

FINAL REPORT

Research project proposal No. 197/99

FIELD LEVEL PERFORMANCE OF MICROIRRIGATION SYSTEM IN KASARAGOD DISTRICT - A CRITICAL ANALYSIS

Sponsored by

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(C. THAMBAN)

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Chapter I

INTRODUCTION

Expansion of irrigation has acted as the prime mover in agricultural development process by way of improving crop production. But globally, water supply situation is worsening due to a growing water demand for drinking, for industrial sectors and for irrigating agricultural crops. Under such a situation judicious utilization of the available water must be made for efficient crop production and higher yield. Microirrigation technology has great potential for high irrigation efficiencies. It is a farm innovation which is gaining popularity among farmers. In spite of the potential benefits of this technology, its rate of adoption is observed to be low in Indian context. Microirrigation is a relatively complex technology that calls for a meticulous system design and effective management and maintenance. It is imperative that farmers are equipped with adequate knowledge and skill to facilitate effective field implementation of technologies like microirrigation.

Microirrigation includes drip irrigation (also called trickle irrigation), bubblers and localized small microsprinklers, microspinners and microsprayers. It is a localized irrigation method that slowly and frequently provides water directly to the plant root zone. The slow rate of water application at discrete locations with associated low pressure and the irrigation of only a portion of the soil volume in the field can result in relatively low cost water delivery systems, as well as reduction in water diversion compared to other irrigation methods. Microirrigation system offers many unique agronomic, agro technical and economic advantages such as increased beneficial use of available water, enhanced plant growth and yield, reduced salinity hazards to plants, improved fertilizer and chemical application, limited weed growth, decreased energy requirements, and improved cultural practices. Microirrigation has the potential for precise, high level management and is an extremely flexible irrigation method to design. It can be adapted to almost any cropping situation and climatic zone. Microirrigation technology has broadened the scope of irrigation for crops grown in areas with problem soils. It can be installed either as a surface or sub-surface irrigation system.

Coconut, is the most important crop cultivated in Kerala State, which plays a vital role in the agrarian economy of the State. It occupies about 40 per cent of the total cropped area of the State. Kerala State has the largest area under coconut cultivation in India. It is also the largest producer of coconuts in the country. Coconut is cultivated in an area of 9.36 lakh ha in Kerala, which is about 50 per cent of the total area under coconut cultivation in India. The annual production of coconut in the State is 5,496 million nuts, which is 44.00 per cent of the total production in the country (Annexure - I). However, the productivity level remained low in the State compared to many other states of India. In Kerala, the productivity of coconut is only 5,870 nuts per ha while it is 9,763 nuts per ha in the neighbouring state of Tamil Nadu. Lack of irrigation is one of the major reasons attributed to the low level of productivity of coconut in Kerala State (Rajagopal *et al.*, 2001). Scarcity of irrigation water is also considered as one of the major constraints in resource use management in coconut farming in Kerala. (Prakash, 1989 and Haridasan, 1995). Experiments conducted in research stations have proved that productivity of coconut can be enhanced even up to one hundred per cent if irrigation is ensured.

Areca nut is another important plantation crop in Kerala, especially in the northern districts like Kasaragod. Kerala state is the second largest producer of areca nut in the country. From an area of about 76,100 ha, 94,000 tonnes of areca nut is produced in Kerala with an average productivity of 1235 kg/ha. As in the case of coconut, the productivity of areca nut also is highly influenced by the adoption of irrigation for the palms.

There are considerable limitations to the conventional surface irrigation methods in Kerala state, such as rolling topography, high infiltration rates of the lateritic formation constituting the soil of the state, low water holding capacity of the lateritic soils, lack of sufficient water, limited root zone depth, small land holding etc. Under the above situation, microirrigation methods such as drip irrigation have great relevance in Kerala state. Wide spacing required for the plantation crops such as coconut, areca nut etc., make the drip system suitable and cost effective. Labour cost in the state is one of the highest in the whole country. Labour savings due to adoption of the drip system over the conventional surface irrigation methods is an added advantage. Irrigation efficiency of drip system will be higher under the high infiltration rate and low water holding capacity

of the lateritic soils in the state as compared to conventional irrigation methods. Under homestead farming, the unique feature in Kerala agriculture, the irrigation is well based. Since the quality of well water is excellent with regard to suspended materials, the problem of clogging in the drip system will be reduced considerably. Drip irrigation system is easily adaptable to the absentee farming situation prevailing in the state, owing to its labour saving nature.

Even though Kerala receives an annual rainfall of 350 cm, the distribution of rainfall is quite uneven. In north Kerala 75 per cent of the rainfall is received during the period from June to August and the long period of summer results in moisture stress which adversely affect the crop productivity (Appendix-I). This situation calls for an efficient management of available irrigation water. Hence there is great scope for effectively utilizing microirrigation technologies such as drip irrigation system in our state. Even though drip irrigation method was introduced many years back, during the current decade only farmers have been made increasingly aware of it. Many coconut and arecanut growers have installed microirrigation system in their gardens with government support to the tune of 75 per cent subsidy under the centrally sponsored scheme (Appendix-II). Effective field implementation of microirrigation technology will help the farmers in the judicious use of scarce water resources for enhancing the productivity of coconut. In spite of the complexity of the technology, the farmers are increasingly becoming aware of the need for adopting frontier technology like microirrigation to combat the issues related to sustainable water resource management.

It is worthwhile to evaluate the performance of microirrigation systems such as drip irrigation installed in farmers' field so that factors associated with the proper adoption of microirrigation technologies can be unearthed. It is also important that perception about the problems by the farmers, extension personnel and other agencies involved in the implementation of such technologies are also analysed, so that meaningful interventions can be made for successful implementation of micro irrigation technologies. Hence the present study was taken up with the following specific objectives:

1. To analyze the socio economic and personal profile of farmers adopting microirrigation systems.
2. To analyze the extent of knowledge of farmers about microirrigation technologies.
3. To delineate the factors contributing to the adoption of microirrigation systems.
4. To compare the economics of coconut / arecanut cultivation under micro irrigation and conventional systems of irrigation
5. To evaluate the technical performance of the microirrigation systems installed in farmers field.
6. To analyze the constraints perceived by the farmers, extension personnel and dealers in the effective utilization of the microirrigation technologies.
7. To study and document successful experience/discontinuance of technology by the farmers in adopting microirrigation systems and
8. To document the re-inventions by farmers in microirrigation systems.

1.1. SCOPE OF THE STUDY

The study proposes a holistic concept to investigate the adoption of microirrigation technology at farm level. The study assumes significance in the emerging context of improving coconut farming through efficient water conserving irrigation. Realising the importance of economizing the use of available water for irrigation, presently emphasis is given for enhancing the adoption of water conserving irrigation methods such as microirrigation. The development agencies are implementing many programmes for providing incentives to farmers for adopting microirrigation technology. The findings of the present study would throw light on factors influencing and constraining the field implementation of the microirrigation technology, economics of cultivation of coconut and arecanut under drip irrigation system, and experiences of farmers in cases of successful adoption and discontinuance of microirrigation technology. The study will be immensely helpful for the policy makers and planners in designing and implementing appropriate strategies that would facilitate speedy diffusion of microirrigation technology among farming community. Information related to successful

adoption, discontinuance and re-inventions of microirrigation technology at farm level will be quite handy for the field level extension personnel to design motivational and educational strategies. On the whole, the study is expected to generate data on multidimensional aspects of use and integration of microirrigation technology at farm level that could be utilized by all stakeholders. The study conceptualises a host of socio-economic, personal and technological variables which are inextricably linked in the adoption and diffusion of resource conserving microirrigation technology.

1.2. LIMITATIONS OF THE STUDY

Owing to the limitations of time and resources, the study was confined only to one district and hence generalizations may not be claimed. Further, the data base on the exact status of technology adoption at farm level was not available with any of the agencies. Thus selection of respondents was primarily done based on the list collected from the offices of the Department of Agriculture, which was not updated in some cases. Since the respondents were not habituated in maintaining farm records, the researcher depended heavily on the recall information from farmers on many key variables being investigated. To combat these inherent limitations, the design and methodology of the study were streamlined objectively and systematically to the extent possible.

1.3. OPERATIONALISATION OF KEY TERMS USED IN THE STUDY

1.3.1. Microirrigation

In this study the term microirrigation is used to denote drip irrigation which is the most commonly used microirrigation method.

1.3.2. Adopter

The term adopter is used to refer to a farmer who has adopted drip irrigation technology in his coconut garden.

1.3.3. Non -adopter

The term non - adopter is used to denote a farmer in the study area who has not adopted the drip irrigation technology, but has adopted conventional basin method of irrigation.

1.4. PRESENTATION OF THE STUDY

The first chapter deals with the introduction wherein the objectives of the study are presented. It also throws light on the scope and limitations of the study. The second chapter, viz., review of literature, deals with the review of available and related studies in the field of present study. The third chapter presents the methodology of the study. Description about the study area, sampling procedure followed, quantification of the variables selected for the study, statistical tests employed etc., are dealt in this chapter. The fourth chapter contains the results and discussion of the study. The fifth chapter summarises the findings of the study with a brief resume on the implications of the findings.

Chapter II

REVIEW OF LITERATURE

This chapter presents the findings of previous researchers on different aspects of the study in the light of the objectives set forth. However, previous studies on some of the aspects were very limited. Hence, to augment this scarcity, closely related research findings were reviewed. The literature survey on different dimensions of the topic under study are presented under the following heads:

- 2.1. Knowledge of farmers about microirrigation technology
- 2.2. Adoption of recommended practices of microirrigation technology by farmers
- 2.3. Techno-economic benefits of microirrigation technology
- 2.4. Factors influencing adoption of microirrigation technology
- 2.5. Discontinuance and re-inventions of microirrigation technology
- 2.6. Constraints in the adoption of microirrigation technology

2.1. KNOWLEDGE OF FARMERS ABOUT MICROIRRIGATION TECHNOLOGY

Since no specific study could be traced on the knowledge level of farmers on microirrigation technology, a review was made in respect of the level of knowledge of farmers on irrigation in general and presented as below:

Patil (1986) reported that 34.26 per cent of respondents possessed low knowledge about irrigation interval, methods of irrigation, critical stages of crop growth and water requirement of crop.

Konde (1987) reported that 40 per cent of the farmers with sprinkler system of irrigation had a medium knowledge level, while 36 per cent had high knowledge and one fourth (26 per cent) had low knowledge about sprinkler irrigation management.

According to Thamban *et al.* (1996), farmers were having fairly good amount of knowledge about the irrigation practices of coconut as reflected by a knowledge index of 64 observed for the item on irrigation among the various aspects of improved coconut farming.

Similarly, Kalavathy and Anithakumari (1998) reported medium level of knowledge (50.00 per cent) of farmers on irrigation of coconut palms.

From these studies it can be fairly concluded that farmers had medium to high level of knowledge about the irrigation technology in coconut. However, these studies are mostly pertaining to conventional irrigation techniques and are not indicative of recent techniques like micro irrigation.

2.2. ADOPTION OF RECOMMENDED PRACTICES OF MICROIRRIGATION TECHNOLOGY BY FARMERS

Specific studies on the extent of adoption of microirrigation technology in coconut and arecanut farming were scarce. Further, no study could be traced on the extent of adoption of recommended practices of microirrigation by the adopters of the technology. Hence some of the studies related to the extent of adoption of irrigation practice *per se* in coconut cultivation were reviewed and presented as hereunder.

Santos (1990), in his study on the assessment of experiences with new varieties of coconut in Philippines, reported that all coconut holdings in Philippines, except a few corporate farms, were dependent on rainfall.

Bastine *et al.* (1991) in their study reported low level (16.3 per cent) of adoption of irrigation by coconut farmers. But, Kalavathy and Anithakumari (1998) reported medium level of adoption of irrigation by coconut cultivators.

Santha *et al.* (1993) found that only 13.7 per cent of coconut growers in Trivandrum district of Kerala were utilizing their water resources for summer irrigation of coconut palms.

Wickramaratne (1998), in his study on the assessment of experiences with new varieties of coconut in Sri Lanka, stated that majority (60.0 per cent) of coconut holdings did not receive irrigation facility.

Thampan (1999) reported that rainfed farming was the most popular practice among coconut farmers of Kerala and only 5-10 per cent of coconut farmers adopted irrigation for their palms. Wherever irrigation was adopted, basin irrigation was the common method and only very few coconut farmers adopted microirrigation technology.

A survey conducted in Kannur District of Kerala state by the Central Plantation Crops Research Institute indicated that only one-third of farmers adopted irrigation for their coconut palms and the extent of adoption of microirrigation was only negligible (2.85 per cent). (Thamban and Venugopalan, 2002).

From the foregoing review of studies, it could fairly be concluded that the extent of adoption of irrigation in coconut farming was low and that of microirrigation technology was only negligible.

2.3. TECHNO-ECONOMIC BENEFITS OF MICROIRRIGATION TECHNOLOGY

Microirrigation technology offers many unique agronomic, agro-technical and economic advantages. Many studies have been reported in different horticultural crops, including coconut, on the beneficial effects of microirrigation technologies, especially drip irrigation technology, which are briefly reviewed as follows.

Mathew and Hemachandra (1990) revealed that drip irrigation in coconut garden can save water up to 50 to 70 per cent and increase the yield up to 30 per cent. According to them, it is a novel method that can solve the water scarcity problem of coconut cultivation in sandy soils.

Patil (1990) reported that the cost of cultivation of grapes under drip irrigation was only 40 per cent of the traditional method of irrigation; water saving was 60 to 70 per cent, i.e. three times more area brought under irrigation. Average yield of grapes under drip irrigation was 15.0 tonnes per hectare, whereas under surface irrigation, it was 9.40 tonnes per hectare. Under drip irrigation labour cost was reduced by 75 per cent and thus the benefit cost ratio of drip irrigation method for grapes was 1: 2.25.

Nagare (1995) reported that farmers adopting drip irrigation system could save water to the extent of 51-81 per cent, saved labour to the extent of 18-30 per cent, had saving on cost of electricity and observed increase in yield. Considerable number of respondents of their study reported improvement in quality of produce and low intensity of diseases.

A study conducted by Subramanian *et al.* (1997) on the evaluation of drip irrigation in comparison with surface irrigation (basin) in coconut revealed that irrigation method had a significant effect on the increment in collar height, and nut yield during certain years. Drip irrigation at a rate of 40 litres/tree gave a saving of 40 per cent of water applied compared with surface irrigation. It produced nut yields comparable with or in excess of those produced with surface irrigation.

Results of a study conducted by Behera and Sahoo (1998) on the economic evaluation of a drip irrigation system in Orissa revealed that this method of irrigation conserves a considerable amount of water since losses due to evaporation, deep percolation etc. are completely controlled. Losses by soil erosion due to surface runoff are also eliminated. A larger area may be irrigated with the same quantity of water by using drip irrigation rather than any other irrigation system. This system provides good returns for appropriate horticultural vegetable crops, nurseries, and special cash crops for a wide range of agro-hydrological conditions.

Kapadiyal *et al.* (1998) after evaluating the economic viability of trickle irrigation on a full bearing coconut plantation in the south Saurashtra region of Gujarat, India, indicated that it can save about 45-50 per cent water over surface irrigation without any significant reduction in yield. With the water thus saved one extra hectare can be brought under irrigation thereby increasing the net income of the farmers.

Alan *et al.* (2000) reported that direct energy costs for microirrigation in citrus groves were estimated at one-third to one-sixth of those for sprinkler or seepage irrigation systems. According to them other potential benefits offered by microirrigation technologies include improved fruit yield and fruit quality.

Results of the foregoing studies clearly indicated the technological advantages and economic viability of adopting drip irrigation system by the cultivators.

2.4. FACTORS INFLUENCING ADOPTION OF MICROIRRIGATION TECHNOLOGY

Sivanappan (1990) reported that the major reasons for adopting drip irrigation by the farmers were scarcity or inadequate availability of water for irrigation complemented by the incentives by way of subsidy; other reason being labour scarcity.

Caswell *et al.* (1991) reported that the most significant factors influencing adoption of drip irrigation system were land quality and water cost savings. Microirrigation technologies were used most often with high value crops, low quality land, saline waters or where water costs were high.

George (1991) reported that the drip irrigation system is rapidly gaining importance all over the world, especially in areas which experience water and power shortage or where water is expensive or the terrain is very uneven or where labour is not easily available.

Mahendran (1993) reported major reasons for taking up drip irrigation for coconut were scarcity of water, availability of subsidy, success in neighbours field, advice by extension agencies and to increase the area under irrigation.

Senthilkumar (1995) reported that scarcity of water was the primary reason for resorting to drip irrigation system.

According to Alan *et al.* (2000), adoption of drip irrigation system was more influenced by perceived norms favourable to drip irrigation from the family, the water management district, the state energy office, and other farmers.

As is the case with the adoption of any innovative farming practice, adoption of microirrigation technology is also significantly influenced by many factors. The foregoing studies indicate various factors that are associated with the farm level adoption of microirrigation technology which include economic factors, situational factors, societal factors and external factors.

2.5. DISCONTINUANCE AND RE-INVENTIONS OF MICROIRRIGATION TECHNOLOGY

2.5.1. Discontinuance of drip irrigation technology

Discontinuance of a technology is a decision to reject an innovation after having previously adopted it. According to Rogers (1995), discontinuance may take two forms viz., replacement discontinuance in which a decision to reject a technology is made by the farmer to adopt a better technology that superseded it and disenchantment discontinuance in which the technology is rejected as a result of dissatisfaction with its performance. The dissatisfaction may come about because the innovation is inappropriate for the individual and does not result in a perceived relative advantage over alternate practice.

Vidal (2001), while elaborating on the adoption of improved irrigation technologies by farmers as part of the measures for water conservation in the Mediterranean Basin reported that in numerous cases, a considerable number of farmers have returned to conventional irrigation system due to various problems such as drip clogging (Egypt), improper operation and maintenance (Egypt, Morocco), difficulties in sharing equipment (pumps) with other farmers (Egypt), higher costs for pumping (Morocco), reluctance from farmers for techniques making water 'invisible' etc.

No other specific studies could be traced on the discontinuance of drip irrigation technology by farmers. But there were reports from the study area about the failure of drip irrigation system in many farmers' gardens due to various reasons. Hence case studies were proposed to be undertaken in such cases where farmers discontinued the adoption of drip irrigation technology.

2.5.2. Re-inventions of microirrigation technology

It is recognized that many a times adopters do make modifications to the innovations to suit their specific requirements. Rogers (1995) defined the concept of reinvention as the degree to which an innovation may be modified by a user in the process of its adoption and implementation. Reasons for reinvention are seen quoted in many diffusion studies.

Innovations that are relatively complex and difficult to understand, adopter's lack of detailed knowledge about innovation, local pride of the ownership of an innovation and the need for adaptation of an innovation to local situation as perceived by a user or change agent are some of the reasons that may lead to reinvention (Rogers, 1995).

An investigation of 101 innovations in scientific instruments by Hippel (1976) found that in about 80 per cent of the cases, the innovation process was dominated by the user. The user might even build a prototype model of the new product, and then turn it over to a manufacturer.

A national survey by Emrick (1977), of schools adopting educational innovations promoted by the National Diffusion Network, a decentralized diffusion system, found that 56 per cent of the adopters implemented only selected aspects of an innovation; much such re-invention was relatively minor, but 20 per cent of the adoptions amounted to large changes in the innovation.

Mansingh (1992) stated that reinvention occurred in the recommended practices of grapes for operations like spacing, manures and fertilizers applications, thinning of bunches, drip irrigation and withholding irrigation prior to harvest. He reported that nearly one-fifth of the respondents switched over to drip irrigation and they have tied the laterals over the pandal instead of placing them on the ground.

All these factors are assumed to have a role in the probable local adaptations/reinvention of microirrigation technologies by farmers. No specific studies, other than the ones above, could be reviewed which revealed the re-inventions made by cultivators in microirrigation technology.

2.6. CONSTRAINTS IN THE ADOPTION OF MICROIRRIGATION TECHNOLOGY

In spite of the technical and socio-economic feasibility, large scale adoption of drip irrigation is not so encouraging among our farmers. Cultivators are exposed to a variety of constraints in the proper utilization of microirrigation technology. A review was made on the same and presented below.

Chauhan and Shukla (1990) reported that for the close growing crops, the installation cost of drip irrigation was quite high. Similarly for other crops such as cotton, sugarcane etc., installation of drip irrigation was quite expensive.

Kandaswamy (1990) reported that the high initial cost, inadequate subsidy, difficulty in getting subsidy, non-uniformity of subsidy, inordinate delay in processing of loan application, lack of availability of technical input and after sales service, clogging of drippers and cracking of laterals, damage due to rat and squirrel, high cost of spares and components were the major problems and constraints experienced by farmers.

Padhye (1990) reported that frequently occurring problems in operating sprinkler and micro irrigation system are few in number that relate to non-availability of spares/components, high cost of component, leakage of pipes, blockage of emitters/micro tubes and faulty design of micro irrigation system.

Nandal *et al.* (1991) concluded that high initial cost, poor application efficiency when installed on steep slopes or uneven land and clogging of emitters were some of the problem that hindered the horizontal expansion of the system.

Prichard (1991) reported that clogging was the most serious problem facing in operation of drip irrigation system although drip tape has smaller orifice. Clogging may occur at any place in the system due to presence of physical particulates, or chemical precipitates or biological growth, causes reduction of water flow.

Jain (1992) stated that, through drip irrigation is beneficial; its usage is limited as today. This is primarily because of low awareness of its overall benefits at the farmer as well as government levels and high initial cost.

Puranik *et al.* (1992) reported that 48.00 per cent of the adopters experienced lack of proper service from the dealers of drip irrigation jets. He also observed that high initial cost of drip system, lack of technical knowledge, non-availability of subsidies and loans, permanent and regular maintenance in repairing of the sets of drippers and micro tubes and non-availability of spare parts at proper time in the villages as the major constraints in adopting drip irrigation system expressed by the farmer.

Rangarajan (1992) reported that the major problem hindering wider use of drip irrigation was the high cost of the system.

Saxena (1992) reported that clogging, high initial cost, damage due to animals, and the quality of water were some of the problems of the system.

Nikhade (1993) reported that the main problem in the adoption of drip irrigation system was its high initial cost. Though government is providing subsidy, it is essential for farmer to recover the initial cost by handsome returns over long years. It has been found that the farmer can get about Rs. 3,000-5,000 more income to recover the cost of drip system within two years.

Mahendran (1993) reported that major constraints in taking up drip irrigation under coconut as perceived by the sample farmers were requirement of skilled labour, damage due to animals, cracking of pipes, clogging of emitters, higher initial cost, higher replacement cost, high initial cost and maintenance cost.

According to Sivanappan and Lamm (1995) the constraints to microirrigation were high initial cost; clogging of drippers and cracking of pipes; lack of adequate technical inputs; damaged due to rodents; high cost of spare components; and insufficient extension education efforts.

According to Nagare (1995), the major problems faced by drip owners were lack of knowledge about relationship between rate of application, pressure and water discharge, difficulty in moving drip sets, lack of timely technical advice, inadequate irrigation water, breaking or cracking of laterals, delay in availability of loan and high initial cost of the drip irrigation equipment.

Polak *et al.* (1997) opined that the main obstacle to the wider adoption of microirrigation technology was its high capital cost which makes installation of drip systems prohibitive for the great majority of farmers in developing countries who cultivate in small and marginal holdings.

According to Alan *et al.* (2000), factors that affect adoption of drip irrigation technology included crop characteristics (cultural requirements), financial situation of the farm, resource situation (energy, soil and water), grower characteristics (education, experience, managerial abilities), farm structure (sole proprietorship vs corporate, own vs lease), costs (installation, operation, maintenance) and institutions (laws, rules,

regulations, customs, traditions) affecting how the farmer is influenced by community standards for action.

Behr and Naik (2000) reported that the initial investment required for the drip irrigation system and related risk is too great for the vast majority of the farmers, even though the cost-benefit ratios ranged from 2-5 and the pay back period is between 6-18 months. According to them farmers lacked basic understanding about the drip irrigation technology, its applicability and benefits. Further, the corruption and long delays in releasing subsidy payments to manufacturers has eroded the subsidy discounts and in some cases increased the real consumer price by 50-100 per cent.

The foregoing studies present an overall picture about various constraints experienced by the farmers in the proper adoption of microirrigation technology, which would be relevant for analyzing the same under the context of utilization of microirrigation technology in coconut farming also.

Chapter III

METHODOLOGY

3.1. Locale of the study

The study was conducted in Kasaragod district of Kerala state. The district represents the areas in northern Kerala where rainfall distribution is quite uneven i.e., mainly confined to 4 -5 months of SW monsoon and experience a long dry spell which provides scope for employing water saving microirrigation techniques. From Kasaragod district all the four development blocks were selected for the study.

3.2. Selection of respondents

3.2.1. Farmers: The list of farmers who installed microirrigation system in their farm was obtained from the office of the concerned Assistant Director of Agriculture in the four development blocks of Kasaragod District viz., Manjeswar, Kasaragod, Kanhangad and Nileswar. From the list of each of the four development blocks, 15 coconut farmers were selected for the study through simple random sampling. Besides, 15 arecanut farmers each were selected from Manjeswar and Kasaragod blocks since these two blocks were having more area under arecanut cultivation. Thus a total of 90 adopters were selected for the study. Similarly from the same locale, 60 coconut farmers and 30 arecanut farmers who did not adopt microirrigation systems were also selected for comparison. Hence the total sample size of farmer respondents was 180; 90 adopters and 90 non adopters.

3.2.2. Extension personnel: All the 25 Agricultural officers working in the Krishibhavans, the panchayat level office of the Department of Agriculture, from where the farmer respondents were selected, constituted the second category of respondents.

3.2.3. Dealers: All the 7 drip equipment dealers functioning in the study area were also selected who constituted the third category of respondents.

3.3. Variables and their measurements

3.3.1. Socio economic and personal profile of farmers

Socio economic and personal characteristics of respondent farmers such as age, education status, occupation, family size, farm size, farming experience, annual income, economic motivation, risk preference, scientific orientation, extension contact, social participation, , and information source utilization were measured using standard scales.

3.3.1.1. Age

This was measured by directly asking the number of years he/she has completed at the time of investigation.

3.3.1.2. Education Status

The educational status was operationally defined as the extent of literacy attained by the respondent. The scale used for the present study the scoring procedure was as follows:

Category	Score
Illiterate	0
Primary school	1
High school	2
Pre degree	3
Degree	4
PG and above	5

3.3.1.3. Occupation

The occupation of the respondent is vocational avenues from which he/she derives the major share of earnings for livelihood. The scoring pattern followed for occupation was as below:

Category	Score
Farming alone	1
Farming + Agricultural labour	2
Farming + Private job	3
Farming + Govt. job	4
Farming + Business	5
Farming + Any other	6

Percentage of respondents under each category was worked out to find out the pattern of occupation of the farmer respondents.

3.3.1.4. Family size

The total number of members in the family of the respondent was recorded.

3.3.1.5. Farm size

Farm size referred to the number of acres of land owned by the respondent.

3.3.1.6. Farming experience

Farming experience referred to the actual completed years of experience of the respondent in farming. A score of one was given to every completed year of experience in farming.

3.3.1.7. Annual income

The income level was assessed based on the annual income of the respondent from agriculture and other subsidiary occupations. The respondents were then grouped into three categories considering the standard deviation and mean as a measure of check.

3.3.1.8. Economic motivation

Economic motivation may be regarded as an indication of the degree of willingness of farmer for investment of his available potential resources in adopting farm innovations. It was operationally defined as the extent to which a farmer was oriented towards profit maximization and the relative value he placed on monetary gains.

The variable was quantified by using the scale suggested by Supe (1969). The scale consists of a five- point response continuum. The positive statements were given the score 5, 4, 3, 2 and 1 for the responses strongly agree, agree, undecided, disagree and strongly disagree, respectively and the reverse order of the scoring was followed for the negative statements. The maximum and minimum score an individual could obtain on this scale were 30 and 6. The respondents were then grouped into three categories considering the standard deviation and mean as a measure of check.

3.3.1.9. Risk preference

Risk preference referred to the degree to which the farmer was oriented towards risk and uncertainty in adopting new ideas in farming. The scale developed by Supe (1969) was used for measuring risk preference in the present study. The responses were collected on a five point continuum ranging from strongly agree to strongly disagree. There were six statements, of which four were positive and two negative. The scoring was done as follows:

Responses	Scores
Strongly agree	7
Agree	5
Undecided	4
Disagree	3
Strongly disagree	1

The scoring pattern was reversed for negative statements. The scores obtained for each statement were summed up to get individual farmer's risk preference score.

3.3.1.10. Scientific orientation

Scientific orientation referred to the degree to which the farmer was oriented to the use of scientific methods in decision making in farming. Scientific orientation scale developed by Supe (1969) and adopted by Ramachandran (1992) was used in the present study.

A score of '1' was given for agreement and '0' for disagreement. The total score obtained by an individual over 6 statements was taken as his scientific orientation score.

3.3.1.11. Extension contact

A measure of the respondent's extension contact was obtained by assigning scores of 3, 2 and 1 respectively for the responses viz., twice a week, once a week and once to thrice a month (Bonny, 1991) for his contact with different extension personnel. The scores were added up for arriving at the total extension contact score.

3.3.1.12. Social participation

Social participation refers to the degree of involvement of an individual in formal organizations that are common in the study area. They were asked to delineate their membership, office held and the frequency of attending meetings of the organizations to measure their social participation. The scoring procedure followed was as follows:

Membership in organization	Score
No membership in any organization	0
Membership in one organization	1
Office bearer in one organization	2

Frequency of attending meetings	
Not attending any meeting	0
Occasional	1
Regular	2

3.3.1.13. Information source utilization

Information source utilization was operationally defined as the use of various sources of information by the respondent in order to get information on agricultural technology. Here the 'source', 'individual' and 'channels' were collectively termed as 'information sources', since for practical purposes, there is no clear demarcation that could be made between 'source' and 'channel'.

Based on discussion with field level functionaries, scientists and progressive farmers, various sources of information utilized by farmers were identified and categorized under mass media sources, personal cosmopolite sources and personal localite source. The procedure adopted by Govind (1992) were followed with slight modification. The respondents were asked to indicate the frequency of use of these sources on a three point continuum viz., 'whenever needed', 'at times needed' and 'never' with scores of 2,1and 0 respectively. The information source utilization score of an individual was the sum of scores obtained by him on these different sources.

3.3.2. Knowledge of farmers about drip irrigation technology

In the present study knowledge of farmers refers to the understanding of farmers about drip irrigation. The knowledge of farmers was measured by developing a knowledge test as described below:

Developing a simple knowledge test

The knowledge test consisted of questions called items. A large number of items with repeat to the various aspects of drip irrigation method relevant to coconut and arecanut cultivation were prepared in consultation with the scientists of Agronomy and Agricultural Engineering disciplines and also extension personnel of the area under study. While preparing the items, care was taken to see that all the major aspects of drip irrigation method relevant to coconut and arecanut cultivation were included. Ambiguous and overlapping items were edited out. Finally 13 items were selected. These items were converted into multiple choice questions.

Scoring procedure

The questions were read out to each farmer respondent and asked to indicate the correct answer from among the choices provided. A score of 1 was given for correct answer and 2 for incorrect answer. The total knowledge score for each respondent was computed by adding his score for each item. The maximum possible score that could be secured by a respondent in this test was 13 and the minimum was zero. The knowledge index was worked out for individual farmer using the formula:

$$\text{Knowledge index} = \frac{\text{Total score secured by a respondent}}{\text{Maximum possible score}} \times 100$$

The knowledge scores of all the respondents were added together and mean and standard deviation were worked out. Based on the mean and standard deviation, the respondents were categorized into three groups viz., Low (Mean – S.D), Medium (Mean \pm S.D) and High (Mean + S.D).

Knowledge index for the two categories of respondents, i.e., coconut farmers and arecanut farmers were worked out separately by the above procedure. Similarly knowledge index was calculated for the items of drip irrigation method relevant to coconut and arecanut cultivation separately and were ranked.

3.3.3. Economic analysis of coconut and arecanut cultivation under microirrigation and conventional basin methods of irrigation

The cost of cultivation of coconut and arecanut was estimated separately for the two groups of coconut gardens viz., those adopting the conventional basin irrigation system and those adopted the drip irrigation system. The estimation procedure followed is as follows.

Total Variable Cost

Total Variable Cost include i) Value of hired labour, ii) values of insecticides, pesticides and other chemicals, iii) Value of manure (owned and purchased), iv) Value of chemical fertilizers v) imputed value of family labour vi) irrigation charges vii) value of seed materials (if any), viii) Miscellaneous expenses @ 5% of the sum of i) to viii)

The tools of economics as applicable in the case of annual crops cannot be applied as such in the case of perennial crops. This is due to their special characteristic features such as i) the long gestation period between the initial investment and first output ii) an extended period of output flow and iii) varying stages of productivity over the life time. Hence the following assumptions were made.

Since this economic analysis is based on perennial crops where land is devoted for more than 30 years, one would like to include the opportunity cost of land investment to the total cost. However cultivation of a perennial crop in a land area over a period of time maintains its fertility and productivity status. Moreover in a state like Kerala where pressure on land is more, the opportunity cost of land investment need not be included since the land value continues to appreciate. Following this concept, this study also excluded the opportunity cost of investment on land. However in order to give weightage to the investment made in the past ten per cent of the Total Variable Cost value was added for the estimation of Total Cost.

Total Returns

The returns are considered based on the market value of the main product. The imputed value of the returns from by products is balanced with that of miscellaneous cost.

3.3.4. Field performance and evaluation of micro-irrigation systems in coconut and arecanut gardens

Despite the success of drip irrigation system in many parts of the world, several practical problems related to optimal water management still remain. While the method has great potential for high irrigation efficiencies, poor system design, management, or maintenance, can lead to low efficiencies. In some instances the trickle irrigation systems were installed with little concern for basic engineering hydraulic principles and resulted in the non-uniform emitter discharges throughout the irrigated field. Irrigators in order to overcome this lack of uniformity found it necessary to over-irrigate. Over-irrigation can lead to the waste of water, nutrients, and energy as well as the possibility of ground water contamination due to excessive leaching.

The non-uniformity of emitter discharge is the result of the several factors. The more important of these are the hydraulic and emitter discharge variation (Bucks et al., 1982). The hydraulic variation along the lateral line, sub-main or manifold is a function of slope, pipe length and diameter, and emitter discharge relations. Emitter variation at a given operating pressure is caused by manufacturing variability, emitter plugging (complete or partial), water temperature changes, and emitter wear. At present time, a design equation which includes all the factors affecting the emitter uniformity in a trickle system has not been developed.

Need for evaluation

The field evaluation of drip irrigation systems is important for several reasons. According to Bralts (1986), the field evaluation is important to (a) the design engineer in establishing whether the desired emitter discharge uniformity specifications are being met, (b) the irrigator in deciding whether the system can be operated efficiently and (c)

the maintenance personnel as a diagnostic tool for determining the proper operation of the system and its components and to take remedial action as required.

In the present study, field performance and evaluation of micro-irrigation systems in coconut and arecanut gardens was done by assessing the following factors:

3.3.4.1. Field uniformity estimation

The evaluation of a drip irrigation system encompasses significantly more than the uniformity of emitter discharges and the accurate estimation of the system uniformity is probably the single most important factor in obtaining the system performance. At present several methods are used for estimating field uniformity. In the present study, absolute emission uniformity and statistical uniformity were worked out for analyzing the uniformity of emitter discharges. Field uniformity estimation was done for a total of 90 drip irrigation units installed in farmers' field i.e. in 60 coconut gardens and in 30 arecanut gardens. Discharge rate of emitters was measured for this purpose using a measuring jar and stop watch as per the procedures referred above. One method is to consider the absolute uniformity (EUa) as follows:

Absolute uniformity

$$EUa = 100 \left(\frac{q_{min}}{q_{avg}} + \frac{q_{avg}}{q_x} \right) (1/2)$$

Where,

EUa = absolute uniformity as a percentage,

q_{min} = minimum discharge rate,

q_{avg} = average emitter flow rate and

q_x = average of the highest 1/8 of emitter flow rates. The above equation is described in the Soil Conservation Service National Engineering Handbook (1983). An example of the type of information collected from the field is shown in Appendix-IV along with the interview schedule and the procedure for collecting such data from point source emitters is as follows:

Step 1 : Choose the four lateral lines and four emitters on each lateral per location given in the table.

Step 2 : Measure the emitter discharge and calculate the emitter flow rate at two adjacent emitters (A and B) at each collection point by collecting the discharge (ml) for one minute in a graduated cylinder.

Step 3 : Calculate the average emitter discharge (lph) for each of the 16 locations.

Step 4 : Calculate the Emission Uniformity using equation desired.

The general criteria for Eua values are:

90% or greater –excellent

80-90% -good

70-80 % - fair and

less than 70%- poor. The primary advantage of this method is its nonstatistical base.

Statistical uniformity coefficient

Another method for estimating system uniformity is based up on the statistical uniformity coefficient as described by Bralts and Kesner (1982) which is given by equation, $U_s = 100 (1 - S_y/Y)$

Where,

U_s =Statistical uniformity coefficient

S_y = standard deviation

Y = mean

By using statistical treatment, all of the various factors such as emitter manufacturing variation, lateral line friction, elevational differences and emitter plugging are included in the final uniformity estimate.

Advantages of this method are that field measurement is simple and confidence limits of the uniformity values can be set. An example of the procedure is as follows.

Step1: Select a container for making flow rate determination. (100ml or 200 ml)

- Step2: Choose 18 emitters at random in the sub-main and measure the time it take to fill the container
- Step3 : Tmax is the sum of the three lowest times it takes to fill the container
- Step 4: Tmin is the sum of three lowest times it takes to fill the container.
- Step 5: Find Tmax on the vertical axis an draw a horizontal line
- Step 6: Find Tmin on the horizontal axis and draw a vertical line.
- Step 7: The intersection of the two lines gives the statistical uniformity'

The general criteria for an acceptable statistical uniformity coefficient are: 90% or greater – excellent,
80 to 90% -very good ,
70-80% - fair ,
60-70%- poor and
below 60%-unacceptable.

3.3.4. 2. Volume of water applied per tree per day

Total quantity of water applied per tree per day was measured to ascertain whether the farmer was irrigating palms with the recommended quantity of water. In the case of coconut CPCRI recommends application of irrigation water @ 66% of open pan evaporation for drip irrigation. With the prevailing climatic conditions of the study area this works out to be approx. 32 lit of water per day per palm for coconut. In the case of arecanut this would be 20 litres per day per palm.

3.3.4. 3. Root zone area wetted

For effective irrigation, a minimum of 30 % of the root zone area should be wetted in drip irrigation. Once the quantity of irrigation water is fixed for a crop only discharge rate and number of dripping points could be adjusted to obtain sufficient root zone area wetted. Top soil around the dripping point was removed and the area of root zone wetted from the dripping point was measured using a measuring tape for this purpose.

3.3.4. 4. Number of dripping points

The present recommendation is to provide four dripping points in sandy loam and laterite soils and six dripping points in sandy soil for coconut to obtain a minimum of 30% of the root zone area to be wetted. Similarly in arecanut, 2-3 dripping points are recommended depending up on the soil type. The actual number of dripping points in the installed system in farmers' field were noted.

3.3.4. 5. Average discharge rate of drippers

Discharge rate of dripper is an important criteria which decides the horizontal and vertical movement of water from a dripping point. Normally more the discharge rate larger will be the horizontal movement of water and there by increasing the root zone area wetted. If the discharge rate is more than the optimum level water will be wasted as surface runoff. Studies conducted at CPCRI revealed that operating emitters at a discharge rate of 6LPH would be sufficient to obtain 30% of wetted root zone. Average discharge rate of drippers was measured in the farmers field since it will directly affect the wetting pattern.

3.3.4. 6. Location of dripping point

In coconut the present recommendation is to provide irrigation through four drippers placed equidistant in the circumference of a circle of radius 100 cm around the base of the tree. This is to obtain maximum wetted soil within the root zone. Similarly in arecanut, the recommendation is to keep the dripping point 50cm away from the palm. Farmers practice in these regards were observed.

3.3.4. 7. Placement of dripping point

Experiments at CPCRI also showed that applying water subsurface will help to reduce the evaporation from soil surface. Farmers practice in the placement of dripping point was observed.

3.3.5. Perception of farmers about the factors associated with the adoption of drip irrigation system

A list of factors associated with the adoption of microirrigation systems was prepared based on review of literature, consultation with experts and beneficiaries and personnel from non study area. The adopters were requested to indicate their perception of the importance of each of the item on a three point continuum viz, most important, important and less important with scores of 3, 2 and 1 respectively. The items were rank ordered based on the total score obtained by individual items for all the respondents.

3.3.6. Perception of farmers about the reasons for non adoption of drip irrigation system

A list of factors associated with the non adoption of microirrigation systems was prepared based on review of literature, consultation with experts and beneficiaries and personnel from non study area. The non adopters were requested to indicate their perception of the importance of each of the item on a three point continuum viz, most important, important and less important with scores of 3, 2 and 1 respectively. The items were rank ordered based on the total score obtained by individual items for all the respondents.

3.3.7. Perception of farmers about the constraints in the operation and maintenance of drip irrigation system

A list of constraints in the operation and maintenance of drip irrigation system was prepared based on review of literature, consultation with experts and beneficiaries and personnel from non study area. The adopters were requested to indicate their perception of the importance of each of the item on a three point continuum viz, most important, important and less important with scores of 3, 2 and 1 respectively. The constraints were rank ordered based on the total score obtained by individual items for all the respondents.

3.3.8. Perception of extension personnel about the constraints in adoption of drip irrigation system

The constraints in the adoption of drip irrigation system as perceived by the extension personnel were studied in a similar way as explained in the item 3.4.7.

3.3.9. Perception of dealers about the constraints in adoption of drip irrigation system

The constraints in the adoption of drip irrigation system as perceived by the dealers was studied in a similar way as explained in the item 3.4.7.

3.4. Case studies on successful experiences of farmers in adopting microirrigation systems and discontinuance of technology

An in-depth analysis of all the aspects of selected successful cases of farmers in the implementation of microirrigation systems as well as cases of technology discontinuance were carried out and documented. A total of four successful experiences and four cases of discontinuance of technology were documented.

3.5. Re-inventions made by farmers in microirrigation systems

At the time of field level investigations in farmers' coconut and arecanut gardens special observations were made to find out local adaptation/ innovations made by farmers in microirrigation systems, the details of which were studied and documented. A total of four such cases were documented.

3.6. Workshop on micro irrigation technique in coconut

Findings of the study was presented in a one day workshop organised at CPCRI, Kasaragod on 5th September, 2001 with respondent farmers, extension personnel and dealers and experts as participants. The objective of organising the workshop was to bring together farmers, extension personnel, dealers and scientists on a common platform to discuss the problems and prospects of microirrigation systems in coconut and arecanut cultivation and to evolve a strategy for effective implementation of the same in farmers field. A report on the workshop was prepared.

3.7. Extension literature on microirrigation technologies

A book on microirrigation technologies for coconut and arecanut is being brought out for the benefit of farmers and extension personnel which will provide information for effective field implementation of the same. The basic concepts of the drip irrigation technology as a water conserving irrigation system, its advantages and limitations, practical problems encountered in the operation and maintenance of the drip system and measures to overcome the same are described in the publication.

3.8. Procedure followed for data collection

The data from farmers, extension personnel and dealers were collected using separate structured, pre-tested interview schedules developed for the purpose (Appendix-III). Successful experiences of farmers in drip irrigation, discontinuance of drip irrigation technology and reinventions/local adaptations of drip irrigation technology by farmers were studied by following case study method. Data collection was done during the period January 2000 to October 2001.

Chapter IV

RESULTS AND DISCUSSION

The results of the study are presented in this chapter under the following sub heads:

- 4.1. Socio-personal profile of the farmers
- 4.2. Knowledge level of farmers on drip irrigation system
- 4.3.** Economic analysis of coconut and arecanut cultivation under microirrigation and conventional basin methods of irrigation
- 4.4. Field performance and evaluation of micro-irrigation systems in coconut and arecanut gardens
- 4.5. Perception of farmers about the factors associated with the adoption of drip irrigation system
- 4.6.** Perception of farmers about the reasons for non adoption of drip irrigation system
- 4.7.** Constraints in the operation and maintenance of drip irrigation system as perceived by farmers, extension personnel and dealers
- 4.8. Successful experiences of farmers in adopting drip irrigation
- 4.9. Discontinuance of drip irrigation technology
- 4.10. Re-inventions made by farmers in drip irrigation system
- 4.11. Report on the workshop on microirrigation technologies in coconut and arecanut farming

4. 1. SOCIO - PERSONAL PROFILE OF FARMERS

4.1.1. Socio-personal profile of coconut farmers

A profile of the socio-personal characteristics of the coconut farmers under the study is presented in the table 1below:

Table1. Distribution of coconut farmers according to their socio personal attributes

Sl. No.	Item	Category	Adopters (n=60)		Non-adopters (n=60)	
			Frequency	Per cent	Frequency	Per cent
1.	Age	< 30 years	1	1.67	1	1.66
		30-40 years	5	8.33	6	1.00
		40-50 years	15	25.00	14	23.33
		50-60 years	20	33.33	19	31.67
		>60 years	19	31.67	20	33.33
2.	Education	Illiterate	0	0	3	5.00
		Primary	13	21.67	12	20.00
		High school	19	31.67	15	25.00
		Pre degree	25	41.67	10	16.67
		Degree	14	23.33	8	13.33
		PG and above	1	1.67	0	0
3.	Occupation	Farming alone	25	41.67	35	58.33
		F. +Ag. labour	2	3.33	7	11.67
		F.+ Pvt.job	9	15.00	2	3.33
		F.+ Govt.job	19	31.67	9	15
		F.+ Business	4	6.67	5	8.3
		F.+ Fisheries	1	1.66	2	3.3
4.	Family size	<5	25	41.66	11	18.3
		5-10	30	50	45	75
		>10	5	8.33	4	6.6
5.	Farm size	<0.5 ha	11	18.33	26	43.3
		0.-1.0 ha	21	35	18	30
		1.0-1.5 ha	9	15	7	11.6
		>1.5	19	31.66	9	15
6.	Farming experience	<10 years	6	10	2	3.3
		10-20 years	6	10	9	15
		20-30 years	18	30	14	23.33
		30-40 years	14	23.33	10	16.66
		>40 years	16	26.66	25	41.66

Contd.....

7.	Annual income	Low	4	6.7	15	25
		Medium	16	26.7	15	25
		High	40	66.7	30	50
			(Mean = 12660 SD = 1539.53)		(Mean = 10025.83 SD = 2276.6)	
8.	Economic motivation	Low	10	16.7	12	20
		Medium	15	25	20	33.3
		High	35	58.3	28	46.7
			(Mean = 24.28 SD = 3.25)		(Mean = 19 SD = 4.4)	
9.	Risk preference	Low	8	13.3	10	16.7
		Medium	32	53.3	12	20
		High	20	33.3	38	63.3
			(Mean = 25.1 SD = 2.31)		(Mean = 17.78 SD = 4.66)	
10.	Scientific orientation	Low	12	20	16	26.7
		Medium	15	25.0	20	33.3
		High	33	55.0	24	40
			(Mean = 5.18 SD = 0.75)		(Mean = 2.32 SD = 1.13)	
11.	Extension contact	Low	12	20	9	15
		Medium	11	18.3	27	45
		High	37	61.7	24	40
			(Mean = 9.95 SD = 1.55)		(Mean = 1.23 SD = 0.96)	
12.	Social participation	Low	7	11.7	22	36.7
		Medium	14	23.3	2	3.3
		High	39	65	36	60
			(Mean = 16.68 SD = 2.08)		(Mean = 1.23 SD = 0.96)	
13.	Information source utilization	Low	8	13.3	12	20
		Medium	23	38.3	23	38.3
		High	29	48.3	25	41.7
			(Mean = 25.68 SD = 2.65)		(Mean = 20.27 SD = 2.79)	

4.1.1.1. Age

From the above table it is clear that majority (55-58 per cent) of the coconut farmers under both the categories of adopters and non-adopters belong to the age group 40-60 years. Only a very few respondents were below 40 years. This is in line with the general trend observed in Kerala state where the younger generation keeps away from farming.

4.1.1.2. Educational status

It was observed that a larger proportion of coconut farmers belonging to adopter category have higher educational status than the non adopters as is evident from the above table. Also it was noted that no illiterate farmers were there in the adopter category.

4.1.1.3. Occupation

Among the coconut farmers, only 25 –35 per cent were depending on farming alone as their source of livelihood. The remaining were engaged in other avenues besides farming for income earning. This is also in line with the general trend observed in Kerala state. The numbers of respondents depending on farming alone and farming and agricultural labour were more in non-adopter category compared to adopters.

4.1.1.4. Family size

The number of members in the family was more in non-adopter category compared to adopters. This observation can be related to the difference in educational status between the adopters and non- adopters.

4.1.1.5. Farm size

Majority of the coconut farmers (53.33 per cent under adopter category and 73.3 per cent under non adopter category) were having only less than one ha of farmland. Compared to adopters only a fewer number of non-adopters were having a farm size more than one ha. It is a generally observed trend that the extent of adoption of improved

farming technologies is higher in the case of farmers having more acreage than small and marginal farmers.

4.1.1.6. Farming experience

The distribution of coconut farmers according to their experience in farming followed a similar trend as in the case of their age. 50 per cent of the adopters were having more than 30 years of farming experience while 35 per cent of the non adopters were having more than 30 years of farming experience.

4.1.1.7. Annual income

The distribution of coconut farmers based on the annual income showed that the number of coconut farmers in the low income category was more in the case of non adopters than among adopters of drip irrigation technology. Drip irrigation technology requires high initial investment for its field implementation, which makes it difficult for the cultivators in the lower income group to adopt the same.

4.1.1.8. Economic motivation

The results showed that there was not much difference between the adopters and non adopters as far as their distribution based on the level of economic motivation was concerned. Most of the cultivators were belonging to medium to higher categories. Some other intervening factors might have resulted in the non adoption of the technology though the non users of the technology were possessing higher degree of economic motivation comparable to that of adopters.

4.1.1.9. Risk preference

More than half (53 per cent) of the adopters were belonging to the medium category in respect of the variable, risk preference was concerned while more than 63 per cent of the non adopters were in the high risk preference category. This result is not in line with the previous findings regarding the association of risk preference and adoption of farm innovations. As in the case of economic motivation some other intervening factors might have resulted in the non adoption of the technology though the non users of

the technology were possessing higher degree of risk preference comparable to that of adopters.

4.1.1.10. Scientific orientation

The results showed that the number of coconut farmers belonging to the category of high level of scientific orientation was 15 per cent more among the adopters of drip irrigation system than among the non adopters. More the scientific orientation among the cultivators more will be the chances of adoption of innovative agricultural practices.

4.1.1.11. Extension contact

Similar to the scientific orientation, the distribution of coconut farmers based on their extension contact showed that the number of coconut farmers belonging to the category of high level of extension contact was more among the adopters of drip irrigation system than among the non adopters. Higher degree of extension contact helps the growers to gather more information about the farm innovations so as to assess the advantages of the same to make favourable decisions on the adoption of technologies.

4.1.1.12. Social participation

It is clear from the distribution of coconut farmers based on the level of social participation that a majority (88.3 per cent) of the adopters were having higher degree of social participation than the adopters. More than one third of the non adopters were placed in the low level category in respect of social participation. Involvement in the activities of local organizations will be helpful for the cultivators for developing favourable attitude towards improved farming practices.

4.1.1.13. Information source utilization

Pattern of distribution of farmers based on the information source utilization did not show much difference between adopters and non adopters except for the slightly more number of farmers in the high category among adopters compared to the non adopters. Other intervening factors might have resulted in the non adoption of the technology even by the farmers with better information source utilization pattern.

4. 1. 2. Socio-personal profile of arecanut farmers

Table 2. Distribution of arecanut farmers according to their socio - personal attributes

Sl. No.	Item	Category	Adopters (n=30)		Non-adopters (n=30)	
			Frequency	Per cent	Frequency	Per cent
1.	Age	< 30 years	1	3.3	0	0
		30-40 years	7	23.3	6	20
		40-50 years	8	26.7	3	10
		50-60 years	8	26.7	8	26.7
		>60 years	6	20	13	43.3
2.	Education	Illiterate	0	0	0	0
		Primary	3	10	1	3.3
		High school	18	60	8	26.7
		Pre degree	3	10	14	46.7
		Degree	6	20	7	23.3
		PG and above	0	0	0	0
3.	Occupation	Farming alone	21	70	24	80
		F. +Ag. labour	0	0	0	0
		F.+ Pvt.job	3	10	3	10
		F.+ Govt.job	4	13.3	3	10
		F.+ Business	2	6.6	0	0
		F.+ Fisheries	0	0	0	0
4.	Family size	<5	13	43.3	7	23.3
		5-10	15	50	23	76.7
		>10	2	6.6	0	0
5.	Farm size	<0.5 ha	3	10	6	20
		0.-1.0 ha	5	16.7	11	36.7
		1.0-1.5 ha	10	33.3	4	13.3
		>1.5	12	40	9	30
6.	Farming experience	<10 years	5	16.7	2	6.7
		10-20 years	5	16.7	5	16.7
		20-30 years	8	26.7	5	16.7
		30-40 years	7	23.3	7	23.3
		>40 years	5	16.7	11	36.7

Contd

7.	Annual income	Low	3	10	8	26.7
		Medium	15	50	3	10
		High	12	40	19	63.3
			(Mean = 19016.67 SD = 1574.05)		(Mean = 14128.33 SD = 1590.36)	
8.	Economic motivation	Low	4	13.3	6	20
		Medium	11	36.7	9	30
		High	15	50	15	50
			(Mean = 27.20 SD = 2.34)		(Mean = 21.7 SD = 3.59)	
9.	Risk preference	Low	4	13.3	4	13.3
		Medium	10	33.3	13	43.3
		High	16	53.3	13	43.3
			(Mean = 25.67 SD = 2.88)		(Mean = 19.13 SD = 3.27)	
10.	Scientific orientation	Low	6	20	6	20
		Medium	11	36.7	11	36.7
		High	13	43.3	13	43.3
			(Mean = 5.17 SD = 0.91)		(Mean = 2.60 SD = 1.30)	
11.	Extension contact	Low	9	30	3	10
		Medium	5	16.7	14	46.7
		High	16	53.3	13	43.3
			(Mean = 10.47 SD = 1.41)		(Mean = 6.37 SD = 1.56)	
12.	Social participation	Low	5	16.7	6	20
		Medium	6	20	7	23.3
		High	19	63.3	17	56.7
			(Mean = 17.67 SD = 1.88)		(Mean = 11.40 SD = 3.33)	
13.	Information source utilization	Low	6	20	4	13.3
		Medium	6	20	13	43.3
		High	18	60	13	43.3
			(Mean = 27.50 SD = 2.49)		(Mean = 18.17 SD = 3.62)	

4.1. 2. 1. Age

From the above table it is clear that majority of the arecanut farmers under both the categories of adopters and non-adopters belonged to the age group 40-60 years. 43.3 per cent of the non adopters were of age above 60 years. Among the adopters about one fourth of the respondents were below 40 years, indicating that more number of adopters were young farmers compared to non adopters.

4.1. 2. 2. Educational status

Unlike in the case of coconut, there was not much perceptible difference between adopter and non adopter category of arecanut farmers in respect of their distribution based on educational status. No illiterate farmers were there in both the categories.

4. 1. 2. 3. Occupation

Among the areca farmers, unlike coconut farmers, majority (70 per cent among adopters and 80 per cent among non adopters) were depending on farming alone as their source of livelihood. It was observed that arecanut being a more remunerative crop and which require more care and management compared to coconut, was getting more attention from farmers whose main source of income was from farming.

4. 1. 2. 4. Family size

Like in the case of coconut, the number of members in the family was more in non-adopter category compared to adopters among arecanut farmers also.

4. 1. 2. 5. Farm size

The results revealed a different distribution pattern of arecanut farmers based on their farm size when compared to coconut farmers. 73.3 per cent of the adopters and 43.3 per cent of the non adopters were having more than one ha of farm size unlike in coconut where majority were having only less than one ha of farmland.

4. 1. 2. 6. Farming experience

The distribution of arecanut farmers according to their experience in farming followed a similar trend as in the case of their age. 40 per cent of the adopters were having more than 30 years of farming experience while 60 per cent of the non adopters were having more than 30 years of farming experience.

4. 1. 2. 7. Annual income

Half of the adopters (50 per cent) were belonging to medium income category while more than 60 per cent of the non adopters were in the high income category unlike the coconut farmers. This might be due to the comparatively higher farm size and the fact that arecanut fetch more financial returns than coconut.

4. 1. 2. 8. Economic motivation

The results showed that there was not much difference between the adopters and non adopters as far as their distribution based on the level of economic motivation was concerned. 50 per cent each of the cultivators of both adopter and non adopter categories were belonging to high category on economic motivation. Some other intervening factors might have resulted in the non adoption of the technology though many of the non users of the technology were possessing higher degree of economic motivation comparable to that of adopters.

4. 1. 2. 9. Risk preference

The results showed that among arecanut growers, more than half (53.3 per cent) of the adopters were belonging to the high category in respect of the variable, risk preference, while more than 43.3 per cent each of the non adopters were in the medium and high risk preference categories. As in the case of economic motivation some other intervening factors might have resulted in the non adoption of the technology though the non users of the technology were possessing higher degree of risk preference comparable to that of adopters.

4. 1. 2. 10. Scientific orientation

Unlike in coconut, same distribution pattern was observed among the areca growers based on their scientific orientation for the adopters and non adopters. As in the case of economic motivation and risk preference some other intervening factors might have resulted in the non adoption of the technology though the non users of the technology were possessing higher degree of scientific orientation comparable to that of adopters.

4. 1. 2. 11. Extension contact

The distribution of arecanut farmers based on their extension contact showed that the number of farmers belonging to the category of high level of extension contact was more among the adopters of drip irrigation system than among the non adopters. But it is interesting to note that nearly one third of the adopters were having low level of extension contact. Even those arecanut growers who did not maintain much contact with the local agricultural extension agencies might have possessed the required level of awareness and knowledge about the drip irrigation system acquired through other sources enabling them for the adoption of the technology.

4. 1. 2. 12. Social participation

Unlike in the case of coconut farmers, almost a similar distribution pattern was observed among the areca growers based on their level of social participation for the adopters and non adopters indicating a lesser significance for social participation as a contributing factor in the adoption of drip irrigation technology by the arecanut growers.

4. 1. 2. 13. Information source utilization

It was observed that a higher percentage of adopters were belonging to the high category in respect of information source utilization when compared to the non adopters indicating a higher extent of association between the level of information source utilization and adoption of drip irrigation technology by the arecanut farmers.

4.2. KNOWLEDGE LEVEL OF FARMERS ON DRIP IRRIGATION SYSTEM

The distribution of farmers according to their level of knowledge about drip irrigation system is furnished in table 3 and table 4 below:

Table 3. Distribution of coconut farmers according to levels of knowledge about drip irrigation system

Sl. No.	Category	Frequency	Per cent
1.	Low	17	28.33
2.	Medium	16	26.66
3.	High	27	45.00
Total		60	100.00

(Mean = 5.26, SD = 0.34)

Table 4. Distribution of arecanut farmers according to levels of knowledge about drip irrigation system (n=30)

Sl. No.	Category	Frequency	Per cent
1.	Low	7	23.33
2.	Medium	7	23.33
3.	High	16	53.33
Total		30	100.00

(Mean = 5.23, SD = 1.74)

It would be seen from table 3 that majority (71 per cent) of coconut farmers were in the medium to high knowledge level categories, and nearly one third (28.33 per cent) were in the low knowledge level category. In the case of arecanut growers the distribution was 53.33 per cent in high, 23.33 per cent each in medium and low knowledge categories (Table 4). The result that there is a considerable proportion of coconut and arecanut growers having drip irrigation system adopted in their orchards belong to low knowledge category points to the fact that even the adopters of a particular technology may not possess the know why and know how aspects of that particular technology. This may result in subsequent constraints in the proper use of the technology in field situation. This is especially true in the case of technologies like drip irrigation system which require considerable amount of knowledge on the part of the cultivator for the proper maintenance and repair for efficient functioning.

A further analysis was also carried out to study the knowledge level of coconut and arecanut farmers on the selected items related to drip irrigation method.

Table 5. Knowledge of coconut farmers about drip irrigation method (N=60)

Sl. No.	Item	Knowledge		Rank
		Score	Index	
1.	Capacity of the pumping unit required	24	40.00	VII
2.	Operating pressure required for the optimum performance of the drip system	27	45.00	VI
3.	Suitable type of drippers required	36	60.00	III
4.	Discharge rate of drippers	22	36.67	VIII
5.	Water requirement per day per tree	32	53.33	IV
6.	Number of drippers required per tree	43	71.67	I
7.	Duration of irrigation required per day	28	46.67	V
8.	Suitable type of filtration unit required	39	65.00	II
9.	Techniques of prevention of clogging of drip system	20	33.33	IX
10.	Monitoring of emitter discharge to ensure field uniformity	19	31.67	X
11.	Periodical backwashing of filters	16	26.67	XII
12.	Periodical flushing of drip system	17	28.33	XI
13.	Application of fertilizers through drip system	15	25.00	XIII

It is evident from the Table 5 that among the 13 selected items related to scientific use of drip irrigation method in coconut garden, number of drippers required per tree, suitable type of filtration unit required and suitable type of drippers required secured rank I, II and III respectively with regard to the knowledge indices. Application of fertilizers through drip system was the item of knowledge which secured the lowest rank. Items such as techniques of prevention of clogging of drip system, monitoring of emitter discharge to ensure field uniformity, periodical flushing of drip system and periodical backwashing of filters secured lower ranks on knowledge indices. Application of fertilizers through drip system was the item of knowledge which secured the lowest rank. In most of the cases for the maintenance works related to the prevention of clogging and related items, farmers were depending on the technical help of the personnel from the dealers. As such the direct participation of farmers in such items were very much limited. This may be partly due to the low level of knowledge on these items of drip irrigation

technology. None of the farmers were adopting the application of fertilizers through drip system as reflected in the lowest rank secured by the same on knowledge index. In advanced countries, farmers widely utilize drip irrigation system for fertilizer application (fertigation) to the crops. In Florida drip irrigation systems were used for fertigation on 98 per cent of drip irrigated acreage (Alan et al 2000). Our cultivators are yet to exploit this conservation technology for achieving fertilizer use efficiency. It may be noted that at present there is no concrete package of recommendations on fertigation in coconut for the farmers to follow. But research programmes are being conducted at CPCRI, Kasaragod on this direction results of which is hoped to bring out appropriate recommendation in fertigation in coconut.

The knowledge level of arecanut farmers on the selected items related to drip irrigation method is furnished in Table 6.

Table 6. Knowledge of arecanut farmers about drip irrigation method (n=30)

Sl.No.	Item	Knowledge		Rank
		Score	Index	
1.	Capacity of the pumping unit required	15	50.00	VIII
2.	Operating pressure required for the optimum performance of the drip system	16	53.33	VII
3.	Suitable type of drippers required	21	70.00	III
4.	Discharge rate of drippers	19	63.33	IV
5.	Water requirement per day per tree	23	76.67	II
6.	Number of drippers required per tree	25	83.33	I
7.	Duration of irrigation required per day	18	60.00	V
8.	Suitable type of filtration unit required	17	56.67	VI
9.	Techniques of prevention of clogging of drip system	13	43.33	IX
10.	Monitoring of emitter discharge to ensure field uniformity	12	40.00	X
11.	Periodical backwashing of filters	9	30.00	XIII
12.	Periodical flushing of drip system	11	36.67	XI
13.	Application of fertilizers through drip system	10	33.33	XII

With respect to the knowledge indices on the items of drip irrigation in arecanut, almost a similar trend was observed as in coconut. Items viz., number of drippers

required per tree, water requirement per day per tree and suitable type of drippers required secured rank I, II and III respectively with regard to the knowledge indices. Items such as techniques of prevention of clogging of drip system, monitoring of emitter discharge to ensure field uniformity, periodical flushing of drip system and application of fertilizers through drip system secured lower ranks on knowledge indices. Periodical backwashing of filters was the item of knowledge which secured the lowest rank. As in the case of coconut, in most of the cases for the maintenance works related to the prevention of clogging and related items, farmers were depending on the technical help of the personnel from the dealers. As such the direct participation of farmers in such items were very much limited. This may be partly due to the low level of knowledge on these items of drip irrigation technology. Compared to coconut, the item on the application of fertilizers through drip system secured a better rank on knowledge index in arecanut. It was observed that two of the farmer respondents were applying chemical fertilizers to areca palms through their drip irrigation system after consulting the scientists of the CPCRI, Regional Station, Vittal. More number of areca farmers were knowledgeable about fertigation compared to coconut growers.

The distribution pattern of farmers based on the level of knowledge on the relevant aspects of drip irrigation technology clearly highlights the need for formulating effective extension strategies to empower the farmers with the required level of knowledge and skill for proper maintenance of the system and effective utilization of the benefits in their field situation. The strategy shall bring together various stakeholders related to the conservation irrigation systems such as the farmers, extension personnel, researchers and the dealers for a meaningful interaction and experience sharing on regular basis for the effective utilization of the technologies in field situation.

4.3. ECONOMIC ANALYSIS OF COCONUT AND ARECANUT CULTIVATION UNDER MICROIRRIGATION AND CONVENTIONAL BASIN METHODS OF IRRIGATION

4.3.1. Economic analysis of cultivation of coconut under microirrigation and conventional basin methods of irrigation

The results pertaining to the analysis of economics of coconut cultivation under micro-irrigation and conventional basin method of irrigation are furnished in the following paragraphs.

Plant density

Under the conventional irrigation systems, the average plant density in coconut gardens varied from 180 in the case of large farms to 210 in the case of marginal farms. The share of bearing palms was 80 per cent irrespective of the holding size. Similarly, in the gardens adopting drip irrigation system, the plant density varied from 180 in medium farms to 188 in marginal farms. The share of bearing palms accounted for 87.00 per cent in medium farms to 81.00 per cent in marginal farms.

Productivity

The average productivity level of coconut under drip irrigation system and conventional basin method of irrigation are given in the following Table.

Table 7. Coconut productivity across holding categories (nuts/palm/year)

Holding category	Marginal		Small		Medium		Large		Average	
	D	B	D	B	D	B	D	B	D	B
Productivity	65	55	63	57	67	57	65	59	65	57

D = Drip method, B = Basin method

It could be inferred from the above table that in the case of farmers adopting conventional irrigation system, the average productivity of coconut ranged between 63 in

the case of small farms to 67 in the case of medium farms. In the case of farmers adopting the drip irrigation system, the same had ranged from 55 in the case of marginal farms to 59 in the case of large farms.

Comparative economics of coconut cultivation with drip and basin method of irrigation

The comparative economics of coconut cultivation with drip and basin method of irrigation is summarized in Table 8.

Cost of cultivation

Labour, one among the prime factors of production, plays a prominent role in farming. Its role assumes of greater importance in socio-economic situations as prevailing in states like Kerala, in which, it is not only costly but also scarce. However, this problem could be tackled by increasing the share of family labour especially in the case of small and marginal farms.

Under conventional irrigation system, the average cost towards labour (other than irrigation and harvesting) varied between Rs. 4075/ha in the case of marginal holdings to Rs.5125/ha in the case of large holdings. The average figures for the present study is Rs.4575/ha, accounting for 22.97 percent of the Total Variable Cost (TVC). The value of organic manures in the form of cow dung, farm yard manure, green leaf manures and other farm wastes ranged from Rs.2900/ha in the case of marginal farms to Rs.3280/ha in the case of large farms. The average expenditure incurred for organic manures was Rs.3100/ha, which accounted for 15.57 percent in the TVC.

Small and marginal farms are resource poor in nature and hence the value of chemical fertilizers applied to their coconut gardens is only to the extent of Rs.1355/ha in marginal farms, whereas the same in large holdings is Rs.2375/ha. The average amount spend on chemical fertilizers is Rs.1835/ha. The same had a share 9.21 percent in the Total Variable Cost.

Harvesting is yet another important operation in coconut crop production. Even the small and marginal farmers also often depend upon the skilled labourers for harvesting. In those gardens, wherein the conventional irrigation methods are being practiced, harvesting charges ranged from Rs.4785/ha in marginal farms to Rs.5820/ha in the large farms. The average expenditure spend on harvesting is Rs.5375/ha, accounting for 26.99 percent in the Total Variable Cost. The irrigation charges including labour and energy charges ranged between Rs.3905/ha in marginal holdings to Rs.5505/ha in large holdings. The average expenditure for irrigation is Rs.4698/ha, which had accounted 23.60 percent in the TVC. The expenditure incurred on plant protection accounted for 1.66 percent in the Total Variable Cost.

't' test was carried out among the various factors of production which indicated that the package of practices does not significantly vary among the various holding groups.

The Total Variable Cost of coconut cultivation under conventional method of irrigation varied from Rs.17110/ha in the case of marginal farms to Rs.22630/ha in large farms. The respective figures for Total Cost is Rs.18821/ha and Rs.24893/ha. The respective figures for Total Cost is Rs.18331/ha and Rs.23221/ha. The average figures for TVC and Total Cost are respectively Rs.19913/ha and Rs.21905/ha.

Under drip irrigation system, the average cost towards the labour (other than irrigation and harvesting) varied between Rs. 4525/ha in the case of marginal holdings to Rs.5375/ha in the case of large holdings. The average figures for the present study is Rs.4950/ha, accounting for 26.14 percent of the Total Variable Cost (TVC). The value of organic manures ranged from Rs.2920/ha in the case of marginal farms to Rs.3330/ha in

the case of large farms. The average expenditure on organics is Rs.3150/ha, which accounted for 16.63 percent in the TVC.

The expenditure on chemical fertilizers ranged between Rs.1370/ha in marginal farms, whereas the same in large holdings is Rs.2420/ha. The average amount spend on chemical fertilizers is Rs.1900/ha. The same had a share 10.03 percent in the Total Variable Cost.

Harvesting charges ranged from Rs. 4990/ha in marginal farms to Rs.5990/ha in the large farms. The average expenditure spend on harvesting is Rs.5525/ha, accounting for 29.17 percent in the Total Variable Cost. The irrigation charges including that of labour and energy charges ranged between Rs.2780/ha in marginal holdings to Rs.3495/ha in large holdings. The average expenditure for irrigation is Rs.3112/ha, which had accounted 16.44 percent in the TVC. The expenditure incurred on plant protection accounted for 1.60 percent in the Total Variable Cost.

The Total Variable Cost of coconut cultivation under drip irrigation method of irrigation varied from Rs.16665/ha in the case of marginal farms to Rs.21110/ha in large farms. The respective figures for Total Cost is Rs.18331/ha and Rs.23221/ha. The average figures for TVC and Total Cost are respectively Rs.18940/ha and Rs.20834/ha.

Returns

The realized gross return of coconut using conventional method of irrigation varied from Rs. 27905/ha in the case of large holdings to Rs.31416/ha in the case of marginal farms. The average figure for gross return is Rs.30012/ha and that of net return is Rs.8107/ha.

The realized gross return of coconut using drip irrigation method of irrigation varied from Rs. 33150/ha in the case of large holdings to Rs.33592/ha in the case of

marginal farms. The average figure for gross return is Rs.34178/ha and that of net return is Rs.13344/ha.

The comparative economics indicated that while other factors remaining the same, adoption of drip irrigation system could yield an additional net return of Rs.5237/ha. Though the value is of moderate in nature, under the changing socio-economic scenario, in which labour availability is becoming more and scarcer, the labour saving technology such as drip irrigation system would be of immense use to the coconut farmers for sustaining coconut production and productivity in Kerala.

Another major advantage of adoption of drip irrigation system is that the total amount of water requirement for cultivating coconut is comparatively lower than what is being utilized under conventional method of irrigation. This benefit is more pronounced in drought prone areas such as North Malabar regions of Kerala, where six months of dry spells is of common feature from November to May. Hence beyond the economics, the advantage of installing drip irrigation system is to be viewed on a holistic approach.

Table 8. Comparative economics of coconut cultivation with drip and basin method of irrigation* (Rs./ha)

	Drip irrigation					Basin irrigation				
	Marginal	Small	Medium	Large	Average	Marginal	Small	Medium	Large	Average
Labour cost	4525	4750	5150	5375	4950	4075	4280	4820	5125	4575
Organics	2920	3100	3250	3330	3150	2900	3020	3200	3280	3100
Chemical fertilizers	1370	1700	2110	2420	1900	1355	1595	2015	2375	1835
Harvesting labour	4990	5275	5845	5990	5525	4785	5275	5620	5820	5375
Labour for irrigation	2380	2525	2750	2995	2662.5	3485	3950	4370	4650	4113.75
Energy for irrigation	400	425	475	500	450	420	480	585	855	585
Plant protection	80	180	450	500	302.5	90	210	495	525	330
Total Variable Cost	16665	17955	20030	21110	18940	17110	18810	21105	22630	19913.75
Weight to Fixed Cost**	1666.5	1795.5	2003	2111	1894	1711	1881	2110.5	2263	1991.375
Total cost	18331.5	19750.5	22033	23221	20834	18821	20691	23215.5	24893	21905.13
Total Returns	33592	35343	34625.6	33150	34178	31416	30232.8	30491.2	27907.2	30012
Net Returns	15260.5	15592.5	12592.6	9929	13344	12595	9541.8	7275.7	3014.2	8107

* 't' tests performed indicated that the management practices does not significantly vary among the various size of holdings.

** Weight age to fixed cost includes depreciation on fixed assets like drip irrigation system, farm buildings, pumps etc.

4.3.2. Economic analysis of cultivation of arecanut under microirrigation and conventional basin method of irrigation

The results pertaining to the analysis of economics of arecanut cultivation under micro-irrigation and conventional basin method of irrigation are furnished in the following paragraphs.

Plant density

Under the conventional irrigation systems, the average plant density in arecanut gardens varied from 1310 in the case of large farms to 1575 in the case of marginal farms. The share of bearing palms was 80 percent irrespective of the holding size. Similarly, in the gardens adopting drip irrigation system, the plant density varied from 1300 in medium and large farms to 1550 in marginal farms. The share of bearing palms is about 80 per cent in all the holding categories.

Productivity levels

The average productivity level of arecanut under drip irrigation system and conventional basin method of irrigation are given in the following Table.

Table 9. Arecanut productivity across holding categories (kg of chali/palm/year)

Holding category	Marginal		Small		Medium		Large		Average	
	D	B	D	B	D	B	D	B	D	B
Irrigation Method										
Productivity	2.1	1.8	2.25	2	2.45	2.18	2.7	2.3	2.37	2.07

D = Drip method, B = Basin method

It could be inferred from the above table that in the case of the farmers adopting conventional irrigation system, the average productivity of arecanut ranged between 1.8 kg of chali per palm in the case of small farms to 2.18 kg of chali per palm in the case of medium farms. In the case of farmers adopting the drip irrigation system, the same had

ranged from 2.1 kg of chali per palm in the case of marginal farms to 2.45 kg of chali in medium farms.

Comparative economics of arecanut cultivation with drip and basin method of irrigation

The comparative economics of coconut cultivation with drip and basin method of irrigation is summarized in Table 10.

Cost of cultivation

The cost of cultivation of arecanut was estimated separately for the two groups of arecanut gardens viz., those adopting the conventional basin irrigation system and those adopted the drip irrigation system. The estimation procedure was similar to that of coconut.

Under conventional irrigation system, the average cost towards labour (other than irrigation and harvesting) varied between Rs. 16320/ha in the case of marginal holdings to Rs.19893/ha in the case of large holdings. The average figures for the present study is Rs.18187/ha, accounting for 28.67 per cent of the Total Variable Cost (TVC). The value of organic manures in the form of cow dung, farm yard manure, green leaf manures and other farm wastes ranged from Rs.8756/ha in the case of marginal farms to Rs.10996/ha in the case of large farms. The average expenditure incurred for organic manures was Rs.9933/ha, which accounted for 15.66 percent in the TVC.

The arecanut farmers in the region add chemical fertilizers as well as other manures such as poultry manures and other branded fertilizers such as Sterameal. The expenditure incurred towards chemical fertilizers including externally purchased manures ranged from Rs.8580/ha in marginal farms to Rs.13962/ha in large farms. The average amount spend on chemical fertilizers is Rs.10323/ha. The same had a share 16.27 percent in the Total Variable Cost.

In those arecanut gardens, where the conventional irrigation methods are being practiced, harvesting charges ranged from Rs. 8645/ha in marginal farms to Rs.9385/ha in the large farms. The average expenditure spend on harvesting was Rs.8920/ha, accounting for 15.26 percent in the Total Variable Cost. The irrigation charges including that of labour and energy charges ranged between Rs.7540/ha in marginal holdings to

Rs.9788/ha in large holdings. The average expenditure for irrigation is Rs.8436/ha, which had accounted 14.44 percent in the TVC. The expenditure incurred on plant protection accounted for 4.52 percent in the Total Variable Cost.

The Total Variable Cost of arecanut cultivation under conventional method of irrigation varied from Rs. 52496/ha in the case of marginal farms to Rs.66954/ha in large farms. The respective figures for Total Cost is Rs.57745/ha and Rs.73649/ha. The average figures for TVC and Total Cost are respectively Rs.58441/ha and Rs.64285/ha.

Under drip irrigation system, the average cost towards the labour (other than irrigation and harvesting) varied between Rs. 18222/ha in the case of marginal holdings to Rs.28500/ha in the case of large holdings. The average figures for the present study was Rs. 23118/ha, accounting for 36.69 percent of the Total Variable Cost (TVC). The value of organic manures ranged from Rs.11750/ha in the case of marginal farms to Rs.18650/ha in the case of large farms. The average expenditure on organics is Rs.14450/ha, which accounted for 22.93 percent in the TVC.

The expenditure on chemical fertilizers ranged between Rs.7590/ha in marginal farms, whereas the same in large holdings is Rs.11408/ha. The average amount spend on chemical fertilizers is Rs.9437/ha. The same had a share 14.98 percent in the Total Variable Cost.

Harvesting charges ranged from Rs. 6075/ha in marginal farms to Rs.9858/ha in the large farms. The average expenditure spend on harvesting is Rs.7767/ha, accounting for 12.33 percent in the Total Variable Cost. The irrigation charges including that of labour and energy charges ranged between Rs.4630/ha in marginal holdings to Rs.6175/ha in large holdings. The average expenditure for irrigation is Rs.5327/ha, which had accounted 8.45 percent in the TVC. The expenditure incurred on plant protection accounted for 4.62 percent in the Total Variable Cost.

The Total Variable Cost of coconut cultivation under drip irrigation method of irrigation varied from Rs.50922/ha in the case of marginal farms to Rs.77798/ha in large farms. The respective figures for Total Cost is Rs.56014/ha and Rs.85577/ha. The average figures for TVC and Total Cost are respectively Rs.63012/ha and Rs.69313/ha.

Returns

The realized gross return of coconut using conventional method of irrigation varied from Rs. 145664/ha in the case of medium holdings to Rs.152880/ha in the case of small farms. The average figure for gross return is Rs.148900/ha and that of net return is Rs.84615/ha.

The realized gross return of coconut using drip irrigation method of irrigation varied from Rs. 163800/ha in the case of small holdings to Rs.193353/ha in the case of largel farms. The average figure for gross return is Rs.173008/ha and that of net return is Rs.103695/ha.

The comparative economics indicated that while other factors remaining the same, adoption of drip system in arecanut gardens, if technically feasible, it is economically viable. Further the economies of scale are another major factor, which could further increase the relative profitability of adoption of drip irrigation system in arecanut gardens. Under the changing socio-economic scenario of Kerala, in which labour availability is not only costly, but also scarce, drip irrigation system would be of immense use to the arecanut farmers for sustaining arecanut production and productivity. The major advantage of adoption of drip irrigation system is more pronounced in drought prone areas such as North Malabar regions of Kerala, where six months of dry spells is of common feature from November to May.

Table 10. Comparative economics of arecanut cultivation with drip and basin method of irrigation* (Rs./ha)

Particulars	Drip irrigation					Basin irrigation				
	Marginal	Small	Medium	Large	Average	Marginal	Small	Medium	Large	Average
Labour cost	18222	21550	24200	28500	23118	16320	17215	19320	19893	18187
Organics	11750	12800	14600	18650	14450	8756	9750	10230	10996	9933
Chemical fertilizers	7590	8475	10275	11408	9437	8580	8475	10275	13962	10323
Harvesting labour	6075	6785	8350	9858	7767	8645	8900	8750	9385	8920
Labour for irrigation	3980	4120	4925	5375	4600	6890	7358	7600	8724	7643
Energy for irrigation	650	708	750	800	727	650	708	750	1064	793
Plant protection	2655	2860	2930	3207	2913	2655	2860	2123	2930	2642
Total Variable Cost	50922	57298	66030	77798	63012	52496	55266	59048	66954	58441
Weight to Fixed Cost**	5092	5729	6603	7779	6301	5249	5526	5904	6695	5844
Total cost	56014	63027	72633	85577	69313	57745	60792	64952	73649	64285
Total Returns	169260	163800	165620	193353	173008	147420	152880	145664	149635	148900
Net Returns	113246	100773	92987	107776	103695	89675	92088	80712	75986	84615

* 't' tests performed indicated that the management practices does not significantly vary among the various size of holdings.

** Weight age to fixed cost includes depreciation on fixed assets like drip irrigation system, farm buildings, pumps etc.

4.4. FIELD PERFORMANCE AND EVALUATION OF DRIP IRRIGATION SYSTEMS IN COCONUT AND ARECANUT GARDENS

4.4.1. Field uniformity estimation

4.4.1.1. Absolute emission uniformity (EUa)

The results of the estimation of field uniformity by recording the absolute emission uniformity (EUa) of the drip irrigation systems installed in coconut and arecanut gardens in farmers' field is summarized in Table 11 below.

Table 11. Absolute emission uniformity of drip irrigation systems in farmers' field

Absolute emission uniformity (EUa)	Coconut garden		Arecanut garden	
	Frequency	Per cent	Frequency	Per cent
<70	11	18.30	1	3.30
70-80	14	23.30	2	6.60
80-90	22	36.70	21	70.00
>90	13	21.70	6	20.00
Total	60	100.00	30	100.00

It was observed that the system uniformity of drip irrigation systems in farmers' field in terms of absolute emission uniformity, probably the single most important factor in influencing the system performance, is maintained with fair and above level in majority (81.70 per cent in coconut and 96.6 per cent in arecanut) of the gardens. However in a few gardens (18.30 per cent in coconut and 3.3 per cent in arecanut) it is maintained at a poor level.

4.4.1.2. Statistical uniformity coefficient

The results of the estimation of field uniformity in terms of statistical uniformity coefficient of the drip irrigation systems installed in coconut and arecanut gardens in farmers' field is summarized in Table 12 below:

Table12. Statistical uniformity of drip irrigation systems in farmers' field

Statistical uniformity coefficient (Us)	Coconut garden		Arecanut garden	
	Frequency	Per cent	Frequency	Per cent
60-70	0	0	2	6.60
70-80	12	20.00	12	40.00
80-90	29	48.30	18	60.00
>90	19	31.70	0	0.00
Total	60	100.00	30	100.00

The results showed that the field emission uniformity in terms of the statistical uniformity coefficient for all the plots is maintained in fair and above level. No coconut plot belonged to poor or unacceptable categories. Majority (80 per cent in coconut and 60 per cent in arecanut) belonged to very good and excellent level of uniformity.

4.4.2. Volume of water applied per tree per day

The details pertaining to the total quantity of water applied per tree per day through drip irrigation system in farmers' field is furnished below:

Table13. Volume of water applied per palm per day through drip irrigation systems in coconut garden

Volume of water applied per palm per day (litres)	Frequency	Per cent
<32	1	1.7
32	1	1.7
>32	58	96.6
Total	60	100.00

For coconut, CPCRI recommends application of irrigation water @ 66 per cent of open pan evaporation for drip irrigation. With the prevailing climatic conditions of the study area this works out to be approximately 32 lit of water per day per palm for coconut. The present study revealed that a vast majority (96.6 per cent) of the farmers were irrigating their coconut palms with more than the recommended quantity of water.

Table14. Volume of water applied per palm per day through of drip irrigation systems in arecanut garden

Volume of water applied per palm per day (litres)	Frequency	Per cent
<20	5	16.60
20	3	10
>20	22	73.30
Total	30	100.00

In the case of arecanut the recommended quantity of water to be provided through drip irrigation is 20 litres per day per palm. From the above table it is clear that majority (73.3 per cent) of the farmers were irrigating their arecanut palms with more than the recommended quantity of water.

4.4.3. Root zone area wetted

As per the guidelines for effective irrigation through drip system, a minimum of 30 per cent of the root zone area should be wetted in drip irrigation. Results of the study furnished in Table15 below showed that in majority of the coconut gardens the recommended level of root zone area of palms were not getting wetted. But 46.6 per cent of the areca plots were maintaining the root zone area wetted above the minimum prescribed level. It may be noted that the guidelines on minimum root zone area to be wetted for effective irrigation is made for tree crops in general. Though there was a considerable number of gardens (98.3 per cent in coconut and 53.4 per cent in arecanut) under the study were unable to meet the specific requirement in terms of a minimum root zone area wetted, there were no reports on any yield decline or negative impact on growth through drip irrigation in those gardens. Hence studies are required for modifying and verifying the specifications in terms of a minimum root zone area to be wetted in coconut and arecanut under drip irrigation.

Table 15. Root zone area wetted through drip irrigation in farmers' field

Root zone area wetted (per cent)	Coconut garden		Arecanut garden	
	Frequency	Per cent	Frequency	Per cent
<30	59	98.30	16	53.4
>30	1	1.70	14	46.6
Total	60	100.00	30	100.00

4.4.4. Number of dripping points

The present recommendation is to provide four dripping points in sandy loam and laterite soils and six dripping points in sandy soil for coconut to obtain a minimum of 30 per cent of the root zone area to be wetted. Similarly in arecanut, 2-3 dripping points are recommended depending up on the soil type. The details on actual number of dripping points in the installed system in farmers' field are furnished in Table16 and Table 17 below.

Table16. Number of dripping points in the drip irrigation system
in coconut gardens in farmers' field

Soil type	Number of dripping points per palm	Number of gardens
Sandy loam	2	2
	3	6
	4	4
	5	1
Laterite	2	2
	3	23
	4	13
	5	1
Sandy	3	8

Table17. Number of dripping points in the drip irrigation system in arecanut
gardens in farmers' field

Soil type	Number of dripping points per palm	Number of gardens
Clay loam	2	3
Laterite	2	27
	Total	30

The recommended number of dripping points in sandy loam and laterite soils is four per palm. But the results showed that only 34 per cent of coconut gardens were having the recommended number of dripping points per palm. More than 60 per cent of the gardens were having less than recommended number of dripping points per palm. Coconut gardens grown in sandy soil also showed a similar situation where none of the gardens were having the recommended number of dripping points per palm. If the recommended number of dripping points per palm are not maintained, proper wetting of root zone will not be achieved and also the loss of water through percolation will be more. Interestingly in arecanut all the farmers maintained the recommended number of dripping points per palm. To ensure maximum benefits from microirrigation technology participation of all the stakeholders viz., farmers, extension personnel and dealers, especially in critical stages such as design and field installation of the system, is desirable.

4.4.5. Location of dripping point

Table 18 and 19 below furnish the details about the location of dripping points in the drip irrigation system installed in coconut and arecanut gardens respectively.

Table 18. Location of dripping points in the drip irrigation system installed in coconut gardens

Distance of dripping point from tree trunk	Frequency	Per cent
Less than 1m	55	91.66
1m	5	8.34
Total	60	100.00

In coconut the present recommendation is to keep dripping point at a distance of 1m away from the palm. This is to obtain maximum wetted soil within the root zone. But from the results obtained, it can be seen that in more than 90 per cent of the coconut gardens distance of dripping point from tree trunk was less than the recommended distance.

Table19. Location of dripping points in the drip irrigation system installed in arecanut in farmers' field

Distance of dripping point from tree trunk	Frequency	Per cent
Less than 50 cm	22	73.3
50 cm	8	26.7
Total	30	100.00

In the case of arecanut about one fourth (26.7 per cent) of the gardens maintained the prescribed distance of dripping point from tree trunk. In arecanut, the recommendation is to keep the dripping point 50cm away from the palm. But still majority (73.3 per cent) of the areca gardens distance of dripping point from tree trunk was less than the recommended distance.

4.4.6. Placement of dripping point

Table 20 provides the distribution of coconut and arecanut gardens according to the placement of dripping points in the drip system.

Table 20. Placement of dripping points in the drip irrigation system

Placement of drippers	Coconut garden		Arecanut garden	
	Frequency	Per cent	Frequency	Per cent
surface	59	98.33	30	100
Sub surface	1	1.7	0	0
Total	60	100.00	30	100.00

Experiments at CPCRI showed that applying water subsurface will help to reduce the evaporation from soil surface. Results showed that all the farmers under study except one coconut farmer were keeping the dripping points on surface itself. Surface placement of dripping points definitely result in loss of water through evaporation. This indicates the need to make efforts to create awareness among the farmers adopting drip irrigation system about the need and importance of proper placement, i.e., subsurface placement to minimize the water loss.

4.4.7. Type of emitters used

From the table 21 below it is clear that a vast majority (91.7 per cent in coconut and 93.3 per cent in arecanut) of the farmers were using micro tube as emitters in their drip system. Pressure compensating type of emitter which is the ideal type was used by only a few (3.3 per cent in coconut and 6.7 per cent in arecanut). The pressure compensating type of emitter is costly and that may be the reason for the very low rate of adoption. Micro tube is sufficient for getting a good performance of the system. Few other farmers (5 per cent in coconut) used non pressure compensating type of emitters which is not recommended as it can not ensure the required emission uniformity in the field.

Table 21. Type of emitters used in drip irrigation system in farmers' field

Type of emitters	Coconut garden		Arecanut garden	
	Frequency	Per cent	Frequency	Per cent
Micro tube	55	91.7	28	93.3
Pressure compensating	2	3.3	2	6.7
Non pressure compensating	3	5.0	0	0
Total	60	100	30	100

4.4.8. Water source

The type of water source being utilized for the drip irrigation system by farmers is as follows:

Table 22. Type of water source utilized for the drip irrigation system

Water source	Coconut garden		Arecanut garden	
	Frequency	Per cent	Frequency	Per cent
Open well	41	68.3	15	50
Bore well	4	6.7	3	10
Open well & Bore well	0	0	2	6.7
Open well & River	0	0	2	6.7
River	14	23.3	4	13.3
Surangam	1	1.67	4	13.3
Total	60	100	30	100

The results showed that open well is the most commonly (68.3 per cent in coconut and 50 per cent in arecanut) used source of water for drip irrigation by growers. Of late, as the water shortage problem is getting severe, farmers have started digging bore wells also as a source of water as indicated in the table above. Few farmers also utilize the traditional water harvesting structure, surangam as a source of water for drip irrigation. As part of the present study a case study was conducted in which integration of the traditional water harvesting structure is made with the advanced irrigation method of drip system.

4.4.9. Method of water supply

The recommended method of water supply is by direct pumping, as it provides a uniform and required operating pressure and discharge. The pattern followed by farmers is furnished in Table 23 below.

Table 23. Method of water supply in drip irrigation system in farmers' field

Method of water supply	Coconut garden		Arecanut garden	
	Frequency	Per cent	Frequency	Per cent
Direct pumping	35	58.3	26	86.7
Through over head tank	25	41.7	4	13.3
Total	60	100	30	100

It was observed that many farmers go for providing water for drip system through overhead tanks because the overhead tanks constructed serve dual purpose, i.e., for domestic as well as irrigation.

4.4.10. Type of filter used

The distribution of coconut and arecanut gardens based on the type of filters used in the drip irrigation system is furnished in Table 24 below.

Table 24. Type of filters used for drip irrigation system in farmers' field

Type of filter	Coconut garden		Arecanut garden	
	Frequency	Per cent	Frequency	Per cent
Nil	2	3.33	1	1.33
Wire mesh filter	54	90	29	96.7
Sand filter	4	6.67	0	0
Total	60	100	30	100

The results showed that a vast majority of the drip irrigation units installed in farmers' field was having the ordinary wire mesh filter type. According to the report on the "Integrated study for sustainable development of Kasaragod District" conducted by the Kerala Land Use Board and national remote Sensing Agency the quality of ground water in Kasaragod District is very good for all domestic use, irrigation purpose and industrial use. When good quality water is used for irrigation, ordinary wire mesh filter is sufficient to use in the drip irrigation system.

4.5. PERCEPTION OF FARMERS ABOUT THE FACTORS ASSOCIATED WITH THE ADOPTION OF DRIP IRRIGATION SYSTEM

Table 25 below furnishes the details on the perception of farmers about the factors associated with the adoption of drip irrigation system.

Table 25. Perception of farmers about the factors associated with the adoption of drip irrigation system (n=90)

SI No.	Item	Total score	Rank
1	Influence of mass media	98	VII
2	Influence of extension personnel	115	V
3	Influence of researchers	74	XI
4	Influence of dealers	93	VIII
5	Influence of peer group	112	VI
6	Economic motive	133	II
7	Community recognition	80	IX
8	Achievement motive	77	X
9	Water shortage during summer	130	III
10	Availability of subsidy	138	I
11	Labour scarcity	128	IV
12	Weed growth in the garden under sprinkler system of irrigation	68	XII

Availability of subsidy secured first rank among the factors associated with the adoption of drip irrigation system as perceived by the adopters. This is in line with the observation of Behr and Naik (2000) who reported that subsidy has encouraged many farmers to install drip systems in their orchard. It was followed by economic motive and water shortage during summer as the II and III important factors. The results on the farmers' perception clearly emphasize the importance of subsidizing high cost farming technologies like drip irrigation system. Farmers also had a high perception on the economic benefits of the technology. Lack of sufficient water for irrigation during the summer months was prompting many farmers to adopt drip irrigation system. Evidently the relative advantage of drip irrigation as a water saving conservation irrigation method was well appreciated by many farmers. Agricultural columns in newspapers, popular articles in farm journals, information provided by extension personnel of the local Krishibhavan, experience sharing between farmers, dealers involved in sales and services

connected to drip irrigation equipments were the other important factors perceived as influencing adoption of drip irrigation system. Factors such as receiving recognition among community members, achievement motive, influence of scientists of agricultural research stations and reduction in weed growth in the garden by adopting drip method were given lesser importance only by the respondents as reflected in their lower ranks. It can be concluded that economic and scientific benefits of the technology were the key factors for its adoption.

4.6. PERCEPTION OF FARMERS ABOUT THE REASONS FOR NON- ADOPTION OF DRIP IRRIGATION SYSTEM

Data on the perception of farmers (non-adopters) about the reasons for the non - adoption of drip irrigation system are summarized as below:

Table 26. Perception of farmers about the reasons for non - adoption of drip irrigation system (n=90)

Sl No.	Item	Total score	Rank
1.	Lack of water during for irrigation, water source available provide water only sufficient to meet the domestic requirements.	210	II
2.	High initial investment.	254	I
3.	Farmers are satisfied with the conventional method of irrigation in places where sufficient water is available.	172	IV
4.	Poor quality of water which may result in clogging of the drip system.	144	VI
5.	Lack of awareness and knowledge about the drip system.	194	III
6.	Perception that the water provided through the drip is not sufficient for the proper crop growth.	152	V
7.	Discontinuance of the technology by many of the adopters.	115	IX
8.	Lack of power supply	130	VII
9.	Voltage problem	121	VIII

As evident from the above table, high initial investment was the top ranking factor for the non adoption of drip irrigation system by the farmers. In spite of many relative advantages, high material cost may prevent many farmers from adopting the drip irrigation system. Lack of water for irrigation was the reason for non adoption ranked II by the farmers. They opined that water source available in their farm provide water only sufficient to meet their domestic requirements. Lack of awareness also emerged as an important factor for the non adoption of the system. Wherever farmers were having sufficient water to irrigate their crop all through the summer months, they were resorting to the conventional systems of irrigation. It is natural that drip irrigation system being a water saving irrigation method, the technology will be perceived more beneficial by those farmers who experience the problem of water shortage for irrigation. This result emphasize the need for popularizing drip irrigation as a conservation irrigation method.

The general perception of some farmers is that the water provided through the drip is insufficient for proper crop growth. Hence intensive extension efforts are required to educate the cultivators about the basic concept of drip irrigation method as a water saving irrigation method. Some farmers who perceived that poor quality of water owing to sediments and algal growth leading to clogging problem as a main reason for non adoption. Discontinuance of drip irrigation technology by many farmers due to various reasons also emerged as a factor for non adoption. Problems related to power supply/low voltage also discouraged the adoption of drip irrigation system by some of the cultivators. Appropriate extension interventions will be required to identify the factors behind discontinuance and providing technical support to farmers to overcome the constraints experienced.

4.7.CONSTRAINTS IN THE OPERATION AND MAINTENANCE OF DRIP IRRIGATION SYSTEM

4.7.1. Perception of farmers about the constraints in the operation and maintenance of drip irrigation system

Table 27. Perception of farmers about the constraints in the operation and maintenance of drip irrigation system (n=90)

Sl.No.	Item	Total score	Rank
1.	Clogging of the system due to impurities in irrigation water	220	I
2.	Erratic electric power supply	144	V
3.	Voltage problem	132	VI
4.	Damage of pipelines and drippers by rats	119	VIII
5.	Damage of pipelines and drippers by wild animals such as wild boar etc.,	129	VII
6.	Damage of pipelines and drippers by falling of coconut leaves	112	IX
7.	Low level of awareness and inadequate knowledge about utility, method of operation and maintenance	156	IV
8.	Improper after sales service	188	II
9.	Lack of timely technical guidance from the extension personnel	170	III
10.	Root concentration on soil surface	105	X

A cursory look at Table 27 clearly indicate that clogging of the drip irrigation system was the most important problem faced by the cultivators which secured the I rank among the constraints in the operation and maintenance of drip irrigation system. Emitter clogging continues to be the major problem associated with the drip irrigation operation. The causes for clogging, which is directly related to the quality of irrigation water may be physical, chemical or biological factors. Even though standard recommendations are available to prevent clogging, farmers were found unaware of these practices. Lack of timely service from dealers and also poor technical aid from extension personnel were clearly reflected in the perception of constraints by farmers. Hence there is an impending need to educate the farmers about the scientific practices related to the operation and maintenance to ensure effective performance of drip irrigation system. Erratic electric power supply, voltage problem, damage of pipelines and drippers by rodents and wild

animals, damage caused by falling of coconut leaves and root concentration on soil surface were the other constraints in the operation and maintenance of drip irrigation system as perceived by the farmers.

4.7.2. Perception of extension personnel about the constraints in adoption of drip irrigation system

Table 28 below summarizes the constraints in the adoption of drip irrigation system as perceived by the extension personnel of the Department of Agriculture.

Table 28. Constraints in the adoption of drip irrigation system as perceived by the extension personnel (n=25)

Sl No.	Item	Total score	Rank
1.	Krishibhavan staff is overburdened with office work, hence proper monitoring of field installation of drip system is not possible.	70	I
2.	Lack of knowledge among farmers about the installation and maintenance of the system	64	II
3.	Agricultural Officers are not properly trained on the installation and maintenance of the system	60	III
4.	Improper maintenance by the farmers	50	IV
5.	High initial investment, hence small farmers can not afford to adopt the system	45	V
6.	Clogging of drippers	41	VI
7.	Farmers' perception that the quantity of water provided through drip irrigation system is insufficient for crop growth	39	VII
8.	Faulty lay out of the system in the field	34	VIII
9.	Low quality of drip irrigation system materials supplied by the manufacturing firms	32	IX
10.	Movement of cattle and other domestic animals in the field, displace and damage the micro tubes and pipe lines	30	X

The analysis of the data collected from the field functionaries identified some key administrative limitations in performing need based extension services. Krishibhavan staff working at the grass root level are perceived to be overburdened with more of routine office work, which in turn affected the frequency and quality of field extension services. This is evident from the fact that only 8 per cent of the extension personnel were

able to visit the farmers garden at the time of installation of the drip irrigation system. Excess office work and inadequacy of staff were the problems often quoted which affect the communication effectiveness of Agricultural Officers. (Anilkumar, 1997). A cursory glance at the profile of extension personnel under the study (Table 29) showed that they are technically highly qualified and experienced. But their capabilities and qualities were not properly exploited due to the inadequacies of the present set up of their work situation.

Table 29. Profile of extension personnel (n=25)

Sl.No.	Particulars	Category	Frequency	Per cent
1.	Age	20 to 30 years	6	24
		30 to 40 years	11	44
		40 to 50 years	6	24
		> 50 years	2	8
2.	Educational qualification	Diploma in Agri.	8	32
		BSc. (Agri.)	12	48
		MSc. (Agri.)	5	20
3.	Professional experience	<10 years	15	60
		10 to 20 years	8	32
		20 to 30 years	2	8

Lack of effective training on the drip irrigation technology was also cited as a constraint in the proper monitoring and follow up of the field installation and maintenance. Most of the farmers were thus forced to depend on the technical help from the dealers for the field installation and maintenance of drip system. A vast majority (96 per cent) of the extension personnel felt the need for further training on drip irrigation technology. Need based training programmes are to be organised on a regular basis to enhance the technical competence of extension personnel. Without redirecting the efforts to strengthen field extension services, the Krishibhavans will be continued to be viewed merely as an agency for distribution of inputs and incentives rather than a source of technical information and guidance by the farmers. High initial investment, clogging of drippers, farmers' misconception about the inadequacy of water provided through drip irrigation system is insufficient for crop growth, faulty lay out of the system in the field, low quality of materials supplied by the manufacturing firms and movement of cattle and other domestic animals in the field, causing damage to the system were the other

constraints in the adoption of drip irrigation system as perceived by the extension personnel. The overall result reinforces the need for streamlining effective extension strategies for educating the farmers on the basic concept, advantages and practice of the drip irrigation system.

4.7.3. Perception of dealers about the constraints in the adoption of drip irrigation system

The constraints in the adoption of drip irrigation system as perceived by the dealers are summarized in Table 30.

Table 30. Constraints in the adoption of drip irrigation system as perceived by the dealers (n=7)

Sl No.	Item	Total score	Rank
1.	Adoption of drip irrigation system by many farmers was subsidy driven. Farmers were not really interested in collecting the required technical information for proper installation and maintenance.	21	I
2.	Farmers were not satisfied with the quantity of water delivered through the drip, as they perceive the quantity provided is quite insufficient for crop growth.	17	II
3.	The fund allotment by the Agriculture Department for the subsidy scheme was untimely.	15	III
4.	Discrepancy in the disbursement of subsidy by the officials of Agriculture Department due to lack of proper guidelines.	11	IV
5.	Farmers do not adopt the recommended practices for the proper maintenance of the drip irrigation system.	9	V
6.	Lack of efforts by the Agriculture Department to impart training to the farmers on drip irrigation technologies.	8	VI

Constraints in the adoption of drip irrigation system as perceived by the dealers of drip irrigation equipments were mainly related to the existing inadequacies they felt with the client system and extension system. They perceived that subsidy provided by the state acted as the key factor leading to the speedy adoption of the technology. The lack of adequate technical know how among the farmers was perceived to hinder effective performance of the system. Factors related to the extension system, such as delay in fund allotment, discrepancy in the disbursement of subsidy, lack of effort to organise farmers' training programmes on drip irrigation technologies were some of the other constraints

in the adoption of drip irrigation system as perceived by the dealers. These perception of dealers points to the need for organising participatory assessment of field level performance of drip irrigation system involving farmers, extension personnel and dealers on a regular basis to ensure effective utilization of technologies.

4.8. SUCCESSFUL EXPERIENCES OF FARMERS IN ADOPTING

DRIP IRRIGATION

Successful adoption of an innovative farm technology depends on many factors. The socio-economic and psychological characteristics of the cultivator along with other situational factors play a vital role in the successful utilization of improved farm practices. Two cases of farmers who successfully adopted microirrigation technology in coconut farming are presented as follows:

4.8.1. Case - I

Mr. M. Narayanan, (Saroj Bhavan, Kuttamath, Cheruvathur post, Kasaragod District) is 60 year old and is actively involved in farming. He resorted to farming as a main occupation after his retirement from the Indian Army. He had formal education up to Pre degree. Mr. Narayanan, now, is a full time farmer who acquired 0.6 ha of cultivated land with coconut as the main crop. Arecanut, cashew and pepper are also cultivated in a small area. Being keen on adopting scientific crop management, he had been following hose irrigation for coconut palms at an interval of once in 3-4 days that would provide the trees with about 300 litre of water per irrigation. In fact, coconut cultivators in this area were severely constrained by shortage of water towards the fag end of summer. Water available from other confined sources; particularly the well, was only sufficient for irrigation up to the end of April every year. Further, frequently interrupted power supply along with low voltage was adding to his constraints. Mr. Narayanan came across drip irrigation technology in an article published in “Karshakasree”, a popular Agricultural Journal in ‘Malayalam’. Even before an in depth understanding, the technology attracted his attention, as it

appeared to be substantially efficient in conserving water. To follow up the initial interest he developed, he approached the local ‘Krishibhavan’ at Cheruvathur. The technical personnel of the Krishibhavan made him aware further about drip irrigation technology and also about the financial incentives available to farmers by the government and other agencies for installation of drip irrigation system.

By availing of the subsidy from the ‘Krishibhavan’, he got the drip irrigation system installed in his coconut garden in 1997 with the help of a private firm in

Kanhangad, M/s Vikas Agro Service. Prior to installation, the average yield realized from coconut was only to the tune of 50-60 nuts per palm per year. After the installation of drip irrigation system, he was able to irrigate his coconut palms daily at the rate of 40 litre of water per palm. Moreover, available water could be conserved till the end of summer. Consequently, he observed an increase of about 25 per cent in the productivity of coconut palms. Correspondingly, his annual income has gone up by about 4000 rupees. Encouraged by the early success, he has acquired adequate knowledge and skill for the proper operation and maintenance of the drip system installed in his garden. He makes earnest efforts to constantly observe the system and clean the pipelines and micro tubes regularly, in order to ensure effective performance of the drip system.

4.8.1.1. Case analysis

The case illustrates that the systematic adoption of the microirrigation technology, as per the recommended practices, by Mr. Narayanan has fetched him the desired results by way of enhanced income from coconut farming. An attitude characterised by a strong orientation towards systematic approach to problem solving to achieve the objectives set-forth have enabled him to reap the benefits of the modern farm technology. Further, his fulltime involvement and commitment in farming, as a main avocation and income generating activity, gave him the confidence for the investment of hard earned resources and time for adopting innovative farm technologies such as microirrigation technology. His personal attention and use of family labour in the operation and maintenance of the irrigation system also contributed to the effective utilization of the improved technology. Utilization of farm magazines and contact with extension agencies helped him in acquiring the required knowledge about the improved farm practices, which proved to be the driving force for the perfect adoption of microirrigation technology in his coconut garden.

4.8.2. Case-II

Mr. K. Abdul Khader Haji, Noor Manzil, Poinachi, Kasaragod District, is a 69 year old full-time farmer. In spite of his low level of education (only up to primary class) he is very keen on collecting latest scientific information on improved farming methods. He regularly reads the agricultural columns in newspapers and also subscribes

to 'Kerala Karshakan', the most popular Malayalam farm magazine published by the Farm Information Bureau of the State Agriculture Department. Besides this, he regularly participates in the extension programmes organized by the 'Krishibhavan', the local office of the Department of Agriculture. He has also visited agricultural research stations like Central Plantation Crops Research Institute, Kasaragod and Regional Agricultural Research Station, Pilicode in order to participate in Kisan Melas and farm exhibitions.

He owns a 2.4 ha farm located near Poinachi town, where coconut is raised as the main crop along with pepper as a mixed crop. He was adopting basin irrigation for coconut, weekly once, using the water from a bore well dug in the garden. Water scarcity during the peak period of summer months and lack of sufficient labour were the major problems faced by him. Mr. Haji thus started exploring water conserving and labour saving methods of irrigation to solve these problems. He got preliminary information on drip irrigation system from 'Kerala Karshakan'. He also gathered information on a private agency undertaking the installation of drip systems, from a newspaper advertisement. The private agency, M/S Vikas Agro Services, Kanhangad provided him with detailed information on the technology. Encouraged further by the staff of Krishibhavan of his Panchayat, from where he acquired information on subsidy, he decided to adopt drip irrigation system in his coconut garden which was installed in the year 1997.

Mr. Haji, at present, is highly appreciative of the drip system, as it has helped him overcome the problem of water shortage during summer, quite effectively. Previously, he was providing about 250-300 litre of water per palm weekly once through basin irrigation, that too only up to the end of April or first week of May. He was also faced with shortage of labour for irrigation. After installing drip system, he is able to provide irrigation daily at about 40 litre per palm throughout the summer season. As he himself was engaged in operating the system, considerable labour could be saved. Mr. Haji has recorded an yield level up to an average of 100-120 nuts per coconut palm per year as against 70-80 nuts prior to the installation of drip irrigation system.

4.8.2.1. Case analysis

As in the previous case, the exposure to mass media and contact with extension agencies helped Mr. Haji in acquiring the required knowledge about the microirrigation technology. He had comparatively a large farm and with the 75 per cent subsidy from the government, he was ready to take the risk of investing in the microirrigation technology in his coconut garden. Due to water scarcity, he was unable to provide irrigation to coconut palms at the fag end of the summer, prior to the adoption of microirrigation technology. He also experienced difficulty to get labourers for irrigating the coconut garden. The adoption of microirrigation technology proved to be effective in overcoming both the problems. Since the drip irrigation method is labour saving, he could achieve considerable reduction in the cost of cultivation of coconut and thereby enhance the profit from coconut farming.

4.8.3. Case-III

Mr. S. N. Bhat, Ammenadukka House, Meappadavu post, Kasaragod District is a successful arecanut farmer adopting drip irrigation system in his farm. He is 42 years old and fully depends on farming for his sustenance. A socially active person owing to his political affiliations Mr. Bhat is closely associated with the development activities of his native Meencha grama panchayat. He is very keen in keeping informed of the improved farming practices. Mr. Bhat effectively utilizes the agricultural columns in the daily newspaper, radio and television programmes on farming related topics, extension activities organised by the local Krishibhavan and visits to the agricultural research stations for updating his knowledge in improved farming. He had completed Pre degree course. He did not pursue his academic studies mainly to concentrate in farming. He cultivates 0.8 ha of arecanut out of the total farm area of 1 ha. Dakshina Kannada local and Mangala are the varieties grown. His farm is located in the lower reach of the hilly terrain on the banks of the small tributary of Uppala river. Previously he was following hose irrigation for the areca palms using Mr. S.N. Bhat in his arecanut garden the water from the well. Later he switched over to sprinkler irrigation system. But he discontinued the sprinkler system after three years as he was disenchanted with it mainly due to the increased incidence of fruit rot or

Mahali disease (Kole roga in Kannada) of areca palms and increased weed growth in the garden. Further there was water shortage during the fag end of the summer.

4.8.3.1 Case analysis

Mr. Bhat developed interest in drip irrigation system after reading an article about drip irrigation system and its advantages which appeared in Udayavani, a popular Kannada daily. He decided to seek more details on it and also see in person how it works in arecanut garden. Accordingly he visited the arecanut garden of Mr. Neerkazha Krishna Bhat, a progressive farmer at Ukkuda in Dakshin Kannada district of Karnataka State whom he personally knew. After seeing the effective functioning of the drip system in Mr. Krishna Bhat's plot and getting convinced about its feasibility in his situation he decided to adopt drip irrigation system in his garden. The extension personnel of the local Krishibhavan further encouraged him. He installed drip irrigation system in his arecanut garden through the private firm Vikas Agro services, Kasaragod in 1997 and availed the subsidy from the Krishibhavan. About 25 litres of water per palm is provided through the drip system. He is thorough with the methods of operation and maintenance of the system. Mr. Bhat perceives that there is a substantial reduction in the incidence of Mahali disease in his arecanut garden after the installation of drip irrigation system. Weed growth in the garden also is kept at the minimum as compared to the sprinkler irrigation system. According to him the yield of areca palms also increased from an average of 1.5-2.0 to 2-2.5 kg chali per palm per year. Further, the water available is sufficient to meet the irrigation requirement all through the summer.

4.8.4. Case-IV

Mr. Laxmi Narayana Bhat, Ayyankavu, Rajapuram post Kasaragod District is a full time farmer who is fully convinced about the feasibility and advantages of adopting drip irrigation system in his farm. He is 52 years old and owns an agricultural farm of 2.8 Ha size with coconut in 2 ha and arecanut in 4 ha . Of the total area of 2.8 ha, 2.4 ha is brought under drip irrigation system. Mr. Bhat is very much interested in procuring information on improved farming practices from farm magazines, technical personnel of the nearby Krishibhavan and occasionally visits agricultural research stations such as CPCRI, Kasaragod and RARS, Pilicode. He adopts most of the recommended package

of practices of cultivation for coconut and arecanut including manuring, weeding, mulching, crop protection and irrigation. But for cashew not much care is taken except for removing the bush growth under the trees for facilitating harvesting and picking of fallen cashew nuts. He believes that cashew is a very hardy crop and fetches good yield even with minimum care.

4.8.4.1. Case analysis

Mr. Bhat was following hose irrigation for arecanut with the water available from a pond and a well in his farm. But the coconut palms were rainfed as the water was not sufficient to irrigate coconut palms. Even for irrigating arecanut palms he experienced water shortage towards the peak summer i.e., during end of April and May. Scarcity of labour and high wage rate were other constraints he faced. Mr. Bhat got some preliminary information about the drip irrigation system as a water saving and labour saving conservation irrigation method from farm magazines such as Kerala Karshakan and Karshakashree. He received information from the Krishibhavan, Panathady about the subsidy scheme which provide financial incentive to farmers for installing drip irrigation system in their orchard. He visited an arecanut garden of a nearby farmer in which drip system was installed and gathered more details on the working of the system and its suitability in arecanut garden. Having convinced about the feasibility of drip irrigation system he got the same installed in his arecanut and coconut garden in an area of 2.4 ha through a private agency in Kanhangad town in 1996 for which subsidy was availed from the Krishibhavan Panathady.

According to Mr. Bhat, after introducing drip irrigation system the water available from his pond and well is sufficient to meet the irrigation requirement of arecanut and coconut. He provides irrigation daily and is applying about 30 litres of water per palm for arecanut and about 50 litres per palm for coconut. The average yield per palm per year has increased from 1.75 to 2.25 kg chali for arecanut and from 60 to 80 nuts for coconut. The operation and maintenance of the drip system is looked after by himself and family members thereby reducing the dependence on hired labour for irrigation.

4. 9. DISCONTINUANCE OF DRIP IRRIGATION TECHNOLOGY

The discontinuance of an innovation is one indication that the new idea may not have been fully institutionalized and routinized into the ongoing practice and way of life of the adopter at the implementation stage of the innovation-decision process. Such routinization is less likely (and discontinuance more frequent) when the innovation is less compatible with the individual's beliefs and past experiences. Four cases of cultivators who discontinued the microirrigation technology after initially adopting it in their coconut gardens are presented below:

4.9.1. Case - I

Mrs. K. Chandramathi, ('Anjali', Near Railway gate, Cheruvathur post Kasaragod District) is a retired primary school teacher aged 56 years. She is managing the coconut farming in 0.8 ha of her farm land. She used to read the agricultural column in 'Malayala Manorama', the popular Malayalam daily occasionally. Though not regular, she also participates in the agricultural seminar and farmers' group meetings organized by the local 'Krishibhavan'. The coconut palms were irrigated once in a week with the water available from a well.

Water scarcity during the fag end of summer and high labour charge were the major constraints she experienced in coconut farming. She came to know about drip irrigation system from an article appeared in the agricultural column in 'Malayala Manorama' and the staff of the nearby 'Krishibhavan' informed her about the subsidy scheme for installing the drip irrigation unit in coconut garden. Subsequently a private firm from Kanhangad installed the drip irrigation system in her coconut garden in 1995. She started irrigating the palms daily through drip system @ 45 litres of water per palm. In the next year during April-May period problem started with the drip system in the form of clogging of micro tubes and filter. It was manifested in the beginning as sharp reduction in the discharge of water through the micro tubes. She was not aware about the methods to overcome the clogging problem in the drip system. Krishibhavan staff directed her to the dealers when she sought technical help to solve the problem.

Though the personnel from the private firm once came and repaired the clogged system the clogging problem was disrupting the irrigation in a recurrent manner. Two years after the installation, i.e., in 1997, she dismantled the drip irrigation system and switched over to the conventional hose method of irrigation for irrigating the coconut palms.

4.9.1.1. Case analysis

The major constraint which paved way for the discontinuance of the technology by Smt. Chandramathi was the clogging of the drip irrigation system. She felt that sufficient technical and service support was not forthcoming and hence she decided to reject the microirrigation technology. During discussion with the farmer it was known that the involvement of farmer during the design and installation of the drip system was at the minimum. As such the farmer was neither having the technical knowledge for the proper maintenance of the system nor did she receive timely service from the extension agencies or the dealer. Further, the quality of the water available from the well in her garden was poor with sedimentation of clay particles and also had salinity problem. As she was not a full time farmer, the time and effort she could spare for the proper maintenance of the drip irrigation system was very much limited.

Drip irrigation, to be successful, requires constant observation of the system for finding out the clogging and such other problems. Preventive measures and proper maintenance of the system are to be ensured to avoid clogging. It is also necessary that timely technical guidance and service are provided to the farmer for proper repair and maintenance of the system. In the case of Mrs. Chandramathi, these essential pre-requisites did not materialize and thus the technology was discontinued.

District) is a 72 year old farmer having 2.5 ha of farm land. Coconut, which is the main crop, is cultivated in 2 ha. He maintains good contact with the local Krishibhavan at Kumbala by attending the extension programmes and availing of subsidies and other incentives for farming. He regularly reads the agricultural column in newspapers. He also used to attend the 'Kisanmela' and agricultural exhibitions organized at Central

Plantation Crops Research Institute (C.P.C.R.I), Kasaragod, which is a nearby research institute. In the year 2000, he got a prize for the best coconut bunch in the competition held for farmers in connection with 'Kisanmela' at C.P.C.R.I, Kasaragod.

Earlier, Mr. Bhat used to irrigate his coconut garden with hose pipes using water from the bore well dug in his farm. Being a farmer keen to try new agricultural technologies, he adopted sprinkler system of irrigation for coconut in 1985. But the problem of water shortage was a constraint he experienced especially towards the fag end of the summer. He came to know about the water saving drip irrigation system during a Kisanmela organized at C.P.C.R.I, Kasaragod. Subsequently, he visited the irrigation experiment plot at CPCRI and familiarized himself with the working of the drip irrigation system in coconut garden.

He was convinced of the feasibility of the technology and with the subsidy from Agriculture Department; he installed drip irrigation system in his coconut garden in 2 ha in 1996. According to Mr. Bhat, after the introduction of drip system, there was reduction in weed growth when compared to sprinkler system and the yield also was enhanced. But after three years, i.e., in 1999, he dismantled the drip irrigation system from his coconut garden and re-installed the sprinkler system. The reason for discontinuance, according to Mr. Bhat, was the problem of low voltage in the electricity supply; under which effective field implementation of the microirrigation technology was not possible.

4.9.2. Case analysis

Low electric voltage was the constraint experienced by Mr. Bhat. In the day time, due to low voltage situation, it was difficult to operate the electric motor to irrigate through drip system. Only during night hours, that too after 9.30-10.00 pm, sufficient voltage would be available to operate the system. According to him, under such a situation it is difficult to properly monitor the irrigation especially under drip system because each and every palm basin has to be observed for ensuring sufficient water availability without any clogging problem. He opined that under sprinkler he was able to monitor the irrigation even in night hours since he was able to observe the irrigation to

the palms by standing in the field in one or two vantage points. Hence after discontinuing the drip system, he reverted back to sprinkler system of irrigation. Since he was keeping the sprinkler irrigation equipment and accessories intact, he did not suffer much financial loss due to the reversion in the irrigation method. Further, it may be noted that a substantial portion of the expenses for the installation of drip irrigation system was met by the subsidy availed from the government. The case of Mr.Bhat illustrating the discontinuance of drip irrigation method clearly indicated that in spite of many perceived comparative advantages of a technology, situational constraints and the subsequent practical difficulties can result in the technology discontinuance.

4.9.3. Case - III

Mrs. Indira Nelliath, (Nelliath House, Ramdas Nagar, Madhur panchayat of Kasaragod District) is a 71 year old retired school teacher. After the demise of her husband, she has been managing a coconut garden with 120 palms in 0.9 ha of farm land with the support of her son. The drip irrigation system was installed in the coconut garden comparatively early i.e., in 1987. At that time, drip irrigation method was just catching up among the farmers. Her son was quite convinced of the advantages of the drip irrigation system and was having the required knowledge and technical know how for the operation and maintenance. The system was working properly and the beneficial effects were reflected in the yield of palms, water saving and labour saving. There used to be the problem due to clogging of emitters in the drip unit which was promptly rectified as and when observed by her son. According to Mrs. Nelliath, for one year after her son left for the job, she was somehow managing the drip unit. But in 1991, one year after her son got a job elsewhere; the drip unit was dismantled because of the frequent problem of emitter clogging. After dismantling the drip system she reverted back to the conventional method of providing water to the coconut palms through basin method.

4.9.3.1. Case analysis

Emitter clogging, a major constraint in the operation and proper maintenance of microirrigation system, emerged as the reason for the discontinuance of microirrigation technology by Mrs. Nelliath. She did not possess the required technical knowledge and skill for rectifying the problem. Further, she was also not getting proper service facilities from the dealer to overcome the system disorders. Here, the discontinuance of the drip irrigation technology was mainly due to the household situation wherein her son who was looking after the system was unable to spend time for the operation and maintenance of the system after getting a job. Mrs. Nelliath did not keep any contact with the local extension agency and as such no guidance could be obtained for the proper field implementation of the advanced farm technology. Prompt service facility was also not forthcoming for rectifying the system disorders. The case points towards the need for having mid level mechanics in rural areas to render timely service to the needy farmers in the proper field implementation of modern farm technologies such

as microirrigation technology. Vocational Higher Secondary Education (VHSE) courses related to agriculture, presently offered in the State, can be streamlined to mould such technical hands for the betterment of farming.

4.9.4. Case - IV

Mr. K. Moideen Kutty, (Thahira Manzil, Mogral Puthur post of Kasaragod District) is a 76 year old farmer having one ha of coconut farm. He is illiterate and seldom shows any interest in acquiring information on improved cultivation practices. But he occasionally visits the local 'Krishibhavan' at Mogral Puthur for availing the subsidies and other incentives under different agricultural development schemes. Though his farm is located just one km away from CPCRI campus, he rarely visits the research institute seeking information on farming.

Earlier Mr. Moideen Kutty used to irrigate his coconut garden with hose pipes using water from the bore well dug in his farm. He said that the bore well provided enough water for irrigating the coconut palms all through the summer. But according to him, he was facing the problem of labour shortage and high wage rate for irrigation. For irrigating the coconut palms twice a week, one person was required every day. So when he came to know about drip irrigation system as a labour saving irrigation method, he developed keen interest for the adoption of the same. He also contacted 'Krishibhavan' for the details on subsidy available for drip irrigation system. In 1999, he installed drip irrigation system in his one ha coconut garden with subsidy from the Department of Agriculture. The installation work was carried out by a private firm in Kasaragod town. As he was not having any information about the design requirement or functioning of the system, his involvement in the installation work was meagre. Prior to installation, he did not try to visit any coconut garden where the drip unit was installed.

According to Mr. Moideen Kutty, on random checking of the drip system in his garden, he found that palms in different locations were not getting the same quantity of water (ie, field uniformity in irrigation was lacking). Further, as per his perception, the most important drawback of the drip irrigation system, was that the quantity of water dripping to the basin of the palms was not sufficient for proper growth of the palms. This perception originated from his observation that under the drip irrigation system, the

extent of wetting of palm basins was very low when compared to the traditional basin irrigation method. It was all dry on the soil surface. He was also dissatisfied because the water movement was also not visible from outside. As such he felt that the drip irrigation system was not ideal. Adding to his negative impressions of the drip system was the problem of emitter clogging. He said that the private firm was not providing timely service for solving the clogging problem. Finally he decided to dismantle the drip irrigation unit from his garden in the very next year i.e., in 2000. He reverted back to the conventional system of irrigating the palms through basin method.

4.9.4.1. Case analysis

In Mr. Moideen Kutty's case, the discontinuance of the drip irrigation technology was mainly due to the misconception he was having about the working of the system. The method of working of the system on the basic principle of trickling of water directly to the root zone of plants was against his strongly held traditional concept of irrigation in which water was applied in large quantities in a visible form. This coupled with the poor service from the private dealer prompted him to discontinue the technology. Further, it may be noted that he was not having any problem with the availability of water. Sufficient water was available to irrigate the palms even through the traditional methods. Hence the drip system, basically a water saving irrigation method, did not attract him in practice. Adoption of the technology was mainly prompted by the labour saving nature of the technology and availability of subsidy from the Agriculture Department. Further, Mr. Moideen Kutty did not possess the required knowledge and skill in the proper operation and maintenance of the drip irrigation system.

Interestingly, the above case studies revealed more or less similar factors for the discontinuance of the microirrigation technology by farmers, as in the case of farmers of the Mediterranean Basin region (Vidal, 2001). Factors such as the frequent problem of emitter clogging, lack of timely service facility, misconceptions by the farmers about the trickle irrigation method that it does not provide enough water required for crop growth and lack of extension guidance were reported from that region also. The reluctance of farmers for adopting techniques which makes water 'invisible' is an important point for the extension personnel to streamline intensive educational activities and to strengthen

farmers' awareness and capacity in the effective utilization of microirrigation technologies in order to foster the adoption of these improved irrigation technologies by farmers on a sustainable basis.

4. 10. RE-INVENTIONS IN MICROIRRIGATION TECHNOLOGY

Flexibility in the process of adopting an innovation may reduce mistakes and encourage customization of the innovation to fit it more approximately to local and or changing conditions. As a result of re-invention, an innovation may be more appropriate in matching, the systems' pre-existing constraints and more responsive to new constraints that arise during the innovation-decision process.

Below are described four cases in which farmers had made re-inventions in microirrigation technology adopted in their coconut gardens.

4.10.1. Case - I

Mr. K. Aboobacker Siddique, (Bayar, Chippar post, Paivalike panchayat of Kasaragod district) is a young farmer who has been following drip irrigation for his arecanut and coconut gardens since 1996. Water from a spring which surfaces at one end of his plot was directed to a farm pond and collected in it. Irrigation was done by pumping water from this pond using a centrifugal pump. Water was directed to the field using PVC pipe, ie., mains and sub-mains. 16mm LLDP laterals were used to carry water towards individual palms. Micro tubes were used as emitters. According to him it was very difficult and time consuming job to check the discharge rate of individual dripper or even to check whether the dripper was functioning at all since the micro tubes were placed at the soil surface, some times even sub-surface. It was felt that if the farmer could see the flow of water from the emitter it could save considerable time and effort. He also felt that the area wetted by the emitters was not sufficient to meet the water requirement of the crop. To overcome these two problems, he has made some modifications in the system especially to the emitter.

The new emitter consists of a ring made of LLDP pipe of 8mm diameter, surrounding the base of the palm. The micro tubes of the already installed system were connected to

the ring through a punch hole. 'L' shaped emitters were connected to the ring and were used to deliver water to the plant. The diameter of the ring was 63.6cm for coconut and 25.5cm for arecanut. On each ring, there were five emitters for coconut and two for arecanut. According to Mr. Siddique, the modifications could rectify the following inadequacies, which he perceived to affect the performance of the drip irrigation system commonly installed in farmers' field:

- The ordinary drip irrigation system with the recommended number of microtubes placed in the basins of coconut and arecanut does not provide sufficient quantity of water to the roots of the palms.
- The flow of water through ordinary micro tubes of the drip system is not visible to the farmers. Hence it is difficult to check the system for possible clogging of micro tubes.
- Displacement of micro tubes in the palm basin, which results in improper water supply to the root zone of the palms.

Mr. Aboobacker Siddique claims that the modifications made to the emitter system solve the above commonly observed problems. The water dripping to the soil is visible and the misplacement of the emitters is avoided. Further, he claims that proper wetting of the root zone of the palms is ensured through the modification made to the system. Efforts were taken by Mr. Aboobacker Siddique to popularize the modified drip system. A press conference was convened by him on 20th April, 2000 at Kasaragod. The local newspapers gave a wide coverage to the innovation the cultivator has made to the drip system. A farmers meeting and field demonstration was organised for popularizing the farmer innovation on 22nd April, 2000 at Muligadde, Bayar, which was inaugurated by the local M.L.A., Mr.Cherkalam Abdulla. Leaflets were printed describing the advantages of the modified system for distribution among farmers. Commercial manufacturing of the system with the trade name "Hani Drip Irrigation Problem Solver" for distribution among farmers is also planned by him.

4.10.1.1. Case analysis

The case illustrates the re-invention of microirrigation technology by Mr. Siddique, based on the perceived limitations of the recommended technology. It revealed the keen interest of a young farmer, who is educated only up to high school level, in experimenting to solve field problems. The genuine interest and involvement in farming were also evident in him. However, a critical examination of the re-inventions made by Mr. Siddique in the drip irrigation unit in his orchard revealed the following:

- In the modified system, since the water comes out of the dripper from a height and is falling on the soil surface, loss of water due to evaporation would be more.
- Each emitter is placed nearly 32 cm and 13 cm from the base of the trunk for coconut and arecanut respectively. However, for coconut active root zone extends to a distance of 100 cm from the base of the palm. Therefore, it is always better to keep the emitter at a distance of 50 cm from the palm in order to wet maximum root zone area.
- No provision is given in the system to control the discharge rate of drippers. Discharge rate varies as per the hydraulic gradient prevailing in the respective laterals.

It is interesting to note that one of the reasons that prompted Mr. Siddique to go for the modification of the drip system is the perception that water provided through the commonly installed system is insufficient for proper crop growth and that water is not visible due to the sub-surface placement of micro tubes. Many other farmers also shared this belief. But considering the observed drawbacks of the modifications made to the system, it is imperative that proper assessment of the system is made before popularizing it among the cultivators. This situation calls for an effective extension strategy for creating awareness among cultivators about the basic concepts involved in drip irrigation technology, its advantages and disadvantages, proper design, operation and maintenance. Participatory technology transfer programmes are to be initiated for the farmers, extension personnel involved in implementing extension programmes and development schemes and dealers of drip irrigation equipments.

4.10.2. Case - II

Mr. Dinesh D Udyavar, (Kanwatheertha Bangara House, Kunchathoor post, Manjeswar of Kasaragod District) is a 53 year old farmer having 1.2 ha of coconut cultivation in the coastal area in the sandy soil. He is actively engaged in farming besides being associated with fishing. He has a keen interest in adopting new agricultural technologies and maintains good contact with 'Krishibhavan', the local office of the Agriculture Department at Manjeswar. Though he had only primary school level of education, he utilizes many sources of information on improved cultivation practices. He came to know about drip irrigation technology from the agricultural column of a Kannada newspaper. Prior to that he was following basin irrigation. Source of water is an open well dug in the plot. Lack of sufficient labour was the major problem experienced by him. He also contacted the local Krishibhavan for availing the subsidy for installing drip irrigation system in his coconut garden. A private firm in Kasaragod town, M/s Vikas agro agencies, installed the system during 1997. Advantages of the system such as water saving, labour saving and energy saving were the factors mainly responsible for his adoption of drip system apart from the financial incentive provided by the Agriculture Department.

According to Mr. Dinesh, after the installation of the system, he observed a thick layer of fibrous root matting formed in the coconut basin. He believed that the root matting was due to the water supply through the microtubes directly to the root zone in the basin. Further he felt that the root matting will prevent the water going down and towards sides in the basin and thereby prevent the availability of water in sufficient quantities to the roots for proper crop growth. He then began thinking about some modifications in the system through which he will be able to supply water with some force rather than trickling to prevent root matting in the palm basin. From the main pipe line, laterals were drawn for the individual palms. The laterals were placed at a distance of 1m away from the base of the palm as a ring surrounding the palm. 6-7 holes were punched on the laterals surrounding the base of the palms. Water is supplied to the palm basin through these modified laterals. Water flows out through these holes as a small fountain. According to Mr.Dinesh, through the holes he made water to fall on the soil surface forcefully thereby preventing the formation of root matting.

It was found that on an average 320 litre of water was applied to each coconut palm per day through the modified system, which is eight times higher than the recommended rate of application of water through drip system of irrigation. Besides preventing the root matting, Mr. Dinesh claims the following additional advantages for the adaptation:

- Water applied to the soil is visible
- The misplacement of the emitter is avoided
- Proper wetting of the root zone and sufficient quantity of water for crop growth
- Labour saving

4.10.2.1 Case analysis

As in the previous case, Mr. Dinesh also showed a keen involvement in farming and an urge to be innovative in his farming methods. These traits coupled with the practical problems experienced with the field implementation of drip irrigation prompted him to make re-inventions. However, observation of the modification of the microirrigation system in Mr. Dinesh's coconut garden, revealed that in the modified system, water is falling on the soil surface and hence losses due to evaporation is more. Also the uniformity in irrigation is not ensured. However, the root matting problem observed in drip irrigated coconut gardens in such locations require further studies. The local adaptation made by Mr. Dinesh in the drip irrigation system solves the major problem perceived by him, i.e. root matting and also save labour. But the rate of application of water to the palms is very high when compared to the recommended rate. Yet he is not bothered about the same because water availability is not a constraint in his garden.

Concentration of roots around dripping point is a common feature in drip irrigation. For tree crops, it is recommended to wet a minimum of 33 per cent of the active root zone to provide sufficient water to the plant. Concentration of roots in such cases would be an advantage. This will help the plant to extract more water from a relatively small area. For farmers, those who follow fertigation along with drip irrigation, this would be an added advantage. However, when drip irrigation is followed in seedlings

and juvenile palms, the concentration of roots around dripping point restrict a uniform root growth around the palm. This will adversely affect proper anchoring of palms. To avoid this, it is better to change the position of dripping points, around the palm, every year. Even though the farmer's observation of getting more area wetted is true, it is mainly because of over irrigation, which leads to loss of water due to deep percolation, especially in sandy soil. To achieve the above objectives commercially available micro sprinklers / micro jets can be used. The farmer can then observe the working of the emitters and at the same time obtain more wetted area within the active root zone. However, when the water is applied as a fine spray, chances of water loss due to evaporation would be more.

4.10.3. Case - III

Mr. A.V. Sudhakaran, (S/O Melathu Appu Nambiar, Odittamavu House, post Chayoth, Kasaragod District) is a 36 year old farmer having 1.6 ha of coconut garden. He is educated up to SSLC. His main source of income is farming. He actively participates in the extension programmes organized by the 'Krishibhavan', the local extension agency. He subscribes to the Malayalam daily, 'Mathrubhumi' and regularly reads the agricultural column for obtaining information about improved farming practices. Besides, he is an avid listener of the radio programmes on rural development, 'Vayalum veedum'.

Earlier, he was irrigating his coconut garden using water from 'Surangam' through the traditional basin irrigation method. 'Surangam' is a traditional water harvesting structure used by the farmers in the hilly areas of Kasaragod District of Kerala State and adjoining areas of Dakshina Kannada district in Karnataka State. This region experiences a long spell of dry period spanning over a period six months resulting in shortage of water during the summer months. Moreover, tapping water from conventional wells is also not very successful owing to the hilly terrain. 'Surangam' is an unique indigenous technology farmer relied on to harvest ground water under such difficult situation. It is a horizontal tunnel dug through a laterite hillock from the periphery of which water seeps out. Depending on the slope, topography and soil characteristics, some local experts used to locate suitable places in the hilly area for surangam construction. Skilled workers are usually engaged to construct a 'surangam'. Water coming from the 'surangam' is usually collected in a small storage tank constructed near the outlet of the 'surangam' at a slightly lower elevation from which water is guided to lower reaches for irrigating the crops. The field is irrigated using gravity, there by saving a considerable amount of energy since no pumping is required.

The 'surangam' in Mr. Sudhakaran's farm is located in the sloping terrain in the upper reach of the hillock and was constructed about 30 years ago. Water obtained from the 'surangam' was used for drinking purpose as well as for irrigation. Mr. Sudhakaran said that he observed a gradual decline in the output of water from the 'surangam' because of various factors such as deforestation in the upper reaches and consequent loss of vegetative cover and changes in the cropping pattern etc which lead to reduction in

ground water recharge. During summer months, he used to irrigate the coconut palms once in four days, through the conventional basin irrigation method. He experienced severe water shortage during the fag end of the summer, especially during May. He came to know about drip irrigation as a water saving technology from the agricultural column in the “Mathrubhumi” newspaper. He visited coconut gardens of few farmers where drip irrigation system was installed and got first hand information about the performance of the system and its advantages. From the Krishibhavan, he got more information about the subsidy available to farmers for installing drip irrigation system. He then decided to install drip irrigation system in his coconut garden utilizing the water available from the ‘surangam’. A private firm in Kanhangad town, M/s Vikas agro agencies, installed the system during 1997 with subsidy from the Department of Agriculture. Mr. Sudhakaran felt that after the installation of drip system, he is able to save water and irrigate the coconut garden throughout the summer months. He said that, on an average, yield of coconut palms increased from 50 nuts to 80 nuts per palm per year.

4.10.3.1. Case analysis

It was an unique case wherein the indigenous technology such as ‘surangam’ was integrated with an advanced irrigation technology like drip irrigation system for the effective use of available water for irrigation. Since the ‘surangam’ in the plot is at a higher level, there is no need for electric power or overhead tank for irrigation. To make use of the limited but continuous supply of water from the ‘surangam’, a small pond was constructed in front of the ‘surangam’. Water coming out of the surangam was collected in this pond and used for irrigation and other purposes. The drip pipelines were directly connected to the pond for irrigation. Another local adaptation he has made is on the filtration of water. He is not using filter. Instead he has tied the pipe to an empty plastic bottle with holes punctured on its bottom and placed in the tail pond of the ‘surangam’. He claims that since the quality of water from the ‘surangam’ is excellent and usually without any impurities, the plastic bottle filter he has made is sufficient for filtration of water.

The unique and successful experimentation involving the integration of an indigenous technology such as 'surangam' with an advanced irrigation technology like drip irrigation system reveal the potential of such local adaptations for effective use of available water for irrigation especially for farmers having 'surangam' in their farm.

4.10.4. Case IV

Mr.Sreekrishna Bhat, Mungila House,,Kanakaje, in Puthige grama panchayat of Kasaragod district is a 47 year old full time farmer with 2.8 ha of cultivated land. Arecanut and coconut are the main crops cultivated. His farm is located in a hilly terrain. Though he studied only up to SSLC, his functional literacy on various aspects of improved farming practices is of high standard. He is an active member of the Farmers' Information Exchange Centre (FIEC); a local farmer organization sponsored by Syndicate Bank for interaction among farmers for technology dissemination on improved cultivation practices. He is a regular subscriber to 'Krishiloka', a Kannada Agricultural magazine. He also watch television programmes on agriculture. He maintains good contact with the Krishibhavan; the local agricultural extension agency. Mr. Bhat also contact the agricultural research stations such as CPCRI, Kasargod and RARS, Pilicode for quality planting materials and also for attending extension programmes.

A bore well dug in his farm is the source of irrigation water. Previously he was following hose and sprinkler irrigation. During the fag end of summer months he experienced severe water shortage for irrigation. Further weed growth was very high in sprinkler irrigated plots. From the Kannada farm journal he came to know about drip irrigation system and its suitability to sloppy areas. For obtaining further information he visited the drip installed arecanut garden of Mr. Neerkazha Krishna Bhat, a nearby progressive farmer. After getting convinced about the impact of drip irrigation, he installed drip irrigation system in his arecanut garden. Vikas Agro services, Kasaragod, a private firm installed the system in his plot in 1997. From the experience of installation of drip irrigation system, Mr. Bhat was convinced of its advantages especially in overcoming the water scarcity problem.

4.10.4.1. Case analysis

Mr. Bhat perceived the need for making some modification to the system, for avoiding the displacement of micro tubes, a practical difficulty experienced which used to result in improper spread of water in the basin of the palm. Mr. Bhat thus made a modification to the lateral. He made a ring of 1.5 feet diameter with a 12 mm lateral. From each ring 3 micro tubes of 2mm diameter provide water to the basin. The ring is connected to the 12 mm lateral line with a long 2mm microtube. The discharge rate of each unit is 25 litres per hour. Thick mulching of the palm basin with organic materials is also done. On field visit made by the scientists of CPCRI, it was observed that the modification made is almost similar to that of Mr. Siddique's. But the difference is that water is not made to fall to the soil surface from a height and as such the loss of water through evaporation is lesser than the former modification.

4. 11. REPORT ON THE WORKSHOP ON MICROIRRIGATION TECHNOLOGIES IN COCONUT AND ARECANUT FARMING

As part of the KRPLLD project on 'Field level performance of microirrigation system in Kasaragod District- a critical analysis', a workshop was organised at CPCRI, Kasaragod on 5th September, 2001 with respondent farmers, extension personnel and dealers and scientists as participants. The objective of organising the workshop was to bring together farmers, extension personnel, dealers and scientists on a common platform to discuss the problems and prospects of microirrigation in coconut and arecanut farming and to evolve a strategy for effective utilization of technology in farmers' field. A total of 64 farmers, 11 Agricultural officers and three dealers participated in the workshop. Shri. Balakrishna Vorkudlu, a farmers respondent of the study and also the vice president of Chengala Grama Panchayat, inaugurated the workshop. The inaugural function was presided by Dr. V. Rajagopal, Director, CPCRI. Shri. K. O. V. Gopalan, Principal Agricultural Officer, Kasaragod and Dr. S. Arulraj, Head, Division of Social Sciences, CPCRI, Kasaragod, offered felicitations.

In the first session, Shri. Abdul Hakeem, Assistant Professor, Department of Irrigation Engineering handled a session on the basic concepts, benefits, and operation and maintenance of drip irrigation system with special emphasis on field problems experienced by farmers in the maintenance of the system. Shri K. O. V. Gopalan, Principal Agricultural Officer, Kasaragod gave a brief account of the scheme implemented by the Department of agriculture to popularize drip irrigation system among farmers. He explained the details of subsidy available under the scheme. Both the sessions were followed by discussion by the participants. In the afternoon session, Shri C.Thamban, Scientist (Agricultural Extension) presented the findings of the study undertaken as part of the KRPLLD project on 'Field level performance of microirrigation system in Kasaragod District- A critical analysis'. Constraints experienced at different levels in the field implementation of drip irrigation technologies were discussed in detail after the presentation. Farmers, Agricultural Officers and dealers actively took part in the discussions on the findings of the study. Based on the discussions held, the following recommendations emerged in the workshop:

- A considerable proportion of coconut and arecanut farmers having drip irrigation system installed in their farm are lacking the required knowledge about the basic concepts, benefits and operation and maintenance of the system. Hence there is urgent need for organizing intensive extension activities to impart the required knowledge and skill to the cultivators for the effective utilization of drip irrigation technology.
- Institutional training programmes are to be organized for farmers at research stations like Central Plantation Crops Research Institute, Kasaragod, CPCRI Regional Station, Vittal, Regional Agricultural Research Station, Pilicode, and CWRDM, Kozhikode.
- The training programmes should give emphasis on topics such as basic concepts of drip irrigation, components of drip system, designing the drip system appropriate to the characteristics of the farm, evaluation of the performance of drip system in field condition, problems associated with drip with special emphasis on clogging and general aspects of operation and maintenance.
- Farmers' study trips are to be organized to farmers' plots where the drip irrigation system have been successfully adopted.
- Demonstration plots on drip irrigation systems in coconut and arecanut gardens of selected farmers are to be arranged as part of the transfer of technology programmes.
- Extension personnel in the Krishibhavans are overburdened with routine miscellaneous office works and as such they are unable to properly monitor the installation of drip irrigation systems in farmers garden, though they are entrusted to certify the proper installation of the system to sanction the eligible subsidy.
- Extension personnel in the Krishibhavan do not possess the required technical competence with respect to the field installation, operation and maintenance of drip irrigation system. And as such they are unable to provide technical guidance to the farmers on the above. Hence comprehensive training programmes on drip irrigation system covering the relevant aspects of field installation, operation and maintenance are to be organised for the benefit of the technical staff of Krishibhavans.

- Availability of subsidy is an important factor in promoting adoption of drip irrigation systems by the farmers. Recently the rate of subsidy has been reduced by the government. It is worthwhile to provide adequate financial incentive to farmers to adopt water conserving sustainable technologies such as drip irrigation systems. Hence steps are to be taken to enhance the rate of subsidy for encouraging more cultivators to adopt conservation technologies like drip which require high initial investment.
- Many a times farmers experience inordinate delay in the availability of subsidy from the Department of Agriculture. Untimely release of funds is a constraint in this regard, as experienced by the officials of Department of Agriculture. Hence steps are to be taken for the timely release of funds for the proper field installation of drip irrigation system.
- Some farmers are not satisfied with the drip irrigation system in which water is trickled to the root zone of the crop directly. They perceive that the quantity of water will not be sufficient for proper of crop growth. This misconception about drip irrigation system is mainly due to the lack of awareness and knowledge about the basic concept of drip irrigation technology. Hence intensive extension activities are to be taken up to create awareness about drip irrigation system among cultivators.
- Clogging is one of the major problems experienced by farmers in drip irrigation. Many farmers do not know the measures to overcome clogging problem. Hence emphasis is to be given on this aspect while streamlining farmers' training programme.
- Farmers, in general, are not satisfied with the after sales service from the dealers. Dealers are required to provide efficient after sales service for solving the problems in drip irrigation system in farmers' field. The staff employed for field installation of drip irrigation system should possess the required technical qualification so as to ensure proper design and installation of drip irrigation in farmers field for the better performance of the same afterwards.

- In some cases inferior quality materials are supplied to the farmers. Strict measures are to be taken for proper verification by the concerned officials for ensuring the supply of good quality materials to the farmer.
- In many instances involvement of farmers is mainly confined to the pre installation phase i.e., availing subsidy, contacting dealers etc. only. Installation is done entirely by the personnel engaged by the dealers without much involvement of farmers, which adversely affect the quality of installation work and also maintenance of the system afterwards. Hence farmers should be involved in all the stages of installation of the drip irrigation system in their field.
- As per the rules, farmers will be eligible for installation of drip irrigation system for the materials purchased from authorized firms only. This sometimes creates difficulty for farmers as they may prefer to procure the materials from a firm which may not have obtained authorization by the Department. Hence action is to be taken to provide authorization to any dealer of drip irrigation equipments subject to satisfying the conditions laid down for the same.
- Interface programmes are to be organized on a regular basis, for the effective utilization of drip irrigation technology in farmers' field, involving farmers, extension personnel, dealers and scientists. Such programmes will be helpful in discussing the problems experienced at different levels and for planning appropriate remedial measures.

Chapter V

SUMMARY

Lack of irrigation is one of the major reasons attributed for the low level of productivity of crops in Kerala. Drip irrigation system is ideally suitable to our state where there are considerable limitations to the conventional surface irrigation methods. Many coconut and arecanut growers have installed microirrigation system in their gardens with government subsidy. A research project was proposed with the following specific objectives:

1. To analyze the socio economic and personal profile of farmers adopting microirrigation systems.
2. To analyze the extent of knowledge of farmers about microirrigation technologies.
3. To delineate the factors contributing to the adoption of microirrigation systems.
4. To compare the economics of coconut/arecanut cultivation under micro irrigation and conventional systems of irrigation
5. To evaluate the technical performance of the microirrigation systems installed in farmers field.
6. To analyse the constraints perceived by the farmers, extension personnel and dealers in the effective utilization of the microirrigation technologies
7. To study and document cases of successful experiences/ discontinuance of technology by the farmers in adopting microirrigation systems and
8. To document the re-inventions by farmers in microirrigation systems.

The study was conducted among the coconut and arecanut farmers in the four development blocks of Kasaragod district. A total of 180 farmers, i.e, 90 adopters and 90

non adopters of drip irrigation system, 25 extension personnel and seven dealers were the respondents of the study. Socio economic and personal characteristics of respondent farmers such as age, education status, occupation, family size, farm size, farming experience, annual income, economic motivation, risk preference, scientific orientation, extension contact, social participation, , and information source utilization were measured using standard scales. Knowledge of farmers about drip irrigation technology was measured by developing a knowledge test. Analyses were done on the farmers' perception about the factors contributing to the adoption of drip irrigation system, economics of coconut cultivation and arecanut cultivation under drip and conventional systems of irrigation, technical performance of micro-irrigation systems in coconut and arecanut gardens, local adaptation/ innovations made by farmers in microirrigation systems and constraints in the adoption of microirrigation systems. Case studies were conducted on successful experiences of farmers in adopting microirrigation systems and discontinuance of technology. As part of the study a workshop was organised to bring together farmers, extension personnel, dealers and scientists on a common platform to discuss the problems and prospects of microirrigation systems in coconut and arecanut cultivation and to evolve a strategy for effective implementation of the same in farmers field. Interview schedule, questionnaire and case studies were employed for the collection of data which was done during the period January 2000 to October 2001.

The results showed that majority (55-58 per cent) of the coconut farmers under both the categories of adopters and non-adopters belong to the age group 40-60 years. This is in line with the general trend observed in Kerala state where the younger generation keeps away from farming. A larger proportion of coconut farmers belonging to adopter category have higher educational status than the non adopter category. Among the coconut farmers, only 25 –35 per cent were depending on farming alone as their source of livelihood. The number of members in the family was more in non-adopter category compared to adopters. Majority of the coconut farmers (53.33 per cent under adopter category and 73.3 per cent under non adopter category) were having only less than one ha of farmland. The distribution of coconut farmers according to their experience in farming followed a similar trend as in the case of their age. The distribution of coconut farmers based on the annual income showed that the number of coconut

farmers in the low income category was more in the case of non adopters than among adopters of drip irrigation technology. The results showed that there was not much difference between the adopters and non adopters as far as their distribution based on the level of economic motivation was concerned. More than half (53 per cent) of the adopters were belonging to the medium category in respect of the variable, risk preference was concerned while more than 63 per cent of the non adopters were in the high risk preference category. The results showed that the number of coconut farmers belonging to the category of high level of scientific orientation was 15 per cent more among the adopters of drip irrigation system than among the non adopters. Similar to the scientific orientation, the distribution of coconut farmers based on their extension contact showed that the number of coconut farmers belonging to the category of high level of extension contact was more among the adopters of drip irrigation system than among the non adopters. Adopters were having higher degree of social participation than the adopters. Pattern of distribution of farmers based on the information source utilization did not show much difference between adopters and non adopters except for the slightly more number of farmers in the high category among adopters compared to the non adopters. Majority of the arecanut farmers under both the categories of adopters and non-adopters belonged to the age group 40-60 years. Unlike in the case of coconut, there was not much perceptible difference between adopter and non adopter category of arecanut farmers in respect of their distribution based on educational status. Among the areca farmers, unlike coconut farmers, majority (70 per cent among adopters and 80 per cent among non adopters) were depending on farming alone as their source of livelihood. Like in the case of coconut, the number of members in the family was more in non-adopter category compared to adopters among arecanut farmers also. 73.3 per cent of the adopters and 43.3 per cent of the non adopters were having more than one ha of farm size unlike in coconut where majority were having only less than one ha of farmland. The distribution of arecanut farmers according to their experience in farming followed a similar trend as in the case of their age. Half of the adopters (50 per cent) were belonging to medium income category while more than 60 per cent of the non adopters were in the high income category unlike the coconut farmers.

The results showed that there was not much difference between the adopters and non adopters as far as their distribution based on the level of economic motivation was concerned. Among arecanut growers, more than half (53.3 per cent) of the adopters were belonging to the high category in respect of the variable, risk preference, while more than 43.3 per cent each of the non adopters were in the medium and high risk preference categories. Unlike in coconut, same distribution pattern was observed among the areca growers based on their scientific orientation for the adopters and non adopters.

The distribution of arecanut farmers based on their extension contact showed that the number of farmers belonging to the category of high level of extension contact was more among the adopters of drip irrigation system than among the non adopters. But nearly one third of the adopters were having low level of extension contact. Unlike in the case of coconut farmers, almost a similar distribution pattern was observed among the areca growers based on their level of social participation for the adopters and non adopters indicating a lesser significance for social participation as a contributing factor in the adoption of drip irrigation technology by the arecanut growers. It was observed that a higher percentage of adopters were belonging to the high category in respect of information source utilization when compared to the non adopters indicating a higher extent of association between the level of information source utilization and adoption of drip irrigation technology by the arecanut farmers.

Majority (71 per cent) of coconut farmers were in the medium and above knowledge level categories, and nearly one third (28.33 per cent) were in the low knowledge level category. In the case of arecanut growers the distribution was 53.33 per cent in high, 23.33 per cent each in medium and low knowledge categories.

Among the 13 selected items related to drip irrigation method in coconut garden, number of drippers required per tree, suitable type of filtration unit required and suitable type of drippers required secured rank I, II and III respectively with regard to the knowledge indices. Application of fertilizers through drip system was the item of knowledge which secured the lowest rank.

With respect to the knowledge indices on the items of drip irrigation in arecanut, almost a similar trend was observed as in coconut. Items viz., number of drippers required per tree, water requirement per day per tree and suitable type of drippers

required secured rank I, II and III respectively with regard to the knowledge indices. Items such as techniques of prevention of clogging of drip system, monitoring of emitter discharge to ensure field uniformity, periodical flushing of drip system and application of fertilizers through drip system secured lower ranks on knowledge indices. Periodical backwashing of filters was the item of knowledge which secured the lowest rank.

The distribution pattern of farmers based on the level of knowledge on the relevant aspects of drip irrigation technology clearly indicated the need for formulating an effective extension strategy to empower the farmers with the required level of knowledge and skill for proper maintenance of the system and effective utilization of the benefits in their field situation.

Analysis on the economics of coconut and arecanut cultivation under drip irrigation indicated that subject to technical feasibility, installation of drip irrigation system in coconut and arecanut gardens is economically viable.

It was observed that the system uniformity of drip irrigation systems in farmers' field in terms of absolute emission uniformity, probably the single most important factor in influencing the system performance, is maintained with fair and above level in majority (81.70 per cent in coconut and 96.6 per cent in arecanut) of the gardens. The results showed that the field emission uniformity in terms of the statistical uniformity coefficient for all the plots is maintained in fair and above level. It was revealed that a vast majority (96.6 per cent) of the farmers were irrigating their coconut palms with more than the recommended quantity of water. A same trend was observed in arecanut plots also. Though there was a considerable number of gardens (98.3 per cent in coconut and 53.4 per cent in arecanut) under the study were unable to meet the specific requirement in terms of a minimum root zone area wetted, there were no reports on any yield decline or negative impact on growth through drip irrigation in those gardens. Hence studies are required for modifying and verifying the specifications in terms of a minimum root zone area to be wetted in coconut and arecanut under drip irrigation.

More than 60 per cent of the coconut gardens were having less than recommended number of dripping points per palm. But in arecanut all the farmers maintained the recommended number of dripping points per palm. It was seen that in more than 90 per

cent of the coconut gardens distance of dripping point from tree trunk was less than the recommended distance. In arecanut about one fourth (26.7 per cent) of the gardens maintained the prescribed distance of dripping point from tree trunk.

Results showed that all the farmers under study (except one coconut farmer) were keeping the dripping points on surface itself thus resulting in loss of water through evaporation. A vast majority (91.7 per cent in coconut and 93.3 per cent in arecanut) of the farmers were using micro tube as emitters in their drip system. Pressure compensating type of emitter which is the ideal type was used by only a few (3.3 per cent in coconut and 6.7 per cent in arecanut). Open well is the most commonly (68.3 per cent in coconut and 50 per cent in arecanut) used source of water for drip irrigation by growers. Few farmers also utilize the traditional water harvesting structure, surangam as a source of water for drip irrigation. It was observed that many farmers go for providing water for drip system through overhead tanks because the overhead tanks constructed serve dual purpose, i.e., for domestic as well as irrigation. A vast majority of the drip irrigation units installed in farmers' field was having the ordinary wire mesh filter type.

Availability of subsidy secured first rank among the factors associated with the adoption of drip irrigation system as perceived by the adopters. It was followed by economic motive and water shortage during summer as the II and III important factors. The result on the farmers' perception clearly indicate the importance of subsidy in enhancing adoption of farm technologies like drip irrigation system which require considerable initial investment. Factors such as receiving recognition among community members, achievement motive, influence of scientists of agricultural research stations and reduction in weed growth in the garden by adopting drip method were given importance only by few farmers as reflected in their lower ranks.

High initial investment secured I rank among the factors for the non adoption of drip irrigation system by the farmers. Lack of water for irrigation was the reason for non adoption ranked II by the farmers. Lack of awareness also emerged as an important factor for the non adoption of the system. Discontinuance of drip irrigation technology by many farmers due to various reasons also emerged as a factor for non adoption.

The study revealed that clogging of the drip irrigation system was the most important problem faced by the cultivators which secured the Ist rank among the

constraints in the operation and maintenance of drip irrigation system. Farmers were not getting quality after sales service from the dealers and timely guidance from the technical staff of the Agriculture Department as reflected in their perception about the constraints. Erratic electric power supply, voltage problem, damage of pipelines and drippers by rats, damage of pipelines and drippers by wild animals such as wild boar etc., damage of pipelines and drippers by falling of coconut leaves and root concentration on soil surface were the other constraints in the operation and maintenance of drip irrigation system perceived by the farmers. Analysis of the perception of extension personnel about the constraints in adoption of drip irrigation system showed that Krishibhavan staff is overburdened with office work, hence proper monitoring of field installation of drip system is not possible.

Lack of effective training on the drip irrigation technology was also cited as a constraint in the proper monitoring of the field installation and maintenance. Constraints in the adoption of drip irrigation system as perceived by the dealers of drip irrigation equipments were mainly related to the inadequacies they felt to exist with the farmers' system and extension system.

Results of the four case studies conducted as part of the study, on the successful experiences of farmers in the adoption of drip irrigation system revealed the congenial factors promoting adoption and continued use of the water conserving technologies such as drip irrigation. On the other hand, four case studies conducted on the discontinuance of drip irrigation technology by the farmers brought out the circumstances in which they decide to do away with the innovative farm technology. Case studies were also conducted on the re-inventions made by farmers in the drip irrigation system.

As part of the KRPLLD project on 'Field level performance of microirrigation system in Kasaragod District- a critical analysis', a workshop was organised at CPCRI, Kasaragod on 5th September, 2001 with respondent farmers, extension personnel and dealers and scientists as participants. The objective of organising the workshop was to bring together farmers, extension personnel, dealers and scientists on a common platform to discuss the problems and prospects of microirrigation in coconut and arecanut farming and to evolve a strategy for effective utilization of technology in farmers' field. Relevant recommendations were made by the workshop for the same.

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* Original not seen

Appendix-I

Monthly rainfall pattern in Kasaragod District

Year	Monthly average rainfall (in mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	0	0	0	0	145.4	1328.9	1313	754.7	100.4	85.4	8.4	0
1992	0	0	0	.4	119	622.6	1273	844	260.7	171.7	495.8	0
1993	0	0	26.6.	34.6	178	1031.4	1291.8	445.8	78.6	368.4	36.9	12.1
1994	.8	0	6.8	111.3	70	1421.8	1452.4	815.6	178.6	304.4	27.6	0
1995	1.6	0	0	26.4	213.2	863.6	1344	498.6	252.6	150.6	50.8	0
1996	.4	.6	0	99.2	21.8	838.8	1053	487.2	223	351.6	21.2	13
1997	0	0	8.4	4.8	22	883.7	1329.3	814.2	118.7	116.6	209.4	60.6
1998	0	0	0	0	281.2	1173	866.4	566	508.6	329.8	47.2	60.2
1999	0	0	0	1.2	576.1	822.8	1027.6	396.9	172.2	253	21.8	0
2000	52.6	0	0	43.7	282.3	1107	638.2	451.2	92.4	232.4	21.6	17.4

(Source: CPCRI, Kasaragod)

Appendix-II

- a) Details of the implementation of centrally sponsored scheme on use of plastic in Agriculture in Kerala State.

Year of implementation	No. of drip irrigation units installed	Area covered (ha)
1992-93	651	300
1993-94	824	706
1994-95	1670	1377
1995-96	1813	1737
1996-97	711	647
1997-98	1484	1330
1998-99	953	891
1999-2000	1491	1584
2000-2001	420	517

(Source: Office of the State Agricultural Engineer, Directorate of Agriculture, Trivandrum)

- b) Details of the implementation of centrally sponsored scheme on use of plastic in Agriculture in Kasaragod District.

Year of implementation	No. of drip irrigation units installed	Area covered (ha)
1996-97	308	141.75
1997-98	179	105.46
1998-99	237	150.53
1999-2000	458	314.418
2000-2001	31	14.728

(Source: Office of the Principal Agricultural Officer, Kasaragod)

**KRPLLD Project on
“FIELD LEVEL PERFORMANCE OF MICROIRRIGATION SYSTEMS IN
KASARAGOD DISTRICT- A CRITICAL ANALYSIS”**

A. Interview schedule for collecting data from farmers (adopters)

Respondent No.	Name of the Grama panchayat

1. Name and address of the farmer	
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2. Age of the farmer	Sex	
	M	F

3. Educational status	Illiterate	Primary	High school	Pre degree	Degree	PG and above

4. Farming experience (No. of years)	
--------------------------------------	--

5. Occupation	Farming alone	F+Agrl. labor	F+Private job	F+Govt. job	F+Business	F+Any other
	1	2	3	4	5	6

6. Family size (No. of dependent members)	
---	--

7. Farm size	Crop	Area (in acres)
	1.	
	2.	
	3.	
	4. Others	
	Total	

8. Area under coconut/ arecanut		Area (in acres)	No.of palms
	Irrigated by drip		
	Irrigated by other methods		
	Unirrigated		
	Total		

9. Annual income (Rs.)

10. Economic motivation

Please give your degree of agreement for the following statements

Sl. No.	Statements	SA	A	UD	DA	SDA
1.	A farmer should work towards larger yields and economic profits					
2.	The most successful farmers is one who makes the most profit					
3.	A farmer must earn his living but the most important thing in life can not be defined in economic terms					
4.	A farmer should grow cash crops to increase monetary profits in comparison to growing of food crops for home consumption					
5.	The farmer should try any new farming idea which may earn him more money					
6.	It is difficult for farmers children to make a good start unless he provides them with economic assistance					

SA- Strongly Agree, A- Agree, UD- Undecided, DA- Disagree, SDA- strongly Disagree

11. Risk preference

Please give your degree of agreement for the following statements

Sl. No.	Statements	SA	A	UD	DA	SDA
1.	A farmer should resort to multiple cropping to avoid greater risk involved in growing a single crop					
2.	A farmer should rather take more of a chance in making a big profit than to be content with a similar but less risky profits					
3.	A farmer who is willing to take more risks than average farmer usually does better financially					

4.	It is good for a farmer to take risk when he know his chance of success is fairly high	
5.	It is better for farmer not to try a new farming idea unless most others have used them with success	
6.	Trying an entirely new practice in farming by a farmer involves risks, but is worth it.	

SA- Strongly Agree, A- Agree, UD- Undecided, DA- Disagree, SDA- Strongly Disagree

12. Scientific orientation

(Please give your agreement/disagreement with the following statements)

1. New method of farming give better results to a farmer than old methods
2. The way of farming by traditional method is still the best way to farm
3. Even a farmer with lot of farming experience should use new methods of farming
4. A good farmer experiments with new ideas in farming
5. Though it takes time for a farmer to learn new methods in farming it is worth the effort
6. The traditional methods of farming have to be changed in order to raise the standard of living of a farmer

13. Extension contact

Officials	Frequency of meeting		
	Twice a week	Once a week	Once to thrice a month
a) Resarch scientists b) Extension officers c) Field level workers d) Input agencies e) Others			

14. Social participation

Are you a member/office bearer in any of the following organizations? If yes, please specify the details:

Organization	Member	Office bearer
a) Grama panchayat b) Grama sabha c) Farmers' club d) Kera vikasana samithi e) Co-operative society f) Any other (specify)		

15 . Information source use pattern.

Source		Frequency of use		
		Whenever needed	At times needed	Never
Mass media	Internet TV Radio Newspaper Periodicals(name)			
Interpersonal cosmopolite	Membership in voluntary organisation Extension personnel Research personnel Others			
Interpersonal localite	Friends Relatives Neighbours Others			

16. Evaluation of technical performance of micro irrigation system

Location on lateral		Lateral location on the main fold		
		Inlet end, m	1/2 d0wn, m	Far end, m
Inlet end m	Operating pressure, Kg/cm ²			
	Percolation, cms			
	Wetted diameter, cms			
	Location of emitter from palm, cms			
1/2 d0wn, m	Operating pressure, Kg/cm ²			
	Percolation, cms			
	Wetted diameter, cms			
	Location of emitter from palm, cms			
Far end, m	Operating pressure, Kg/cm ²			
	Percolation, cms			
	Wetted diameter, cms			
	Location of emitter from palm, cms			

Number of dripping points per tree =

Volume of water applied per tree per day =

Sample form for recording emitter discharge rates in the field for calculating field emission uniformity.

Location On lateral		Lateral location on the main fold							
		Inlet end		1/3 down		2/3 down		Far end	
		Ml	Lph	Ml	Lph	Ml	Lph	Ml	Lph
Inlet end	A								
	B								
	Ave								
1/3 down	A								
	B								
	Ave								
2/3 down	A								
	B								
	Ave								
Far end	A								
	B								
	Ave								

Estimation of total statistical uniformity

Emitter no.	1	2	3	4	5	6	7	8	9
Time sec									

Emitter no.	10	12	13	14	15	16	17	18
Time sec								

Type of emitter	Pressure Compensating type	Non pressure compensating type	Tap type	Micro tube, mm

Water source	Open well	Tube well	river
Type of filter	nil	Wire mesh	sand
Flushing frequency (days)			

Emitter placement	surface	subsurface
Water supply	Direct pumping (hp)	Over head tank (m)

Soil type	sandy	Sandy loam	laterite	Any other

17. Economics of coconut/arecanut cultivation

a. Cost of installation of drip system

S.No.	Particulars	Details
01	Year of installation	
02	Area under drip system in acre/cents	
03	Cost of installation (Rs.) Labour Materials Water Tank Others Total	
04	Details of subsidy received (if any)	
05	Approximate cost of maintenance of the system	
06	Average yield before installation (nuts/palm)	
07	Average yield after installation (nuts/palm)	

b. Cost of cultivation of coconut/arecanut

S. No.	Field Operations	Qty. used	Unit Cost	Labour used	Unit cost of labour	Total Cost
01.	Basin opening and application of Organic manures FYM/Compost/Cow Dung Green leaf Ash Neem cake/Others					
02.	Chemical fertilizers (Specify the fertilizers) Coconut Mixture Urea Mussoriephos Potash Common Salt Others					
03.	Irrigation Basin Hose					

	Drip Others					
04.	Plant Protection (Specify the chemical)					
05.	Other cultural operations (Specify the operation)					

S. No.	Field Operations	Qty. used	Unit Cost	Labour used	Unit cost of labour	Total Cost	Remarks
06.	Crown Cleaning						
07.	Harvesting						
08.	Miscellaneous						
09.	Total Variable Cost						

Note: Include the quantity of own/family labour and inputs for all the field operations

c. Returns from coconut/arecanut cultivation

S.No	Particulars	Value
01.	Total Palms	
02.	Total Bearing Palms	
03.	Average Yield in Bearing Palms for the year 1998-99	
04.	Average farm gate price of the nut	

18. Perception of farmers (adopters) about the factors affecting adoption of microirrigation system

(Kindly indicate your response to the importance of factors in the adoption of microirrigation technologies.)

SI No.	Item	Very important	Important	Less important
1	Influence of mass media			
2	Influence of extension personnel			
3	Influence of researchers			
4	Influence of dealers			
5	Influence of peer group			
6	Economic motive			
7	Community recognition			
8	Achievement motive			
9	Water shortage during summer			
10	Availability of subsidy			
11	Labour scarcity			
12	Weed growth in the garden under sprinkler system of irrigation			

19. Perception of farmers (non adopters) about the reasons for non adoption of microirrigation system

(Kindly indicate your response to the importance of reasons for the non adoption of microirrigation system.)

Sl No.	Item	Very important	Important	Less important
1.	Lack of water during for irrigation, water source available provide water only sufficient to meet the domestic requirements.			
2.	High initial investment.			
3.	Farmers are satisfied with the conventional method of irrigation in places where sufficient water is available.			
4.	Poor quality of water which may result in clogging of the drip system.			
5.	Lack of awareness and knowledge about the drip system.			
6.	Perception that the water provided through the drip is not sufficient for the proper crop growth.			
7.	Discontinuance of the technology by many of the adopters.			
8.	Lack of power supply			
9.	Voltage problem			

20. Perception of farmers (adopters) about the constraints in the operation and maintenance of drip irrigation system.

(Kindly indicate your response to the importance of the constraints in the operation and maintenance of drip irrigation system.)

Sl. No.	Item	Very important	Important	Less important
1.	Clogging of the system due to impurities in irrigation water			
2.	Erratic electric power supply			
3.	Voltage problem			
4.	Damage of pipelines and drippers by rats			

5.	Damage of pipelines and drippers by wild animals such as wild boar etc.,.			
6.	Damage of pipelines and drippers by falling of coconut leaves			
7.	Low level of awareness and inadequate knowledge about utility, method of operation and maintenance			
8.	Improper after sales service			
9.	Lack of timely technical guidance from the extension personnel			
10.	Root concentration on soil surface			

B.Questionnaire for data collection from Extension personnel

1. Name of the officer:

2. Office address:

3. Age:

4. Educational qualification:

5. Professional experience (In completed years):

6. Perception about the constraints in the adoption of microirrigation technologies by the farmers.

Kindly indicate your response to the constraints in the adoption of microirrigation technologies by the farmers by giving a tick () against each item according to your perception of the importance of each of the item.

Sl No.	Item	Very important	Important	Less important
1.	Krishibhavan staff is overburdened with office work, hence proper monitoring of field installation of drip system is not possible.			
2.	Lack of knowledge among farmers about the installation and maintenance of the system			
3.	Agricultural Officers are not properly trained on the installation and maintenance of the system			
4.	Improper maintenance by the farmers			

5.	High initial investment, hence small farmers can not afford to adopt the system			
6.	Clogging of drippers			
7.	Farmers' perception that the quantity of water provided through drip irrigation system is insufficient for crop growth			
8.	Faulty lay out of the system in the field			
9.	Low quality of drip irrigation system materials supplied by the manufacturing firms			
10.	Movement of cattle and other domestic animals in the field, displace and damage the micro tubes and pipe lines			
11.	Any other (please specify)			

C. Questionnaire for data collection from dealers

1. Name of the dealer:

2. Address:

3. Age:

4. Educational qualification:

5. Details of staff employed for field installation of micro irrigation systems

Sl. No	Name of technical staff	Educational qualification	Experience	Specific training undergone
1.				
2.				
3.				

6. Perception about the constraints in the adoption of micro irrigation technologies by the farmers:

Kindly indicate your response to the constraints in the adoption of microirrigation technologies by the farmers by giving a tick (✓) against each item according to your perception of the importance of each of the item.

Sl No.	Item	Very important	Important	Less important
1.	Adoption of drip irrigation system by many farmers was subsidy driven. Farmers were not really interested in collecting the required technical information for proper installation and maintenance.			
2.	Farmers were not satisfied with the quantity of water delivered through the drip, as they perceive the quantity provided is quite insufficient for crop growth.			
3.	The fund allotment by the Agriculture Department for the subsidy scheme was untimely.			
4.	Discrepancy in the disbursement of subsidy by the officials of Agriculture Department due to lack of proper guidelines.			
5.	Farmers do not adopt the recommended practices for the proper maintenance of the drip irrigation system.			
6.	Lack of efforts by the Agriculture Department to impart training to the farmers on drip irrigation technologies.			
7.	Any other (please specify)			

