. Societies, Central Building Annex, Pune .
27. Shri J.S.V. Prasad, Commissioner of Horticulture, Government of Andhra Pradesh, Public Garden, Hyderabad.
28. Dr. B.R. Shah, Jt. Director of Horticulture, Govt. of Gujarat, Rohit Chamber (Nr. Bharat Sewashram Sangh), Ashram Road, Navrangpura, Ahmedabad.
29. Dr. V.P. Ahlawat, Director of Horticulture, Govt. of Haryana, Sericulture Complex, Sector, 21, Panchkula – 134108



30. Shri R.D. Mulay, Director of Horticulture, Govt. of Maharashtra, Pune.
31. Dr. G.K. Vahanta Kumar, Director of Horticulture, Govt. of Karnataka, Lalbagh, Bangalore.
32. Shri K. Dhanvel, IAS, Director of Horticulture and Plantation Crops, Govt. of Tamil Nadu, Agriculture Complex, III Floor, Chepauk, Chennai.

Universities/ Research Institutes/PFDCs

33. Dr. M Velayutham, M/s Swaminathan Research Foundation, Chennai.
34. Dr. S.S. Magar, Vice Chancellor, Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri.
35. Dr. U.B. Pande, Director, NHRDF, 2954-E, Kanadu Butata Bhavan, Nasik, Maharashtra.
36. Dr. Ashwani Kumar, Project Coordinator, AICRP- Plasticulture, CIPHET, PAU Campus, Ludhiana, Punjab.
37. Dr. P.G. Adusule, NRC for Grape, Post Box No. 3, Manjri Farm Post, Solapur Road, Pune.
38. Dr. C. Gopala Rao, Head, Deptt. of Agricultural Engineering, N.G. Ranga A.P. Agriculture University, College of Agricultural Engineering, Rajendranagar, Hyderabad.
39. Dr. (Mrs.) D.B. Pookan, Principal Investigator (PDC), Department of Agronomy, Assam Agricultural University, Jorhat- 785013, Assam
40. Dr. A.K. Tiwari, Head Soil & Water Conservation Engineering, Pusa Samastipur, Bihar.
41. Dr. Rajindra Singh, Department of Soil & Water Engineering, Haryana Agricultural University, Hissar, Haryana- 125004.
42. Dr. B.C. Thakur, Associate Professor, Deptt. of Soil Science, Dr. Y.S. Parmar University of Hort. & Forestry, Solan, Himachal Pradesh.
43. Dr. T.B.S. Rajput, Principal Scientist, Water Technology Centre, IARI, New Delhi
44. Dr. Krishna Manohar, University of Agricultural Sciences, Division of Horticulture, GKVK, Bangalore – 560065 Karnataka.



45. Dr. John Thomas, Dean & Principal Investigator, PFDC, Kerala Agriculture University, Tavanur, Kerala.
46. Shri U.S. Kadam, Principal Investigator, PFDC, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra
47. Dr. Gorakh Singh, Principal Investigator, CISH, Rehmankheda, Lucknow, Uttar Pradesh.
48. Dr. K.K. Shukla, Principal Investigator, G.B. Pant University of Agriculture & Technology, Pant Nagar – 263145. Uttar Pradesh.
49. Dr. K.N. Tiwari, Investigation-in-Charge, Department of Agricultural Engineering, Indian Institute of Technology, Kharagpur – 721302. West Bengal.
50. Dr. S. Raman, Principal Investigator (Retd.), Gujarat Agricultural University, Navsari, Gujarat
51. Dr. A. Narayanamoorthy, Gokhale Institute of Politics & Economics, Pune.
52. Padmabhushan Dr. R.P. Singh, Former Asst. Director Gen. FAO, New Delhi.

President Secretaries of Commodity Federations/Association

53. Shri S.S. Mehta, President, Amla Growers Association of India, 256, Asvaita Ashram Road, Fair Lands, Salem–636016 (TN)
54. Shri K. Natarajan, President, Flowers Growers Federation of India, Natural Synergies Ltd., 20 (Old 156), Santhome High Road, 1Chennai – 600004 (T.N.)
55. Dr. I. Irulappan, President, Mango Growers Association of India, 76, Maxworthnagar, Chennai – 602101 (T.N.)
56. Shri Mohanraoji Totey, President, Orange Growers Federation of India, At Post Hiwerkhed, Tehsil, Morshi, District Amravati (MS).

Financial Institutes

57. Mr. Purwar A.K., Chairman, State Bank of India, Corporate Centre, Madam Cama Road, Mumbai – 400021.



58. Mr. K.V. Kamath, CEO, ICICI Bank Ltd., Bandra Kurla Complex, Mumbai – 400051
59. Shri S.K. Mitra, Executive Director, NABARD, Plot No. C-24, A-Wing, 5th Floor, Bandra Kurla Complex, Post Box – 8121, Bandra East, Mumbai - 400051.
60. Shri S.M. Mehta, Chief General Manager, NABARD, Plot No. C-24, A-Wing, 5th Floor, Bandra Kurla Complex, Post Box – 8121, Bandra East, Mumbai - 400051.
61. Shri V. Suresh, Asst. General Manager, NABARD, Plot No. C-24, A-Wing, 5th Floor, Bandra Kurla Complex, Post Box – 8121, Bandra East, Mumbai - 400051.
62. Dr. M.R. Sharma, NABARD, Plot No. C-24, A-Wing, 5th Floor, Bandra Kurla Complex, Post Box – 8121, Bandra East, Mumbai - 400051.
63. Shri Sundershyam, Chief General Manager, State Bank of India, Mumbai.
64. Shri P.G. Baria, General Manager, Bank of Baroda, Mumbai.
65. Shri P. Subbarao, General Manager, Central Bank of India, Mumbai.
66. Shri H.R. Lal, Deputy General Manager, Union Bank of India, Mumbai.
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Industries

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75. Shri M.S. Mruthyunjay, National President, Irrigation Association of India, C/o Sujay Irrigations (P) Ltd., No. 86 Main Road, Petechannappa Industrial Estate, Kamakshipalaya, Bangalore – 560079.
76. Shri Ajit Jain, Chief Operating Officer, Jain Irrigation Systems Ltd, Jain Hills, Jalgaon, Maharashtra – 425001

General

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