7. SUMMARY AND CONCLUSIONS

Water is the prime natural resource, which does not have any substitute in its main uses (Sivanappan, 1994). The country receives about 1170mm of rainfall which generate about 400million ha m of surface run off. The total irrigation potential including ground water is assessed at about 114 million ha m (INCID, 1994). In many parts of the world including India, the demand for available water resources is fast exceeding the economic supply, and the competition among the various sectors of the economy for the scarce water is becoming intense. The rapid declining and dwindling of ground water resources cause a threat to farming community and forced to adopt better water management practices to get sustainable production.

The concept of irrigation is as old as the human civilization, however there has been enhanced efficiency in the irrigation patterns over a period of time. Adoption of improved water management practices is an important need of the day. India's crop production suffers not only from drought but also from indiscriminate use of irrigation water. There is wastage of huge quantity of water with the present methods of irrigation which were in vogue. It is becoming increasingly clear that with the advent of high yielding varieties the next major advance in our agricultural production is expected to come through efficient water management practices like adoption of water saving methods such as microirrigation.
Microirrigation has revolutionized agriculture in many countries of the world. The essential characteristics of this system are frequent, slow and low volume application of water directly to the plant root zone or on the land surface beneath the plant. It is based on the fundamental concept of irrigation only at the root zone of the crop and maintaining the soil moisture near optimum level.

Keeping in view the importance of irrigation water management the Government of Andhra Pradesh launched the Andhra Pradesh Microirrigation Project (APMIP) on November 3rd 2003 covering 22 districts in four sectors viz., horticulture, agriculture, sericulture and sugar with an initial target of 0.247 million ha and a financial out lay of Rs. 1187 crores.

Since APMIP was the first mega and unique microirrigation project in the world it was intended to assess the impact of adoption of microirrigation technologies such as drip by beneficiary farmers.

7.1 OBJECTIVES OF THE STUDY

- To analyze the impact of adoption of drip irrigation technology by farmers on productivity of fruits, sugarcane and vegetables by comparing it with conventional non-drip irrigated fields
- To assess the efficiency of water, electricity and fertilizer use under drip and non-drip irrigated fruit, sugarcane and vegetable crops cultivation
- To analyze the economic viability of drip system investment in fruit, sugarcane and vegetable crops
➢ To investigate the salinity and nitrate-N distribution in the soil profile under drip and conventional (non-drip) irrigated cropped farmers fields

➢ To verify nitrate contamination in ground water sources from wells located in drip irrigated and conventional (non-drip) irrigated cropped fields

7.2 SAMPLING PROCEDURE

Six major districts like Rangareddy, Anantapur, Kadapa, Nalgonda, Medak, and Nizamabad were selected keeping in view of the huge coverage of area under the project. Firstly, the sample for the study was designed based on the data collected from APMIP, Commissionerate of Horticulture, Government of Andhra Pradesh from the above six districts where APMIP scheme is in operation since 2003 with a relatively more extensive use of drip irrigation technologies were selected and provide the empirical context for this study. Secondly, since the physical and economic impact of drip irrigation varies by crop, dominant fruit crops such as mango, sweet orange, pomegranate, papaya & banana; field crop sugarcane; and vegetables such as tomato, brinjal & chillies were selected. Thirdly, having identified the crops, a field survey was carried out using a detailed questionnaire besides key informant surveys and group discussions adopting standard random sampling procedures to obtain the relevant data as per the outlined objectives.

Thus it is the sample of 100 – 150 farmers for each crop with a land holding size varying between 1.24 to 2.0 ha for whom the
relevant data on the crop yield, water use, electricity consumption, fertilizer doses, economics were collected during the year 2005 – 2007 that forms the basis for the field level evaluation of adopters and non-adopters of drip irrigation technology. Likewise the soil samples from the effective crop root zone depth and water samples from the bore wells of the beneficiary farmers were collected both from drip irrigated and non-drip irrigated cropped fields and analyzed by adopting standard procedures. The soil samples were analyzed with respect to salinity and nitrate-N in the soil profile and groundwater samples for nitrate contamination. Thus collected data on all parameters were tabulated and analyzed statistically for testing the significance of difference between drip and non-drip irrigated farmers. Further to evaluate the economic viability of drip investment, indices such as cost of infrastructure, cost of production, net present value (NPV), cash flow, internal rate of return (IRR), break-even point for yield and price, payback period etc were computed for all the crops both under drip and non-drip irrigated cases utilizing the discounted cash flow technique – NESS software. The data have been suitably illustrated through graphs and charts, wherever necessary without any duplication.
7.3 THE IMPORTANT FINDINGS OF THE STUDY

7.3.1 Increased Crop Yield

The favourable soil water balance in the crop root zone depth resulted in optimal soil water plant relations, nutrient availability, improved weed control etc., and in turn contributed to higher yield. The adoption of microirrigation resulted in increased yield varying from 21% to 60%. The yield increase was varying from 21 – 60% in fruit crops, 25 – 33% in vegetable crops and 58% in sugarcane.

7.3.2 Impact on Water Savings

Water conservation and improved water productivity are the most important advantages of drip irrigation. Therefore, controlled precise delivery of water and nutrients to the crop root zone through drip system according to crops daily water needs lead to substantial reduction in water losses by seepage, runoff and deep percolation as compared to conventional (non-drip) irrigation resulting in significant savings in water (49% to 54%) in different crops. The water savings amounted to 51 – 53% in fruit crops, in 49 – 54% in vegetable crops and 54% in sugarcane.

7.3.3 Power Savings

Significant saving in applied water to crops in drip irrigated farmers fields substantially reduced the working hours of pump set consequently leading to less electricity consumption per ha in comparison to conventional non-drip irrigation. Net saving in energy by adoption of drip varied from 557 to 1532 kWh/ha in different
crops. This amounted to an energy conservation of 51 – 53% in fruit crops, 49 – 54% in vegetables and 54% in sugarcane as compared to conventional (non-drip) irrigation

7.3.4 Fertilizer Savings

Application of fertilizers through drip irrigation fertigation ensures higher fertilizer use efficiency. Fertilizer use efficiency varied from 26.09 to 289.94 kg/kg of fertilizer applied in comparison to conventional (non-drip) irrigation (16.8 to 137.62 kg/kg of fertilizer applied). The fertilizer use efficiency varied from 40% to 70% among the different crops.

7.3.5 Cost Economics

The adoption of drip irrigation resulted in reduced cost of cultivation in terms of labour component, reduced cultural practices like weeding etc., there by resulted in a lesser cost of cultivation by 7-28% among the different crops studied. Though the initial investment on drip system was high, because of increased yields and reduced cost of cultivation the farmers can recover the fixed investment cost on drip irrigation system at the end of the first year in banana, sugarcane, papaya, brinjal, chillies and tomatoes and for mango, sweet orange and pomegranate between 3 to 7 years even in the absence of Government subsidy. The net present value was positive and the internal rate of return was higher than the customer cost of capital (interest rate).
7.3.6 Soil Salinity and NO\textsubscript{3} level

The salinity profiles in the crop root zone depth for different crops indicated that drip irrigation of crops lead to reduced electrical conductivity in comparison to conventional (non-drip) irrigation. This is because of reduced leaching losses of nutrients and their accumulation in the soil. The leaching of nitrate below the crop root was less with drip irrigation compared to conventional flood irrigation.

7.3.7 NO\textsubscript{3} Contamination of Ground Water

Nitrates are soluble and mobile in soil and move with the leaching water. Thus mean residual nitrate nitrogen distribution in the soil profile indicated that frequent drip irrigation & fertigation of crops in precise quantities resulted in less migration of nitrates to deeper layers in comparison to conventional (non-drip) irrigation at longer intervals with more depth of water. The results further demonstrate that the NO\textsubscript{3}-N concentrations exceeded the threshold limit (i.e. 10 mg/L set by EPA) in certain crops under conventional irrigation method but remained below the threshold limit under drip irrigation in deeper soil layers. Measured NO\textsubscript{3}-N concentrations in ground water samples from well water source located in cropped fields practicing drip irrigation & fertigation had lower NO\textsubscript{3}-N concentrations in comparison to practicing conventional (non-drip) irrigation.
7.4 CONCLUSIONS

The field study revealed that drip irrigation & fertigation has the potential to increase productivity in fruit, vegetable crops and sugarcane significantly besides conserving resources such as water, fertilizer, power, labour etc as compared to conventional irrigation practices. The economic analysis revealed that drip irrigation was found to be a profitable and efficient technology for fruit, sugarcane and vegetable crops with positive NPV and higher IRR than customer cost of capital. With reduced leaching losses and by maintaining the soil health the MI technology is proved to be an environment friendly technology.

7.5 SUGGESTIONS FOR FUTURE RESEARCH

The results of the present study revealed for future research endeavor in several directions as suggested below

- The present study was confined to only six districts of Andhra Pradesh, India. Future studies should be focused on Agro climatic zones wise instead of district wise may be done by collecting larger samples covering more number of crops so that the inferences could be generalized to a greater extent and contribute to policy decisions.

- To have an accurate idea about the impact, future studies be conducted by including social parameters like expenditure incurred by farmers on children’s education, food consumption, GDP growth rate, debt’s repayment etc,. 
• In the present study variables that are directly influencing the impact have been studied. Further, studies can be carried out to find out the influence of other factors such as institutional linkages, transfer of technology, input availability, agronomic & technical support to farmers, disbursement of loans by financial institutions, necessity of subsidy etc. for improving the sustainability of programme.

• The study was conducted in plain areas, however the impact of microirrigation technology on the crops raised in different soil textural class including problem soil / situations such as saline & alkaline areas, using saline water, undulated topography etc., can further be studied.