ADOPTION OF DRIP IRRIGATION SYSTEMS: PROBLEMS AND OPTIONS

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HARTI

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FOREWORD

Water stress conditions have been reported from many parts of the country during the recent past, mainly due to increasing demand of the growing population and developing industries. In addition, water deficit condition has been aggravated by the adverse consequences of climate change.

Agriculture being the largest consumer of water in the world there is an immediate requirement to increase the efficiency of irrigation water. The government has invested heavily on popularizing water saving technologies in agriculture such as drip irrigation. Though the drip irrigation projects implemented in the past were successful in attracting substantial farmer attention, there is still considerable room for its expansion in the country. However, there are only few studies on factors that influence its adoption and on constrains that keep farmers away from it.

Under these circumstances, the research team has attempted to find out the factors affecting drip irrigation adoption and constrains experienced in using it in crop cultivation in Sri Lanka. I trust this study will be useful for policy makers and other stake holders in planning future projects which are aimed at increasing the extent under drip irrigation in the country.

E.M. Abhayaratne

Director

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ABSTRACT

To satisfy the global demand for food by 2025, water requirements for agriculture is expected to be increased by 1.2 times (IGES, 2003). Therefore, it is extremely important to adopt an appropriate irrigation technology which maximizes water use efficiency to meet the anticipated water demand. Micro Irrigation (MI) technology which includes both drip and sprinkler systems is proved to be an efficient method of water saving in irrigated agriculture. Governments with majority of resource poor farmers, after recognizing the importance of adopting MI and realizing the financial and technical constraints of the farmers has implemented many subsidy schemes investing large amounts of money to promote MI technology. Government is paying more attention to support drip irrigation considering its higher efficiency in water saving compared to sprinkler irrigation. Therefore present study is aimed at identifying the current status of drip irrigation adoption and the problems and options for increasing the area under drip irrigation in Sri Lanka.

According to the research findings, only 45 per cent of beneficiaries in the government sponsored subsidy schemes have adopted drip irrigation, while 63 per cent who have invested their own funds to purchase drip systems have adopted the technology. Extent under cultivation, access to ground water and amount of money spent by the farmer to obtain the drip system were found to be significantly affecting the adoption decision of drip irrigation. It was found that major constraints faced by the farmers to continue drip irrigation were frequent clogging of the emitters, and non availability of spare parts easily access. However, farmers have perceived increased production, higher quality yield and water and labour saving due to drip irrigation.

In future projects aiming to increase the extent under drip irrigation, more emphasis should be given to farmers who cultivate perennial crops with more than 2 acres of land extent. Access to a permanent water source should be considered as a mandatory factor to received drip irrigation systems. Availability of low cost spare parts at local level should be ensured. Further, by providing required technical knowledge on installation and maintenance of drip systems to the field level officers, farmers would benefit geting much needed technical support services. Selection of cluster farmers as beneficiaries is recommended as it will facilitate easy monitoring & provision of after sales services.

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CHAPTER ONE

Introduction

1.1 Background

Water scarcity is a major crisis faced by the present global population and its severity will be more on future generations. It is said that one in three people of the world face water shortages even today (IWMI, 2007) and by 2025, one third of the world population will be facing absolute water scarcity (Seckler *et.al*, 1998). Increasing demand for water with the increasing population, rapid urbanization, industrialization and expansion of services such as tourism and recreation which intensifies the pressure on freshwater resources is a serious concern all over the world. In order to sustain their needs, it is extremely important to focus on the efficient use of all available water sources including groundwater, surface water and rainwater. To achieve this task water managers around the world are working hard to find strategies that maximize the economic and social returns to the limited water resources, while increasing the water use efficiency in all water use sectors.

In many countries, especially in developing countries including Sri Lanka, irrigated agriculture is the predominant consumer of water. In 2000, agriculture accounted for 67% of the world's total water withdrawal and 86% of its consumption (UNEP, 2008). To satisfy the global demand for food by 2025, water requirements for agriculture is expected to increase by 1.2 times. It is projected that demand for water from the industrial sector will be 1.5 times while the domestic water requirement will be 1.8 times in the year 2025 (IGES,2003). Demand management is an important component of satisfying the water need of the agricultural sector. This could only be achieved through increasing the productivity of irrigation water.

Micro Irrigation (MI) technology which includes both drip and sprinkler systems is proved to be an efficient method of water saving in irrigated agriculture. Besides water saving, past research also indicates that MI can bring many other benefits such as higher and better yields, reduction of labour requirement, weed problems, and fuel consumption. Micro irrigation was first experimented in Israel and by now MI technology is widespread in developed countries. By 2008, in the United Sates of America, extent under drip, trickle or low flow micro sprinklers was about 7% from the total irrigated extent in the country while area under sprinkler irrigation was about 56% (USDA, 2010). Many developing countries in South East Asia with majority of resource poor farmers after recognizing the importance of adopting MI and realizing the financial and technical constraints of the farmers have implemented various projects targeting different crop types and different areas of water availability since early nineteenth century to increase the area under micro irrigation.

The government of Sri Lanka and several other funding agencies by investing large sums of money through subsidy and loan schemes have taken great pains to introduce MI technology to the rural farmers of the country. The Agricultural Development

Authority (ADA), Department of Agriculture, Mahaweli Authority of Sri Lanka an Southern Development Authority are some of the government institutions th implemented pilot projects to promote MI. According to the cooperate plan for th period from 2011 to 2013 prepared by the Ministry of Agriculture, the Ministry ha allocated 34.8, 41.7 and 45.0 million rupees in 2011,2012 and 2013 respectively fo implementation of micro irrigation projects to increase the extent of area under micr irrigation. The present government's development policy is also aiming at reducin the level of water use by irrigation sector to around 60% (Mahinda Chintana – Visio for the Future, 2010). Therefore, government is paying more attention to promote dri irrigation technology as water saving from drip irrigation is higher than that o sprinkler irrigation.

However according to the available literature, despite governments' support i adopting MI, use of MI for cultivation is rather low in some of the developin countries namely India, Pakistan and Nepal. Discussing the current status of adoptin micro irrigation in India, Shan and Keller (2002) has reported that despite perceive benefits of micro irrigation and subsidies provided by respective governments adoption of MI technologies had shown very limited success mainly among larg scale farmers. Even though various research and development organizations i Pakistan put great effort to introduce and demonstrate the benefits of sprinkler an drip irrigation technologies, it records limited success with respect to adoptability o these systems by the farmers (Alam, *et.al*, undated).

1.2 Research Problem

Micro irrigation technology is known to the farmers for quite some time an government has invested large sums of money on popularizing this technology. Man studies on application of drip irrigation technology in relation to different crops wit respect to productivity, water saving and economic feasibility have been undertake both in developed and developing countries including Sri Lanka.(Desal *et.al*,2003;Waykar *et.al*,2003;Kumar *et.al*,2004; Aheeyar,*et.al*, 2005; Jayapiratha,*et.al*,2010). However in Sri Lanka, there is only limited information available on rate of drip irrigation adoption and factors influencing the farmers' decision on drip irrigation adoption to modify the strategies of future projects aimin to promote drip irrigation.

1.3 Objectives

General Objective:
To find out the status of drip irrigation adoption by the farmers in Sri Lanka.

Specific Objectives:

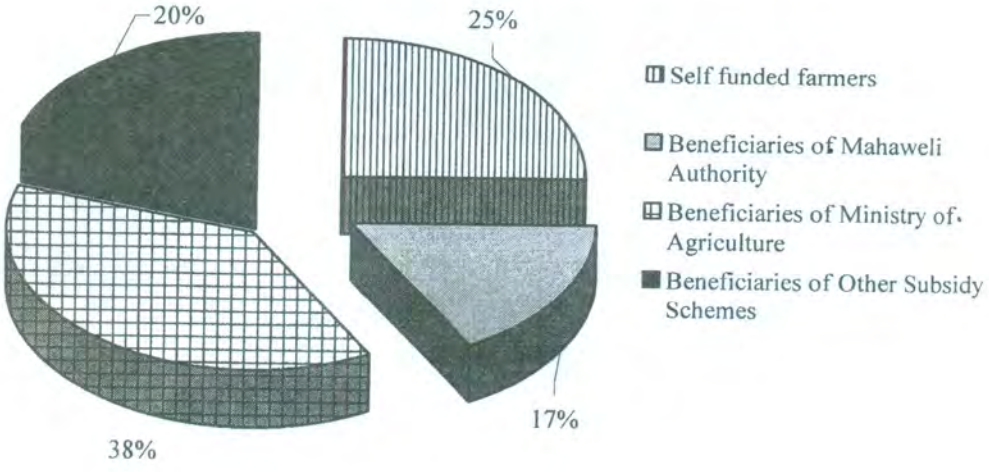
(a) To review the strategies of previous micro irrigation projects implemented by the government to promote drip irrigation among the farmers in Sri Lanka
(b) To study the factors affecting farmers decision of adopting drip irrigation
(c) To examine the constraints experienced by the farmers in using drip irrigation

1.4 Research Methodology

1.4.1 Sample frame

Due to non availability of a data base of drip farmers in the country a data base of drip farmers was prepared for this study using the beneficiary lists of drip irrigation projects implemented recently by many government agencies and customer lists available at the leading private micro irrigation dealers in the country. Farmers who had started drip irrigation between 2000 and 2008 period were considered for this study to get details of previous four cultivation seasons. Due to highly scattered nature of distribution, sample farmers were randomly selected from areas where many drip irrigation farmers were located. Considering the time and resource availability, sample size had to be limited to 150 farmers and majority of the sample consisted with subsidy farmers as there was only a small number of drip farmers who had self financed the drip systems. Composition of the sample farmers according to funding for drip systems are given in Figure 1.1. The study didn't include farmers who cultivate under protected environment and farmers with solar power drip irrigation systems.

Figure 1.1: Composition of Sample Farmers



1.4.2 Data collection

The study was undertaken during September to December 2011. Both primary and secondary data and information was used in the study. Primary data was collected using a structured questionnaire and key informants discussions and focus group discussions were conducted in order to validate the data collected. The secondary data and information were used to review different strategies adopted by government agencies to promote drip irrigation.

1.4.3 Data analysis

Logit and probit models are the most commonly used to analyze technology adoption processes (Peng *et.al*,2002; Musara, 2010). In this study logit regression model was used to establish relationship between the likelihood of adoption of drip irrigation technology and various factors affecting it.

The specification of the logit model is as follows:

$$Y = \beta_{0+} \sum_{i}^{m} \beta_1 X_i$$

Where β0 is the intercept, β1 is a slope parameter in the model, and the Xi is an independent variable.

Drip irrigation adopters are those farmers who had used the drip system during the two seasons of the year of the field survey. The non adopters, or non-drip irrigation farmers, are those who had not used drip irrigation during the year of the survey. In this case, the drip irrigation adoption variable is a discrete dichotomous variable (a farmer is either a drip irrigation adopter or a non-adopter).

The variables were selected based on literature reviews of the determinants of drip irrigation adoption (Shrestha and Gopalakrishnan, 1993; Namara *et.al*,2005; Shamaila, 2001). In addition researchers' knowledge and perceptions of the socio-economic attributes in relation to the locations, and the technical attributes of the drip irrigation systems have been taken into consideration. In the present study, the variables hypothesized to influence drip irrigation adoption decision are as follows;

* Family size
* Age of the farmer
* Farmer's level of education
* Access to ground water
* Share of off farm and non farm income
* Extent of farm land
* Capital investment on drip irrigation systems
* Type of crops cultivated

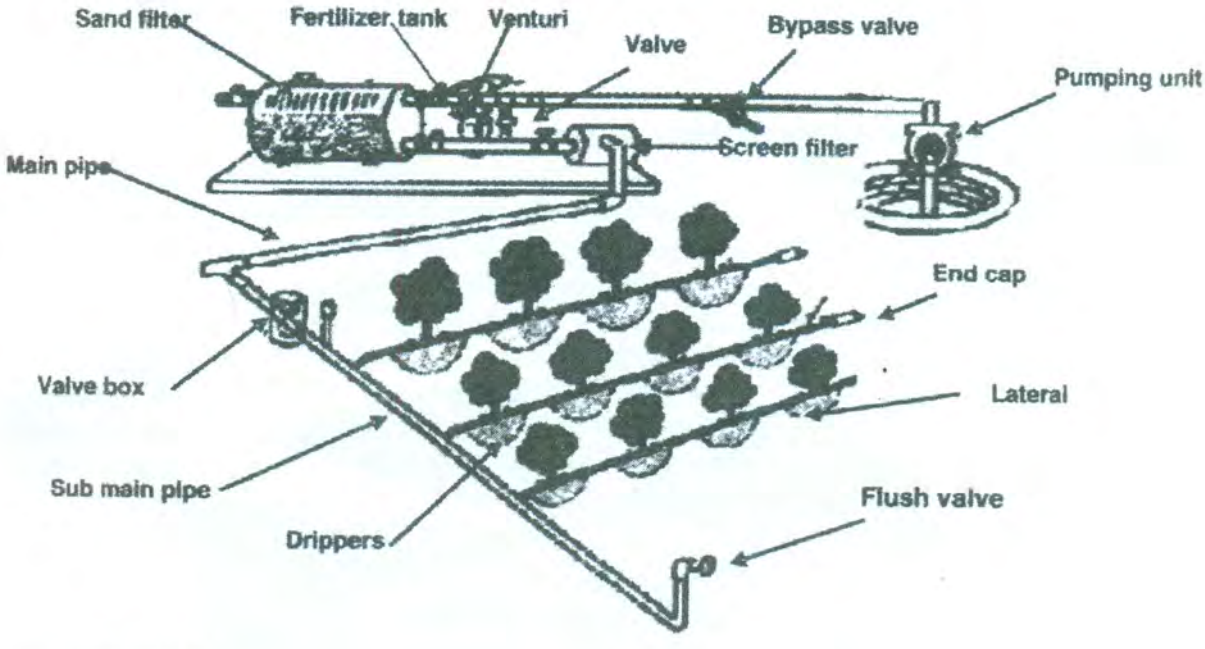
CHAPTER TWO

Literature Review

2.1 Drip Irrigation Technology

The basic concept underlying the drip irrigation technology is to supply the amount of water required by the plant within a limited volume of soil. Drip irrigation systems involve in dripping water at very low rates varying from 2-20 liters per hour, through a system of small diameter flexible polyethylene pipes fitted with devices called drip emitters (Figure 2.1). Water application efficiency which refers to the total amount of water diverted from the source is high as 90-95 per cent in drip irrigation while it is 70-80 per cent in sprinkler irrigation and 60 per cent in surface irrigation (Sivanappan, 1998; IARI, 2010).

Figure 2.1: Components of a Typical Drip Irrigation System

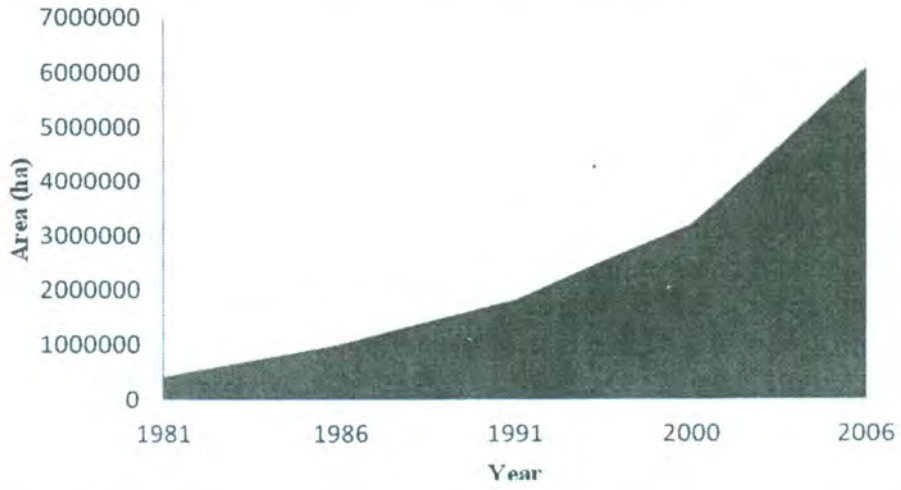


Source: IARI, 2010

2.2 Spread of Drip Technology

Initially drip irrigation had been taken up by commercial farmers in Israel during 1960s and later it had spread to many other countries (Shah and Keller, 2002). Micro-irrigation systems are immensely popular in arid regions and urban settings and also in sub humid and humid zones where water supplies are limited or water is expensive (*ibid*). During twenty years period from 1986 to 2006, area under micro irrigation in the world had increased almost six times (Figure 2.2).

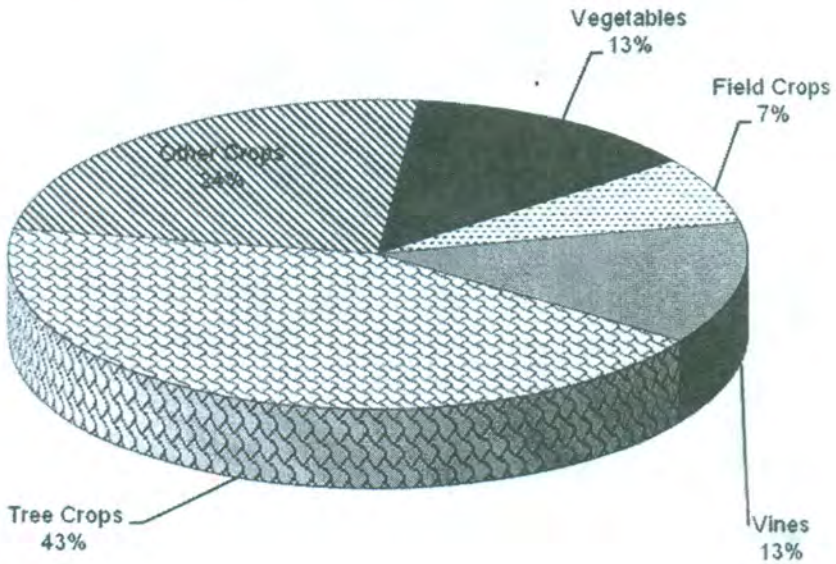
Figure 2.2: Area Under Micro-irrigation in the World



Source: Reinders, undated

Drip irrigation is used extensively for wide variety of crops such as plantation cr orchard crops, flowers and especially vegetables. Figure 2.3 describes the worldw coverage of different crops under drip irrigation.

Figure 2.3: World-wide Crop Coverage by Drip/Trickle System



Source: Alam *et.al*, undated

2.3 Experiences of Drip Irrigation

2.3.1 Drip irrigation in India

Drip irrigation was first introduced to India in 1970s and by 2007, India was rank the 7th position in terms of coverage of area under drip irrigation with an irri area of 2,87,500 hectares. According to the data compiled by the Internat

Commission on Irrigation and Drainage, area under drip and sprinkler irrigation in India accounts 9.185lac ha, of which 0.261 million ha are under drip irrigation (Kumar *et.al*, undated).

However there is a potential area of 21.01 million ha for drip irrigation in India (Narayanmoorthy, undated). Substantial efforts have been made by the government through encouraging the private sector involvement in the manufacturing and distribution of the technologies and adoption by farmers through targeted subsidy schemes to disseminate and popularize these technologies. Despite these efforts the area under current micro irrigation systems remains an insignificant proportion of the potential. Studying the reasons for slower growth of the area under drip irrigation Narayanmoorthi (undated) has identified that slow spread of micro irrigation is not mainly due to economic reasons, but due to less awareness among the farmers about its real economic and revenue-related benefits.

Therefore he has highlighted the importance of making various technical and policy interventions such as restructuring the current government subsidy policies that are fixed uniformly for both water-intensive as well as less water-intensive crops and water abundant and water scarce areas.

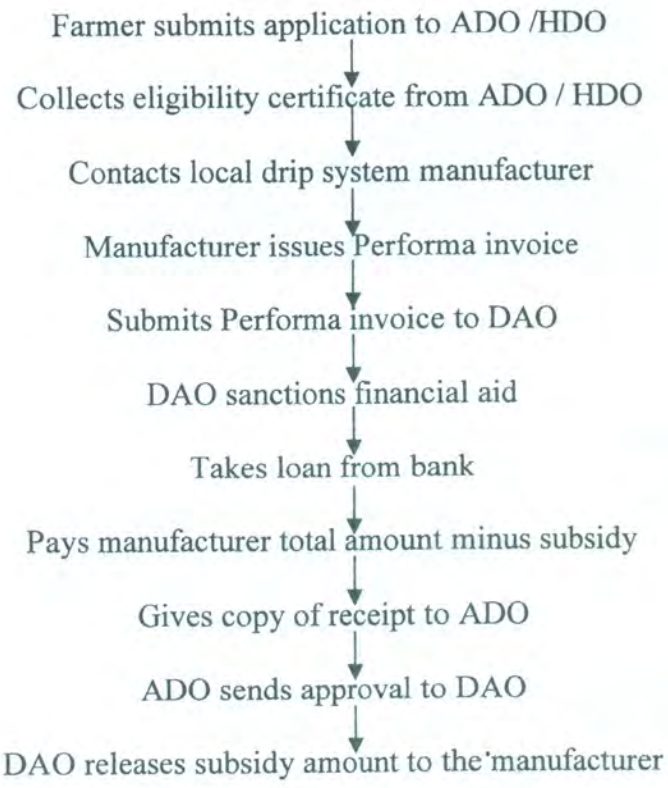
A study conducted in the state of Tamil Nadu to find out the reasons for the poor adoption to drip irrigation technologies by the farmers has found that many farmers had experienced non availability of quality parts of drip systems (95.55%) and non existence of follow up services by drip agencies (81.11%). Requirement of high initial investment, delay in sanctioning of loans and problem of water leakage in the present drip system were among other reasons for not adopting this technology (Shashidhara, *et.al*, 2007). The National Committee on Irrigation and Drainage has added some other factors such as clogging of drippers and cracking of pipes, lack of adequate technical inputs, damages done by rodents, high cost of spare parts and salinity hazards to the list of problems as contributing in the slow rate of adoption of drip irrigation in India (GOI, 1994). Shiyani *et.al* (1999) have reported difficulty in inter-cropping as another reason for non-adoption of drip irrigation.

Knowledge regarding the technology is a prerequisite for its adoption. Hence the farmers should be made aware of the technologies to get it adopted. A research study undertaken in Jaipur region of Rajasthan in India, to measure the knowledge level of farmers about drip irrigation technology, has found that only 21 percent of the farmers had high level of knowledge while majority of the farmers (53 percent) had medium knowledge level regarding the usefulness of drip irrigation. Less exposure to information sources, less contact with extension personnel, inadequate technical guidance have been identified as possible reasons for the current state of knowledge level (Jitarwal and Sharam,2007).

In government sponsored subsidy programmes the state governments claims to be providing subsidies ranging from50 per cent to their total cost. But procedure needed to obtain a drip system is a long and complex process for the poor and marginal farmers (Figure 2.3). As the process involves a huge amount of paperwork, which

requires government approval it tends to breed corruption and mostly benefit the lea needy.

Figure 2.4: Procedure to be Followed to Obtain a Subsidized Drip System



Note: ADO: Agriculture Development Officer
DAO: District Agriculture officer
HDO: Horticulture Development Officer
Adopted from: Docstock (2011)

According to Namara *et.al,* (2005) the most important determinants of mic irrigation adoption in India include access to groundwater, the prevailing croppi pattern, level of education, financial resources and the social stratum of the household and the wealth or poverty status of the farmer. Findings of the study show increased likelihood of micro irrigation adoption with increased level of education the household head. Ownership of dug or bore wells has significantly increased t probability of micro irrigation adoption. The study also indicates lower probability micro irrigation adoption in the event where the share of cereals and pulses are high their farms. In Maharashtra, majority of micro irrigation adopters were relativ wealthier farmers while in Gujarat the adoption has extended to the middle and r farmers indicating the importance of cash in the initial adoption decision of farmers. However, in both locations the poor and the poorest section of the farmi population had not benefited much from innovations in micro irrigation.

2.3.2 Drip irrigation in Pakistan

In Pakistan many research and development (R&D) organizations had made efforts to introduce drip/trickle irrigation systems for irrigation during 1980s. All those efforts were based solely using imported materials which required higher capital investment. Another constraint for slower growth of extent under drip irrigation was the lack of after sales services and skills to install and maintain the system. Later on instead of high cost imported drip systems, those respective R&D organizations were entrusted to promote indigenized drip irrigation system using local knowledge and skills. At the level of present appropriate technology, skills & services that required installing standard trickle/drip irrigation systems are available in Pakistan (Moshabbir *et.al*,1993). In Pakistan 80 per cent water saving with drip irrigation is reported (Ahmad and Ahmad,1993). Due to various demonstration programmes farmers are convinced about the usefulness and benefits of drip irrigation. In spite of all these efforts adoption to drip irrigation is rather slow in the country. As identified by Alam *et.al* (undated), factors that have contributed for less adoptability of drip irrigation technology in Pakistan include high investment costs of the system with recurring operation and management costs, availability of canal water at low cost, non availability of system spare parts, poor backup support and limited capacity of manufacturers with respect to quantity, quality and efficiency of these systems.

2.3.3 Drip irrigation in Nepal

International Development Enterprises (IDE)/Nepal had developed a low cost micro irrigation technology which is suitable for vegetable production in mountain areas of the country. This technology was field tested and introduced by the IDE as a pro-poor technology targeted of smallholder farmers in Pokharathok village of the Palpa district in the western hills of Nepal. The technology was popular among smallholder farmers in the respective area due to its very low cost and simple design technology. A village level impact assessment study had been carried out within 2-3 years of the technology adoption in order to understand the socio-economic implications of the adoption of low-cost micro irrigation technology. It has found that many households surveyed were able to double their annual farm income after adopting this technology. The beneficial impacts of the technology have been perceived by economically and socially better-off as well as worse-off groups (Upadhyay, 2005).

2.3.4 Drip irrigation in Bulgaria

Drip irrigation has been successfully applied in Bulgaria for the past 20 years in the cultivation of substantial number of crops including orchards which grow apples, peaches, apricots, pears, and cherries and certain vegetables like tomatoes, pepper, and cucumbers. In addition grapes, flowers, berries, tobacco, and cotton are grown successfully under drip irrigation. The interest towards drip irrigation and its use in the past decades of the 20th century in Bulgaria has prompted due to perceived benefits of water saving, increases in yields and improvements in yield quality, as well as the ability to apply it in rough terrain conditions.

The successful experiences achieved so far confirms the suitability of drip irrigatio technology in Bulgaria. Further due to the increased cultivation of intensive crops, th worsening conditions of water deficit and limited water resources diverted t agricultural use, which emanate from the tendencies of climate warming an increased drought incidence in the region, it is likely to expand the extent under dri irrigation in the future (Petkov and Kireva, undated).

CHAPTER THREE

Government Support Systems for Drip Irrigation

Majority of the small scale micro irrigation farmers are beneficiaries of many projects implemented by government and nongovernmental organizations with the objective of popularizing micro irrigation through subsidy or total grant. Ministry of Agriculture via Agricultural Development Authority (ADA), Samurdhi Authority, Mahaweli Authority, Southern Development Authority, Coconut Cultivation Board and Japanese International Co-operation Agency (JICA) were among those institutions (Aheeyar *et.al*, 2005).

By 2003, there were 27 private firms engaged in marketing and distributing micro irrigation systems in the country. However with time, number of agents dealing with micro irrigation equipment has decreased. Currently in Sri Lanka, there are only few companies that are largely involved in this business. (Annex 1).During the initial period of micro irrigation in the country these private firms were acting as sub contractors for government sponsored micro irrigation projects. They had imported micro irrigation systems and other necessary accessories and provided transport facilities to those respective areas. These firms did the field installation of micro irrigation systems while providing basic knowledge on use and maintenance of the systems. However from about 2004 government micro irrigation projects started dealing with the manufacturing or donor agencies directly for supply of micro irrigation systems, their installation and maintenance. Private micro irrigation firms started doing self business only after these changes and even at present larger portion of their business accounts for micro irrigation and rural development projects sponsored by the government, local and international NGOs. Average cost for a drip system for 0.25 acre of land including mainline, laterals and drippers was about Rs22,000/- during the study period. Due to limited number of individuals who adopt micro irrigation with their own funds, many firms moved away from this business as they found it hard to sustain in the business of micro irrigation.

Majority of the sample farmers accounted for beneficiaries of projects implemented by Department of Agriculture and the Mahaweli Authority of Sri Lanka.

3.1 Ministry of Agriculture

In the year 2000 then ADA of Ministry of Agriculture has implemented a micro irrigation project targeting beneficiaries of ADA agro well subsidy programme. Under phase 1 of the project MI units that sufficient to irrigate 0.5acres of highland had been distributed among 540 beneficiaries. Following criteria had been adopted by the ADA for selection of beneficiary farmers (Aheeyar *et.al,* 2005).

(a) The farmer should be an agro well cultivator who had benefited from the ADA agro well subsidy programme
(b) There should be a minimum water level of 10feet in their agro well during the dry months of July to August to ensure cultivation of the *yala* season

(c) The farmer should possess a 2 inch water pump with horsepower not less tha 2
(d) The farmer should be able to deposit his share of money in the micro irrigation account of ADA within 10 days of notice
(e) Beneficiary farmer is a knowledgeable person on new agricultural technolog and be a suitable candidate to receive a subsidy
(f) Beneficiary farmer should be a permanent resident around the agro well area
(g) Land extent cultivated under the agro well should be not less than 1 acre

During the 1st phase of the project a farmer's contribution for the MI system w Rs.10,000, while government subsidy was Rs.20,000. Again in 2002 Phase 2 of t above project was implemented and 375 small farmers were expected to benefit fro this project. However financial contribution from both parties had slightly increas as an adjustment to prices of MI equipment during this project period accounti Rs.12, 500 from the farmers and Rs.25,000 as the government subsidy. Selecti criteria for beneficiaries remained unchanged for both phases.

Leading MI firms as well as NGOs that had involvement in MI business had be selected by ADA as sub contractors for this project. After listening to the introducto sessions conducted by each of these MI suppliers, farmers had given the opportuni of deciding on the type of MI they were going to adopt and the supplier from whc they were going to purchase the system. Sales agreement had been made betwe individual farmers and the respective suppliers. According to the agreement supplie had to provide all required MI equipment for 0.5acre of land, free transpo installation and after sales services for one cultivation season.

Again in 2004, then Ministry of Agriculture, Livestock, Lands and Irrigati implemented another large scale micro irrigation project through its Sustainab Agriculture Water Management Project (SAWMP) using a loan worth 32.2 milli US dollars provided by the Australian government to distribute drip irrigation syste which operated with solar energy. The BP Solar (PVT) Ltd of Australia was t equipment supplier and technology disseminator for this project. Each solar pow drip irrigation (SPDI) system was said to worth Rs.300,000.00 and under phase-1 this project nearly 5000 solar power drip irrigation kits had been distributed amo farmers in most parts of dry zone except in areas in North and East and certain wa scarce areas in the wet zone districts through Agrarian Service Department a Samurdhi Authority. In phase 2 of the project another 5000 SPDI systems had be distributed targeting the North and East part of the country. As per the Ministry Agriculture, beneficiary selection was based on the criteria given below:

(a) Beneficiary should be an agro based full time farmer in the target area.
(b) Beneficiary farmer's agro well should have the capacity of withdrawing l less than 7000 liters of water per day.
(c) Farmer needs to deposit Rs.5000/= in Govijana or Samurdhi bank initial After six months beneficiaries had to start paying the balance amount money within 10 years as biannual installments. A grace period of one y was given to settle the due amount of money.

(d) Beneficiary farmers should be residents in the target area where there is no access to grid electricity.
(e) Beneficiary farmers should own more than 0.5acre of land.

However it is reported that most of the Solar Power Drip Irrigation Systems (SPDIS) distributed in the phase 1 of the solar power drip irrigation project were either not fully utilized or abandoned. Poor quality of water, lack of proper water source, technical problems of the system and lack of after sales services were identified as major reasons for the failure of these systems (Aheeyar *et.al*, 2012).

3.2 Mahaweli Authority of Sri Lanka

Mahaweli Authority of Sri Lanka has implemented many projects to increase the area under drip irrigation. One such programme implemented in 2003 as a component of Cascade Development Project had distributed 41 drip systems by investing nearly 2 million Rupees. Main objective of this project was to obtain the maximum productivity from agriculture by utilizing least amount of water in dry zone areas of Puttlam and Anuradhapura districts where available water is very limited. This project was focused on banana cultivation. Therefore along with the drip system, sufficient planting materials multiplied by tissue culture were given to beneficiaries to cultivate 0.5acres of land. Selected farmers were given the facility of making the payment in three installments. After settling the beneficiaries' contribution, they were given a drip system consisting of a filter, drip tapes and a fertigation unit. Procurement

Criteria adopted in selection of beneficiaries are as follows:

* Ownership of 0.5acre of land that is suitable for banana cultivation
* Availability of a permanent water source
* Possession of a water pump
* Having the financial capacity to bear 25 percent of the cost
* Not being a beneficiary of another government subsidy program or not being an employee paid by the government and
* Willingness of the farmer to demonstrate field trials

Before selecting the beneficiaries, particulars provided in the application were verified with assistance of respective Agricultural Instructor, Agrarian Development Officer, *Grama Niladhari and* Agricultural Research and Production Assistants. Besides these evaluations, officials of the Mahaweli Authority of Sri Lanka (MASL) had made direct observations on the information provided by the applicants before announcing the selected beneficiaries.

Before installing the drip system in the field, beneficiaries were given a three months training at FMTC (Farm machinery training center) on technical knowledge required for operation and maintenance of the system. In addition, during the training they were informed about the closest places where they could purchase spare parts necessary for maintaining the system. Suppliers of the drip systems also had provided facilities to the famers to closely observe the process of operation & maintenance

while installing the system at the field. Arrangements had been made to provid service of the supplier whenever the farmer found it necessary.

During the field days organized by the Mahaweli Authority of Sri Lanka (MA farmers were encouraged to use the drip system continuously. However in inst where officials of the MASL observed practical difficulties beyond farmers' co they had transferred the drip system to new farmers who could use the syste cultivation. Lack of support from collaborating agencies in beneficiary selectio progress monitoring had been experienced by MASL during the project period.

3.3 Southern Development Authority

A project was initiated by Southern Development Authority (SDA) of Sri Lan 1997, with the objective of popularizing new technology to develop agricu plantations and fisheries sectors within the designated area of the SDA. This inc four districts namely Galle, Matara, Hambantota and Moneragala and Divis Secretary's divisions of Kolonna and Embilipitiya in the Ratnapura district. component of this project a drip system sufficient to irrigate $1/8^{th}$ acre of land distributed among 400 farmers free of charge. This drip system included a filter tapes, fertigation unit and a storage tank. Ownership of the system was with the for three years. This had provided the facility of taking back the system i beneficiary moved away from drip irrigation during this period. *Grama Niladhar* also involved in the beneficiary selection.

According to SDA, following criteria had been adopted in selecting the beneficia

* being a farmer who was doing cultivation at the time of beneficiary select
* having ownership of $1/8^{th}$ of land suitable for cultivation
* accessing of a permanent water source
* being a young farmer who was willing to experiment the new technology

Installation of the drip system had been undertaken by the suppliers of drip irrig systems. They had given a basic training sufficient to operate and maintain the system.

Zonal managers of SDA assigned for each Divisional Secretariat Division h submit a frequency report to the SDA head office, providing the progress constraints faced by the beneficiaries. Necessary solutions and instructions were to the farmers via Divisional Officers by the SDA management and suppliers of irrigation equipment.

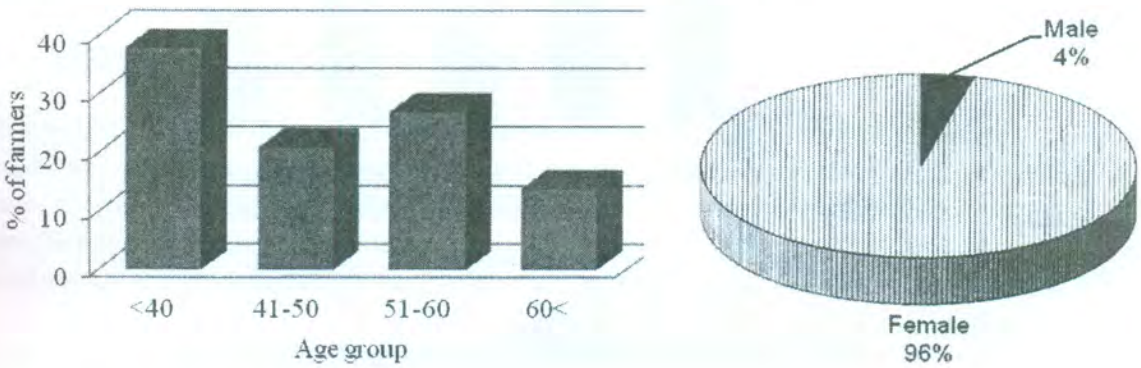
CHAPTER FOUR

Adoption of Drip Irrigation

4.1 Profile of the Sample Farmers

Sample shows a fair distribution of young and elderly farmers. Among the sample farmers 38 per cent were under 40 years while 41 per cent were over 50 years of age. Male farmers accounted for 96 per cent of the sample (Figure 4.1).

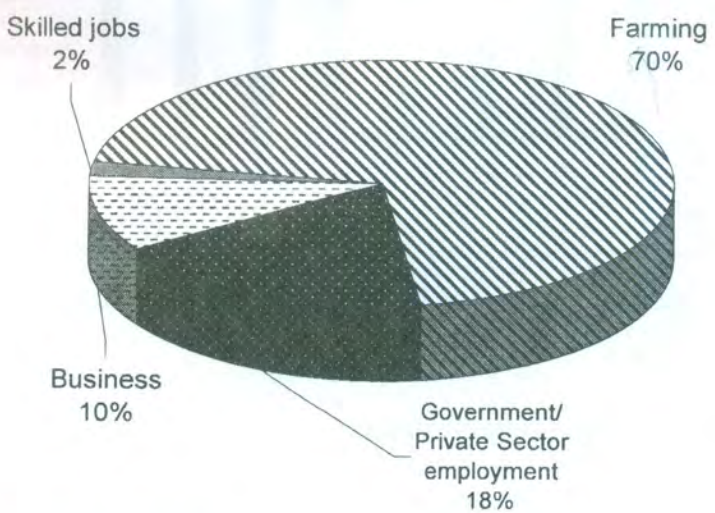
Figure 4.1: Sample Distribution by Gender and Age Groups



Source: HARTI Survey Data, 2011

Primary employment of 70 per cent of the sample beneficiaries was farming while others were involved in government or private sector employment as primary occupation (Figure 4.2).

Figure 4.2: Primary Occupation of the Sample Farmers

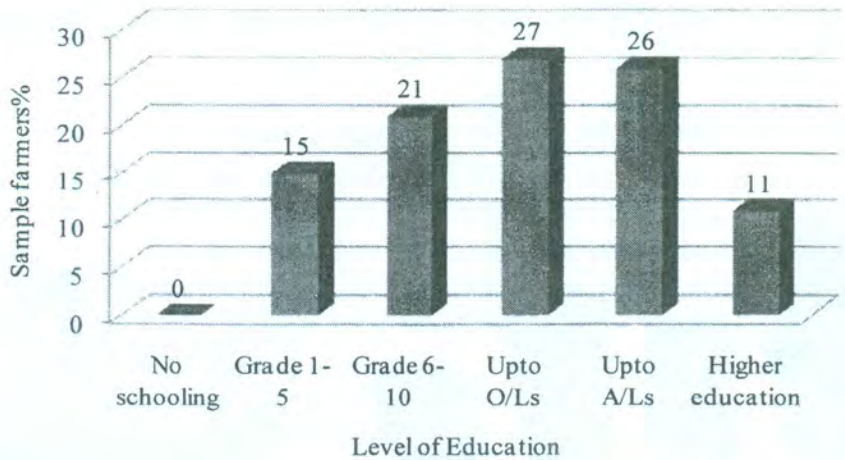


Source: HARTI Survey Data, 2011

Level of education of sample farmers

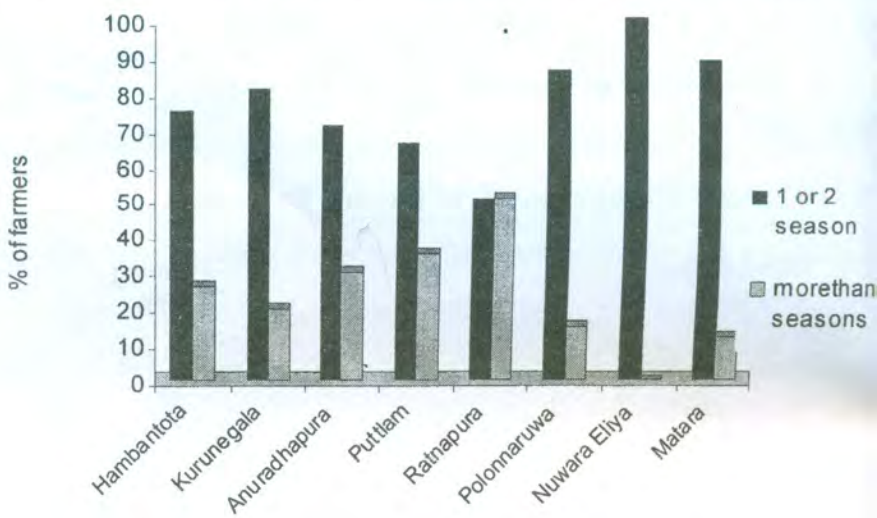
More than 75 percent of the farmers had received education beyond pr education. Percentage of the farmers who had received education above G.C.E. was 37.

Figure 4.3: Education Level of the Sample Farmers



Source: HARTI Survey Data, 2011

Figure 4.4: Number of Seasons Cultivated Under Drip Irrigation System



Source: HARTI Survey Data,2011

4.2 Current Status of Using Drip Systems

Though majority of the sample farmers were aware of the benefits of drip irri technology, 62 percent of them had abandoned drip irrigation by the time of th survey. In almost all the areas farmers had used drip systems for irrigation for

one or two seasons only. Even in areas where available water for cultivation was limited, majority of the farmers had stopped using drip irrigation after one or two cultivation seasons (Figure 4.4). Among the 38 per cent of the farmers that used drip irrigation systems, only 14 percent are using the complete system including the fertigation unit.

4.3 Status of Drip Irrigation Adoption

For this particular study to be considered as a drip irrigation adopter, he/she had to cultivate one of the last two cultivation seasons using drip systems. Accordingly only 49 per cent of the farmers had adopted drip irrigation. Adoption rate was 63 per cent for the farmers who had self financed their drip systems whereas it was 45 per cent for the beneficiaries of government sponsored subsidy schemes.

4.4 Determinants of Drip Irrigation Adoption

To identify the factors that had an influence on adoption of drip irrigation, mean separation was done by performing a simple t test. Three variables were identified to have an influence for the adoption process in the present study. Other predictor variables were removed from the model. The three variables used in the logit model were access to groundwater, money spent on the drip system and extent of farmland.

Fitness of the developed logit model was statistically tested by performing likelihood-ratio test and wald test (Tables 4.1 and 4.2).

Table 4.1: Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	27.678			
Final	16.913	10.765	3	0.013

Table 4.2: Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	0.517	2	0.772
Deviance	0.521	2	0.771

Results of the empirical model for drip irrigation adoption is given in Table 4.3.

Table 4.3: Results of Logit Regression

Variables	B	S.E.	Wald	df	Sig.
Access to Ground Water(AGW)	0.051	0.117	0.203	1	0.652
Capital Investment on Drip Irrigation Systems (CIDIS)	0.306	0.158	3.359	1	0.067
Extent of Farm Land(EFL)	0.190	0.110	2.789	1	0.095
Constant	0.138	0.139	3.589	1	0.058

Logit model for the present study was as follows:

Adoptability of drip irrigation=0.138+0.051AGW+ 0.306CIDIS+ 0.190EFL

Figure 4.5 and 4.6 shows the validity of the logit model for drip irrigation adoption

Figure 4.5: Normal Q-Q Plot of Deviance

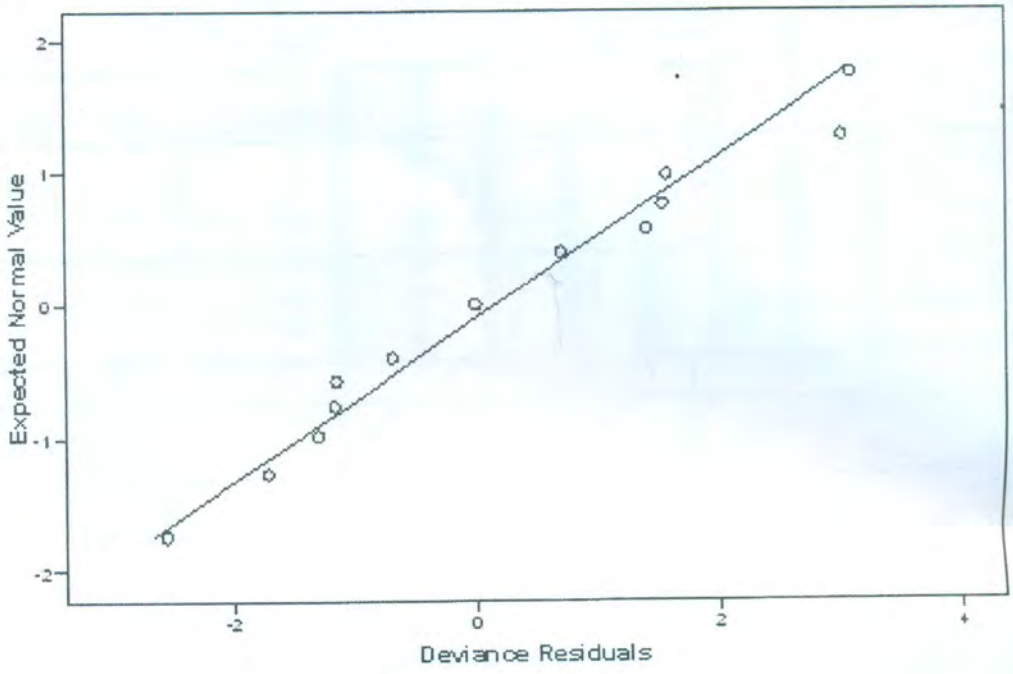
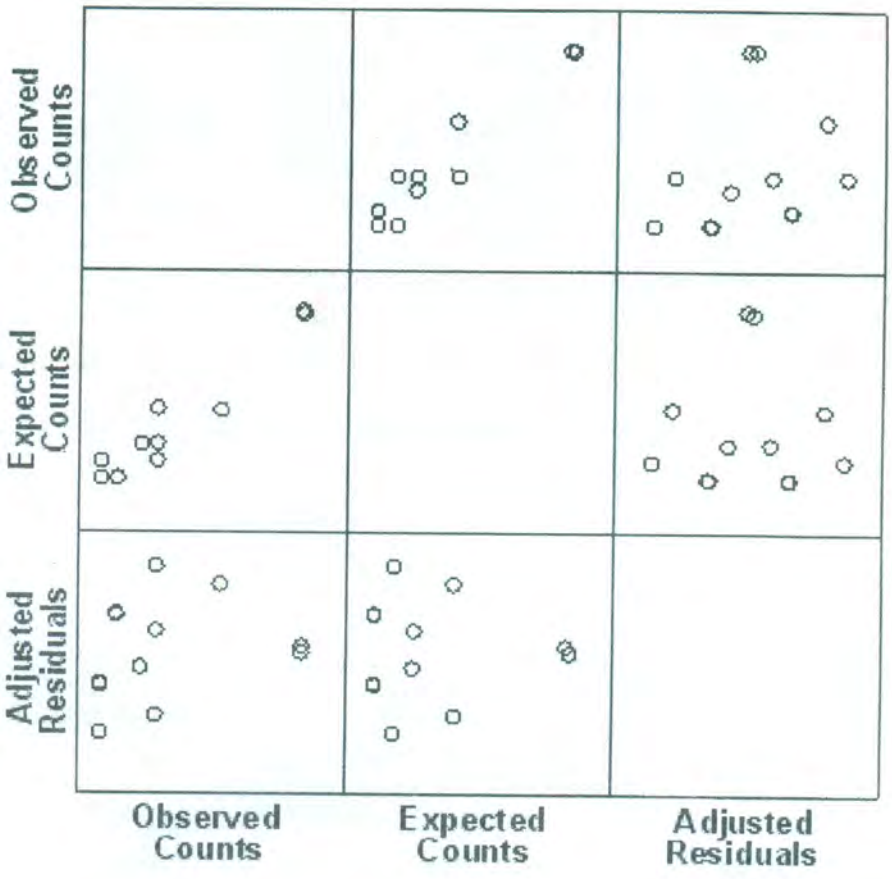


Figure 4.6: Logit Model



Access to groundwater showed a positive influence regarding the farmers' decision to adopt drip irrigation and the coefficient was not statistically significant. During dry seasons in many parts of the country water available is limited for cultivation.. Therefore during dry spells farmers are compelled to use ground water to do any cultivation. Therefore those farmers with no access to ground water find drip systems are no longer useful as they have sufficient water during rainy seasons. According to the field observations farmers who cultivated small extent of land with only the family labour and use freely available irrigation water from canals had not recognized the value of water saved from drip irrigation. Namara *et.al,* (2005) have reported similar findings showing the increasing probability of micro irrigation adoption with ownership of dug wells or bore wells. According to another study conducted in Zimbabwe to assess the sustainability of drip irrigation project has also reported problems related to water availability and access to water had resulted poor adoption to drip technology (Moyo *et.al*,2005).

Extent of farm land

Figure 4.7 shows the change in adoption rate with the extent of farmland. Adoption rate was very low in the farm plots with less than 0.5acres. It was more than 80% in farmlands with more than 2 acres. Due to the economics of scale more land area the

investment to return is larger. So, when cultivable land extent increases the use o (adoption) drip systems is more successful.

Majority of the adopters (88%) were growing coconuts, fruit crops such as banana papaya, guava and citrus crops. In Puttalam area, large scale farmers with 5acres o more of coconut and cashew plantation had successfully adopted drip irrigation usin agro wells. They were able to protect the perennial crop cultivation from water stres and saved labour which was the major cost component. According to Kumar *et.a* (undated) similar situation existed in India with cotton, sugarcane, coconut, banan and other orchard crops irrigated with drip systems. Shashidhara *et.al,* (2007) reporte similar results from the study conducted to identify the benefits and constraint experienced by the areca nut and banana growers in Karnataka.

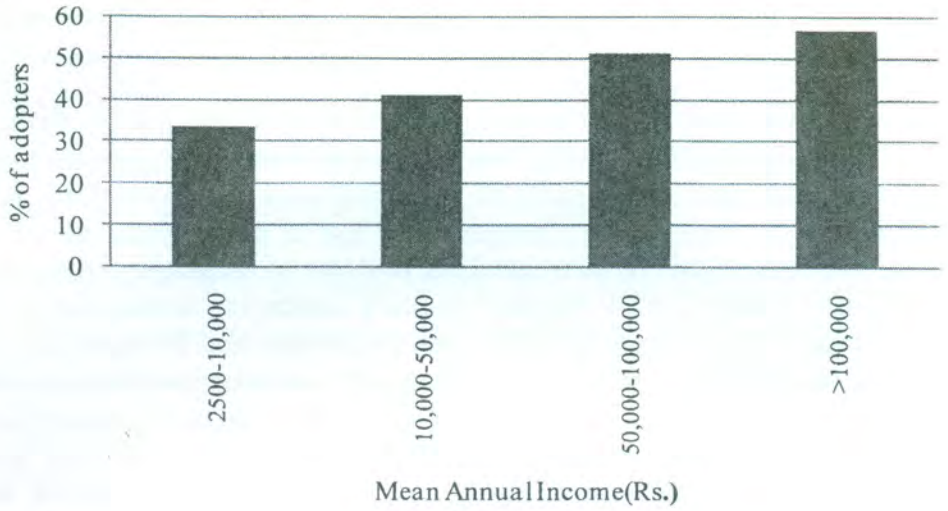
Figure 4.7: Adoption of Drip Irrigation with Extent of Farmland

Source: HARTI Survey Data,2011

Capital investment on drip irrigation systems

Amount of money invested by the farmers to get the drip system has an influence o the rate of adoption. When farmers had spent major portion of the cost of the system they had continued using it irrespective of the practical issues such as emitte clogging, interference with weeding etc. However farmers who had made large financial investments had certain other attributes such as belonging to higher incom category (Figure 4.8), larger extents of farms and higher level of education that wa more favourable for the adoption process. In Maharashtra and Gujarat also the larges proportion of micro irrigation adopters belong to the very rich group of farmer (Namara *et.al*,2007).

Figure 4.8: Distribution of Income among the Drip Irrigation Adopters

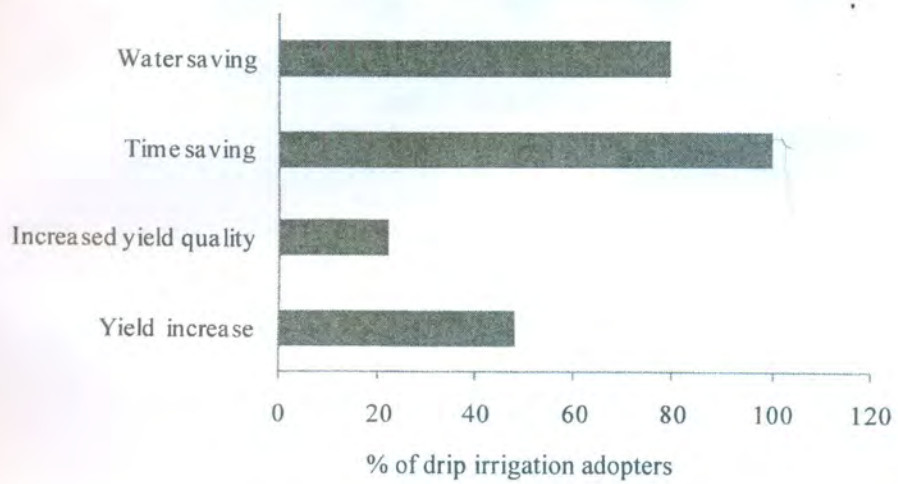


Source: HARTI Survey Data,2011

4.5 Benefits and Constraints in Using Drip Irrigation

As shown in figure 4.9, highest percentage of farmers had perceived time saving due to adoption of drip irrigation. In addition they had benefited by water saving, increased yield and its quality.

Figure 4.9: Benefits of Drip Irrigation

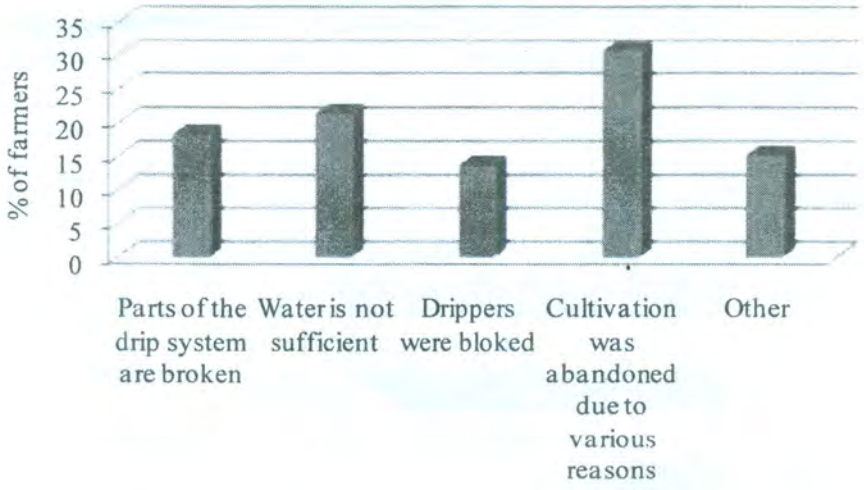


*Multiple responses possible
Source: HARTI Survey Data,2011

The physical constraint experienced by more than 70% of the farmers in using drip irrigation systems is clogging of the emitters. Main reason for about 14 per cent of the farmers who moved away from drip irrigation was frequent blockage of drippers (Figure 4.10). This should be considered as a common constraint experienced by the

farmers in using drip irrigation technology. Emitter clogging can happen due physical, biological or chemical contaminants. To minimize the clogging due physical contaminants such as clay particles and plant debris, it is important to cl the filter regularly. To prevent emitter clogging due to other contaminants, chemi treatment using acids was practiced by the farmers. However the acid treatment led frequent replacement of emitters. Majority of the small scale farmers did not ha overhead storage tanks in their fields. Therefore they had to pump water directly the drip system. Because of this farmers faced the problem of breakage of drip tu due to high pressure of water (24%). Another common constraint experienced by farmers was breakage of drip lines at weeding, land preparation and damages done small animals such as rats and squirrels. Once the system was removed from the fi during land preparation they found it difficult to put it on the field again successful However it was understood from the key informant discussions that the field le officers did not have sufficient technical knowledge on system installation a maintenance.

Figure 4.10: Reasons for Discontinuing Drip Irrigation



Source: HARTI Survey Data,2011

Box Story: 1

Mr.Weerasinghe is a retired police officer who is fully engaged in cultivation of vegetables. He lives in a remote village in Embilipitiya. He has received a drip system from the Southern Development Authority in 2003. He has used the system to irrigate the crops for nearly 8 years and the system is no more usable.

Therefore he is irrigating his crops using a rubber horse. He is not aware of facility of purchasing micro irrigation systems from private dealers. This highlights the importance of strengthening awareness programmes on micro irrigation among the rural farmers. It is understood from field visits that capital cost required to install drip irrigation is relatively high. Because of this reason, considerable percentage of farmers have expressed that they are unable to adopt this technology for low value crops. If drip system is made available with low cost, area under drip irrigation can be increased at a faster rate. Some companies have come out with low cost drip irrigation systems which can be adopted even by the farmers who own less than one acre of land.

CHAPTER FIVE

Conclusions and Recommendations

5.1 Conclusions

1. Adoption of drip irrigation has not achieved much success though government and many other institutions have made considerable efforts to promote drip irrigation. Though subsidies are necessary to adopt drip irrigation which requires high capital investment, majority of the smallholder beneficiaries have abandoned the technology.
2. Extent under cultivation, access to groundwater and money invested by the farmer to get the drip system were found to be significantly affecting the adoption decision of drip irrigation technology.
3. Requirement of regular maintenance, non availability of spare parts at village level were found to be the major constraints for farmers in continuing drip irrigation.
4. Most perceived benefit by adopting drip irrigation was time saving. The adopters have also benefited by water saving and yield increment in terms of quantity and quality.

5.2 Recommendations

1. Extent of farm plot
   In future projects aiming to increase the area under drip irrigation, grater emphasis should be paid to farmers who cultivate perennial crops in larger farm lands of more than 2 acres.

2. Reliable water source
   Access to a reliable water source should be considered as a mandatory factor to get drip irrigation systems.

3. Training the farmers and field level officers
   It is important to conduct training sessions on regular basis at village level until field level officers and farmers achieve sufficient level of competency in system installation and maintenance.

4. Establishment of Drip Cluster farmers
   It is recommended selecting beneficiary farmers as clusters for drip irrigation projects. It will be easier then to deliver required after sales services. Further successful farms can be used as model farms to encourage and motivate the farmers to adopt drip irrigation systems in other areas

5. Availability of spare parts and systems locally.
   Availability of low cost spare parts at village level should be ensured.

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Annex 1: Private Firms Engaged in Distribution and Marketing of Mi Irrigation Systems

Name of the company	Present Address
C.I.C.Fertilizer Pvt(Ltd)	No.205, D.R. Wijewardane Mw, Colombo
Piyadasa & Sons Pvt(Ltd)	No.34, Quarry Road, Colombo 12.
Seva Lanka Foundation	High Level Road, Nugegoda
Jinasena Pvt (Ltd)	No.176/1,Thibirigasyaya Road, Colombo
Hayleys Agro Products(Ltd)	No.25,Foster Lane, Colombo 10
Citi Gardens pvt(Ltd)	284A,Hill Street, Nedimala, Dehiwala

Persons Interviewed

Name of the company	Name of the Informant
Piyadasa & Sons Pvt(Ltd)	Mr.Priyantha Dassanayake
Seva Lanka Foundation	Mr.Sirimewan
Jinasena Pvt (Ltd)	Mr.Ajith de Silva
Hayleys Agro Products(Ltd)	Mr.Prasanna
Citi Gardens pvt(Ltd)	Mr.Hilru M.Siddeeque

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