

**EVALUATION, IMPROVEMENT AND ADOPTATION OF  
LOW LIFT PUMPS FOR MARGINAL FARMERS**

**ARAVIND M. RATHOD**

**DEPARTMENT OF AGRICULTURAL ENGINEERING  
UNIVERSITY OF AGRICULTURAL SCIENCES  
BANGALORE**

**1999**

# **EVALUATION, IMPROVEMENT AND ADOPTATION OF LOW LIFT PUMPS FOR MARGINAL FARMERS**

**ARAVIND M. RATHOD**

Thesis submitted to the  
**University of Agricultural Sciences, Bangalore**  
in partial fulfilment of the requirements  
for the award of the Degree of

**Master of Science (AGRICULTURE)**

in

**SOIL AND CONSERVATION ENGINEERING**

BANGALORE

AUGUST 1995

EVALUATION, IMPROVEMENT AND ADOPTION OF  
LOW LIFT PUMPS FOR MARGINAL FARMERS

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ  
ಪ್ರಾಥಮಿಕ ವಿಜ್ಞಾನ ಶಾಖೆ  
ಸಿ. ಕೆ. ವಿ. ಕೆ., ಬೆಂಗಳೂರು-65  
27 SEP 1999  
ID: 5313  
ಕನುಷ್ಠ ಸಂ.....  
ವ. ಸಂ.....

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ  
ಪ್ರಾಥಮಿಕ ವಿಜ್ಞಾನ ಶಾಖೆ  
ಸಿ. ಕೆ. ವಿ. ಕೆ., ಬೆಂಗಳೂರು-65  
ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ  
ಪ್ರಾಥಮಿಕ ವಿಜ್ಞಾನ ಶಾಖೆ  
ಸಿ. ಕೆ. ವಿ. ಕೆ., ಬೆಂಗಳೂರು-65


*Affectionately dedicated to my  
beloved parents, Brothers, Sisters,  
Brother-in-laws, wife & children.*

DEPARTMENT OF AGRICULTURAL ENGINEERING  
UNIVERSITY OF AGRICULTURAL SCIENCES  
BANGALORE.

CERTIFICATE.


*This is to certify that the thesis entitled "EVALUATION, IMPROVEMENT AND ADOPTATION OF LOW LIFT PUMPS FOR MARGINAL FARMERS " Submitted by Mr.Aravind.M.Rathod for degree of MASTER OF SCIENCE (AGRICULTURE) in SOIL AND WATER CONSERVATION ENGINEERING to the University of Agricultural Sciences, Bangalore, is a record of research work done by him during the period of his study in this University under my guidance and supervision and the thesis has not previously formed the basis for the award of any other degree, diploma, associate ship, fellowship or other similar titles.*

Bangalore.  
September, 1999

  
( D.GANESH MURTHY )  
Associate Professor (Retd)  
Department of Agricultural Engineering

Approved By :

Chairman :

  
\_\_\_\_\_  
( D.GANESH MURTHY )

Member :

1.

  
\_\_\_\_\_  
( S.JAVARE GOWDA )

2.

  
\_\_\_\_\_  
( R.RAMIAH )

3.

\_\_\_\_\_  
( SHRIDHAR )

## ACKNOWLEDGEMENT.

*I wish to express my unfledged appreciation, deep sense of gratitude and devotion to Mr.D.Ganesh Murthy, Associate Professor (Rtd), of Agricultural Engineering, University of Agricultural Sciences, Bangalore for being the chairman of my Advisory Committee for his valuable suggestion, painstaking excellent guidance, continued calm endurance, inspiring encouragements, constructive criticisms and constant advice during the course of my studies and compilation of thesis.*

*Sincere thanks to members of my Advisory Committee Dr.S.Javare Gowda, Professor and Head Department of Agricultural Engineering, Dr.R.Ramiah, Emeratus Scientist, University of Agricultural Sciences, Bangalore and Dr.Shridhar, Associate professor, Department of Statistics, University of Agricultural Sciences, Bangalore for their suggestions and constructive criticisms while conducting research and in writing up to this thesis.*

*Needless to state that, I am equally grateful to Dr.M.Chowde Gowda, Agricultural Engineer, Department of Agricultural Engineering and Mr.Ramachandra, Associate Professor, Department of Agricultural Sciences, Bangalore for their constant source of inspiration and support during the course of the study.*

*My everlasting thanks are due to Mr.S.B.Batagurki, Associate Professor, Department of Agricultural Engineering, Mr.B.K.Anandram, Assistant Professor, Department of Agriculture Engineering and the staff members and friends in the Department of Agriculture Engineering, University of Agricultural Sciences, Bangalore, for their inspiration and kind help throughout the course of the study.*

*I am very much grateful and indebted to my parents, sisters, brothers and wife for their induvance, abudant love and affection, moral encouragement, constant support, and general assistance showed on me during my student career.*

*I am very much grateful to my frlends Mr.Pratapchand Rathod Mr.A.R.Radhakrishna, Mr.Prasannakumar, Mr.Nanjundaswamy, Mr.Rangnath, Mr.Dhanjaya, for their worth while help, moral encouragement, assistance and acted as my two hands during all minutes of investigation, without which it would not have been possible to complete this work.*

*I remain grateful to all those who are responsible for completing this study. Any omission in this brief acknowledgement does not mean lack of gratitude.*

*Last but not the least, to be thanked sincerely will be my friend K.Shiva Kumar for typing neatly my thesis at the earliest.*

  
( ARAVIND.M.RATHOD )

# CONTENTS

CHAPTER	TITLE	PAGE
I	INTRODUCTION	1
II	REVIEW OF LITERATURE	7
III	MATERIALS AND METHODS	16
IV	EXPERIMENTAL RESULTS	25
V	DISCUSSION	51
VI	SUMMARY	68
VII	REFERENCES	73
VIII	APPENDICES	

# LIST OF TABLES

TABLES	TITLE	PAGE
1.	Monthly mean weather over a period from 1975 to 1995 at experimental site.	17
2.	Agricultural land holdings in Dakshina Kannada District.	27
3.	Socio-Economic characters of farmers in Dakshina Kannada District.	28
4.	Distribution of Animals (Nos) in Dakshina Kannada District.	30
5.	Distribution of Bullock drawn implements (Nos) in Dakshina Kannada District.	31
6.	Distribution of Farm machineries (Nos) in Dakshina Kannada District.	33
7.	Distribution of low lift water lifting devices (Nos) in Dakshina Kannada District.	34
8.	Discharge of two pedal operated pumps	36
9.	Operation of duration	37
10.	Constraints of pedal operated pumps	39
11.	Cost of modification (Rs.)	41
12.	Operating cost of pedal operated pumps	42
13.	Irrigation cost per hectras	44
14.	Estimated area to be irrigated 1 cm depth per day (8 hrs) in hectares	45
15.	Number of strokes	47
16.	Efficiency of pedal operated pumps	48
17.	Portability of pedal operated pumps.	50

# LIST OF FIGURES

FIGURE	TITLE	BETWEEN PAGES
1.	Monthly mean rainfall	17 - 18
2.	Monthly mean temperature (Max and Min)	17 - 18
3.	Monthly mean evaporation	17 - 18
4.	Monthly mean relative humidity	17 - 18
5.	Layout plan of an experiment	17 - 18
6.	Existing pedal operated pump	19 - 20
7.	Modified pedal operated pump	20 - 21
8.	Performance of pedal operated pumps in relation to suction head and discharge	36 - 37
9.	Relationship of suction head and maximum time of operation	37 - 38
10.	Relationship of irrigation cost and suction head	44 - 45
11.	Relation between suction head and estimated area to be irrigated	45 - 46
12.	Relation between suction head and number of strokes	47 - 48
13.	Relationship of suction head and efficiency	48 - 49
14.	Relationship of number of strokes per minute and efficiency	48 - 49
15.	Relationship of number of strokes per minute and discharge	48 - 49

## LIST OF PLATES

PLATES	TITLE	BETWEEN PAGES
1.	Existing pedal operated low lift pump	19 - 20
2.	Existing pedal operated pump in operation	19 - 20
3.	Modified pedal operated low lift pump	20 - 21
4.	Modified pedal operated low lift in operation	20 - 21

# INTRODUCTION

# CHAPTER - I

## INTRODUCTION

Irrigation is an age old art and as old as civilization. It defines the artificial application of water to the soil for the purpose of crop production. Thus, applied is just to supplement the water available from rainfall and the depleted level of soil moisture. The increasing population necessities constant and continuous effort to modernise the various types of irrigation. Out of 328 million hectares of total geographical area, 139 million hectare fall under cultivable area, 65.75 million hectare fall under forest, 100.45 million hectare is left as follow and 79.20 million hectare is under non-agricultural use and others.

The cultivable area requires water in varying degree depending upon the type of crop cultivated, soil type, topography, ground water potential, rainfall duration and other climatic conditions. The water that is needed for crop production is received mainly from atmospheric precipitation. The average annual rainfall of our country is around 119.4 cm which when collected over the entire land area can yield a volume of 400 million hectare meter out of

400 million hectare meter of precipitation, 215 million hectare meter infiltrates into the soil, 70 million hectare meter is lost to atmosphere and 115 million hectare meter flows as surface run off. The water that infiltrates into the soil is divided into two parts, the one being retained as soil moisture which is available for crop growth and the other as deep percolation which reaches the ground, the precolated water is extracted by constructing open or tube wells using appropriate water lifting devices. It is estimated that about 115 million hectares of land will be brought under irrigation both for major and minor irrigation sources of which about 75 million hectares will be irrigated by surface water and the remaining 40 million hectare from groundwater in the year 2000 AD. This works out to about 50-52% of the area under rain fed agriculture. Technology is being developed to give one or two protective irrigation by forming farm ponds in dry lands also to increase the productivity from the lands.

For crop cultivation irrigation is done primarily by two ways namely flow irrigation and lift irrigation. Under flow irrigation water will be diverted from canals, river flows, tanks and the lakes. It is adopted in places where the water

source is at high level. Lift irrigation is practiced wherever the land is placed at higher level than water source.

Water conveyed through canals is less expensive than ground water, since the later is to be lifted from lower levels which need some investment and power. But there are certain definite advantages in going for pumping out water from tube wells since they provide steady supply of water for irrigation at optimum times with reference to the stage of growth of the crops, thus maximising the production canal supplies fluctuate and canals remain closed for long time when there is need for water, these circumstances demand more use of suitable water lifting devices in the present day agriculture.

The water lifting devices are indigenous and modern pumps. In the indigenous type, the source of power is either manual or animal power. These devices usually deliver smaller quantity of water when compared to mechanically or electrically driven pumps.

The indigenous type water lifts are mostly employed in areas where the water is used for protective irrigation. In arid and semiarid zones the rainfall will be meager and it may

leave moisture in the soil for about a week duration only. But the runoff from the rainfall can be stored in tanks, lakes and farm ponds wherever such facilities are available and these water can be lifted for irrigation. During dry spells when there is no release of water from the tanks, small open wells situated in command areas can yield water at shallow depths which is mainly the seepage water. Under such situations also water lifts can serve for protective irrigation.

These water lifts are simple in construction, operation and maintenance when compared to modern pumpsets some of the indigenous lifts are as follows :

Swing basket is a basket to which four ropes are attached, two persons are required to operate and optimum lift is 0.9 to 1.2 m. Don is a boat shaped trough closed at one end and open at the other end, one person is required to operate and optimum lift is 0.5 to 1.0m. Archemedian screw consists of a wooden or metal wheel drum with the interior portion is in the form of screw, the drum is placed at an angle less than 30 degree, with its lower end in water. One person is required to operate and optimum lift is 0.5 to 1.2m. Persian wheel consists of a chain and bucket mounted on an open

spoked drum and provided with a suitable mechanism. One pair of bullock or one pair of he-buffaloes or a camel can lift 5.0 to 10.0m. Water wheel consists of small peddle mounted radially on a horizontal shaft. The wheel is fixed on a close fitting concave through a pair of bullocks and a person is required to operate and optimum lift is 1.0 to 2.0m.

Chain pump consists of an endless chain which is provided with leather discs or washer spaced at an interval of about 25cm. One pair of bullocks is required to operate and optimum lift is 3.0 to 6.0m. Rope and bucket lift with self emptying bucket consists of sheet metal or leather having a capacity of 100 to 150 liters, on bottom of the bucket is fixed a leather tube or spot, one pair of bullock and a man is required to operate and optimum lift is 4.0 to 6.0m. Circular two bucket lift uses two buckets which are alternatively raised emptied, lowered and filled one pair of bullock and one man is required to operate, optimum lift is 4.0 to 5.0m. Counter poise lift consists of a long wooden pole which is provided as lever on a post. A dead weight is fixed to the shorter end of the pole which serve as counter weight to operate the lift. One man is required to operate and optimum lift is 1.2 to 4.0m. Rope and bucket lift consists of a water or

bag having a capacity of about 150 to 200 liters and is made of leather galvanized iron sheet. One pair of bullock and three persons are required to operate and optimum lift is 10.0 to 30.0mts.

In many parts of the country irrigation development is limited by the cost of conventional energy sources for water lifting, this is because the shortage of electricity, the high cost of energy. In view of the likely future costs and reduced availability of diesel fuel, there is a possibility of introducing pedal operated low lift pump. Survey was also conducted to know the status of water lifting devices available in Dakshina Kannada district and hand pumps are widely adopted in case of marginal and small farmers.

With the following objectives the experiment on "Evaluation, improvement and adoption of low lift pumps for marginal farmers" has been conducted.

1. To study the performance of pedal operated low lift pumps for different suction heads.
2. To study the performance of pedal operated low lift pumps for different duration.
3. Constraints during the operation and suitable mechanism for operation in the field.
4. To study economics of operation.
5. To compare efficiency with improved low lift pump.

# REVIEW OF LITERATURE

## CHAPTER II

### REVIEW OF LITERATURE

The water lifting devices are of indigenous lifts and modern pumps. In the indigenous type, the source of power is either manual or animal power, these devices usually deliver smaller quantity of water when compared to mechanically or electrically driven pumps.

The indigenous type water lifts are mostly employed in area where the water is used for protective irrigation. In arid and semi arid zones the rainfall will be meagre and it may leave moisture in the soil for about a week duration only. But run off from rainfall can be stored in tanks, lakes and farm ponds wherever such facilities are available and these water can be lifted for irrigation.

During dry spells when there is no release of water from the tanks, small open wells situated in command areas can yield water at shallow depths which is mainly the seepage water. Under such situations water lifts can serve for protective irrigation.

In many parts of the country irrigation development is limited by the cost of conventional energy sources for water lifting. This is because the shortage of electricity, the cost of energy. In view of the likely future costs and reduced availability of diesel fuel, there is a necessity of introducing pedal operated pumps.

A survey was conducted in Dakshina Kannada District of Karnataka State to know the status of indigenous water lifting devices. Low lift water lifting devices found are only low lift hand pump as these are used for irrigation and drinking purpose. Low lift hand pumps are found 9 numbers in case of marginal farmers, 18 numbers in case of small farmers and 12 numbers are in case of big farmers.

Following are some of the studies conducted on low head water lifting devices. A brief review of literature relating to various aspects of the present study has been made and presented with following topics :

1. Performance of low lift pumps for different suction heads
2. Performance of low lift pumps for duration.
3. Constraints during the operation of low lift pumps.

4. Economics of operation of low lift pumps.

5. Efficiency of low lift pumps.

### **2.1. Performance of low lift pumps for different suction heads :**

R.J.Yadav (1979) has conducted a study on Don pump and reported that the "Don" is the main manually operated water lifting device in West Bengal to lift water from ponds, tanks and reservoirs from a maximum suction lift of 2.0m. During rainy season the suction lift generally exceeds more than 2.0m there 3-4 Dons are operated in series. To minimise cost of irrigation and loss of man hours a reciprocating manually operated lifting device is developed for small farmers.

Mohammad Abdul Baqui (1980) has reported that hand operated diaphragm pump has an optimum suction lift of 2.74m with a discharge of about 17,040lits/hr and 1.54 ha-cm of irrigation can be done per day.

Md.Shirazul Islam et al., (1981) has reported that with the increase of suction head, the discharge decreases. The Diaphragm pump will discharge 52lits/min for suction head of 3.5m, At suction head ranging from 3.66m to 5.50m,

the double acting gardening pump will discharge 52 to 40lits/min. The Rower pump has an output ranging from 40 to 32lits/min at suction heads between 5.50 to 7.50mts.

Choudhury Md.Amiruddin Khan (1983) has reported that the manually operated Wheel Pump of five different sizes 8.9, 9.3, 10.8, 12.0 and 13.0 cm were tested at different suction lifts of up to 5.48m. The discharge capacities of the smallest and the largest sizes ranged from 21.1 to 74.7 and 44.0 to 137.4lits/min respectively, at suction lifts of 1.29 to 5.48m. The capacities of the remaining sizes were in between these two ranges. The power required for operation were within the range of power that can be developed by a healthy man.

Shivappan et al., (1984) has reported that swing bucket will lift up to 0.90 to 1.20m with a discharge of 14000 to 19000lits/hr. Don will lift up to 0.50 to 1.00 m with a discharge of 9000 to 13000lits/hr. Archemedian screw will lift up to 0.50 to 1.00m with a discharge of 14000 to 19000 lits/hr. Water Wheel will lift up to 1.00 to 2.00m with a discharge of 40000 to 60000lits/hr. Persian wheel will lift up to 5.00m to 10.00m with a discharge of 14000 to 18000 lits/hr. Chain pump will lift up to 3.00 to 6.00m with a

discharge of 15000 to 20000 lits/hr. Self emptying type rope and bucket lift will lift up to 4.00 to 6.00mts with a discharge of 10000 to 15000lits/hr. Circular two bucket lift will lift up to 4.00 to 5.00m with a discharge of 12000 to 14000lits/hr. Counterpoise bucket lift will lift up to 1.20 to 4.00m with a discharge of 8000 to 11000lits/hr. Rope and bucket lift will lift upto 10.00 to 30.00 m with a discharge of 6000 to 10000lits/hr.

G.Barnes (1987) has reported that the twin treadle pump will discharge 2-3 lits/sec for a suction lift of 2-4 m. It will lift to a maximum suction head of 6-7 m.

Dr.V.K.Dixit (1990) has reported that the twin cylinder foot operated pump can be used wherever the depth of static water level is 5m below ground level with this pump 0.5 hac of land can be easily irrigated, pump requires less efforts and deliver up to 150 lits/min.

A.M.Azizul Huq et al., (1992) has reported that the hand pump delivers 0.56 - 0.69 lits/sec at 1-8 m head while the Tara pump discharges same quantity of water at 16 m head. The Treadle pump has highest discharge but the range of operating head is lowest.

Md.Muzzammil Haq et al., (1994) has conducted studies on three manual operated pumps namely Diaphragm pump, Twin treadle pump and Power pump. The average discharges were 4.03lits/sec for diaphragm pump, 1.4 lits/sec for Rower pump and 1.5 lits/sec for treadle pump at 1.25, 1.60 and 1.76 m operating heads.

## **2.2. Performance of low lift pumps for duration :**

P.K.Moitra et al., (1978) has reported that increase in suction head or increase in stroke length, the maximum time of operation decreases.

R.J.Yadav (1979) has reported that the Don Pump can be operated continuously for two hours and rest for fifteen minute, after every two hours of operation.

Mohammed Abdul Baqui (1981) has reported that the machine should be such that the operator can operate machine continuously for a considerable period with ease. During operation it was found that the maximum time of operation was more with the Rower pump for a suction head of 7.5m. The Y-Pump is a pedal operated pump the operator could take the advantage of pumping it for a long time with

ease. The single and double actions gardening pumps were easy to operate up to a suction head of 3.5m

Choudhury Md.Amiruddin Khan (1983) has reported, during the operation of wheel pump it was found that a healthy operator can operate the pump for a long time continuously without applying much physical effort. This is due to use of wheel which makes the operation very light. As the flow through suction pipe is continues, the inertia of column of water helps in reducing the total force.

### **2.3. Constraints during the operation of low lift pumps :**

Md.Muzzammil Haq (1994) has conducted a studies on Diaphragm pump, Treadle pump and Rower pump. He has reported that the Diaphragm pump created problem in all research and demonstration site. First the diaphragm of diaphragm pump had to be replaced one to three times in one season. Second by, decaying of wooden sandwich plate shortened durability of other parts like inlet and outlet valves, pin, supporting arm welding frames etc created some problems during the operation. In the treadle and power pumps, only buckets created problems in the field. The repair cost of Diaphragm pump was TK.137,154 and 245 (33.83 TK - 11 US \$) at three different experimental sites. But in

any research sites per season the repair cost of the Treadle or power pumps did not exceed TK 30 (33.83 TK = 1 US \$).

#### **2.4. Economics of operation of low lift pumps :**

Mohammed Abdul Baqui (1980) has conducted studies on comparative cost analysis of Diaphragm pump, Doon and half cusec pump and reported that the capital cost of 1/2 cusec pump is about 10-11 times higher than either Diaphragm pump or Doon. Moreover, there are difficulties in maintaining the engine operated pumps since spare parts are not always available. On the other hand, Diaphragm pumps is very easy and cheap to maintain and operate considering the investment and operational cost and water lifting efficiency, the Diaphragm pump seems to be a very promising substitute as a water lifting equipment.

Md. Shirazul Islam et al., (1981) has reported that the irrigation cost per hectare for Diaphragm pump, treadle pump, rower pump and swing basket are TK 9,582.40, TK 16,145.00, TK 18,979.20 and TK 13,164.50 respectively (33.83 TK = 1 US \$).

15

Md.Muzzammil Haq et al., (1994) has reported that the two Diaphragm pump, eight power pumps and seven treadle pumps are required to irrigate one hectare of rice field. At full cost basis irrigation cost per hectare for rice field were. TK 9,582 for Diaphragm pump, TK 16,145 for Treadle pump and TK 18,979 for power pump (33.83 TK = 1 US \$). The irrigation cost for the Diaphragm pump was cheapest. The rice irrigation by the treadle pump and power pump were expensive. Ignoring labour wages, the irrigation cost for one hectare of rice field were T.K.1,700 for Diaphragm pump, TK 1,063 for Treadle pump and TK 1,842 for Power pump (33.83 TK = 1 US \$).

### 2.5. Efficiency of low lift pump :

Mohammed Abdul Baqui (1980) has reported that the overall performance of Diaphragm pump. The efficiency decreased with the increase of head. Maximum efficiency of about 74% was obtained at a vertical lift of 0.911m and minimum of about 30% at 6.00m satisfactory efficiency 56 to 66 percent can be obtained at a vertical lift ranging from 2.74 to 3.50m.

A.M.Azizul Haq et al., (1992) has reported that the Hand pump and power pump are given for a single head of 7m and both pumps run with almost efficiencies of 60%  $\pm$  5%

# MATERIALS AND METHODS

# CHAPTER III

## MATERIALS AND METHODS

Details of techniques adopted, procedure followed, schedule of operation and materials used during the course of investigation are presented in this chapter under different heads :

### **3.1. Experimental site :**

Experiment was conducted at Gandhi Krishi Vignan Kendra, University of Agricultural Sciences, Bangalore, Gandhi Krishi Vignan Kendra situated at  $77^{\circ} 35'E$  longitude and  $12^{\circ} 58' N$  attitude. The exact location of experimental site was underground tank of size  $2.30 \times 2.30 \times 2.00m$  near Department of Agricultural Engineering.

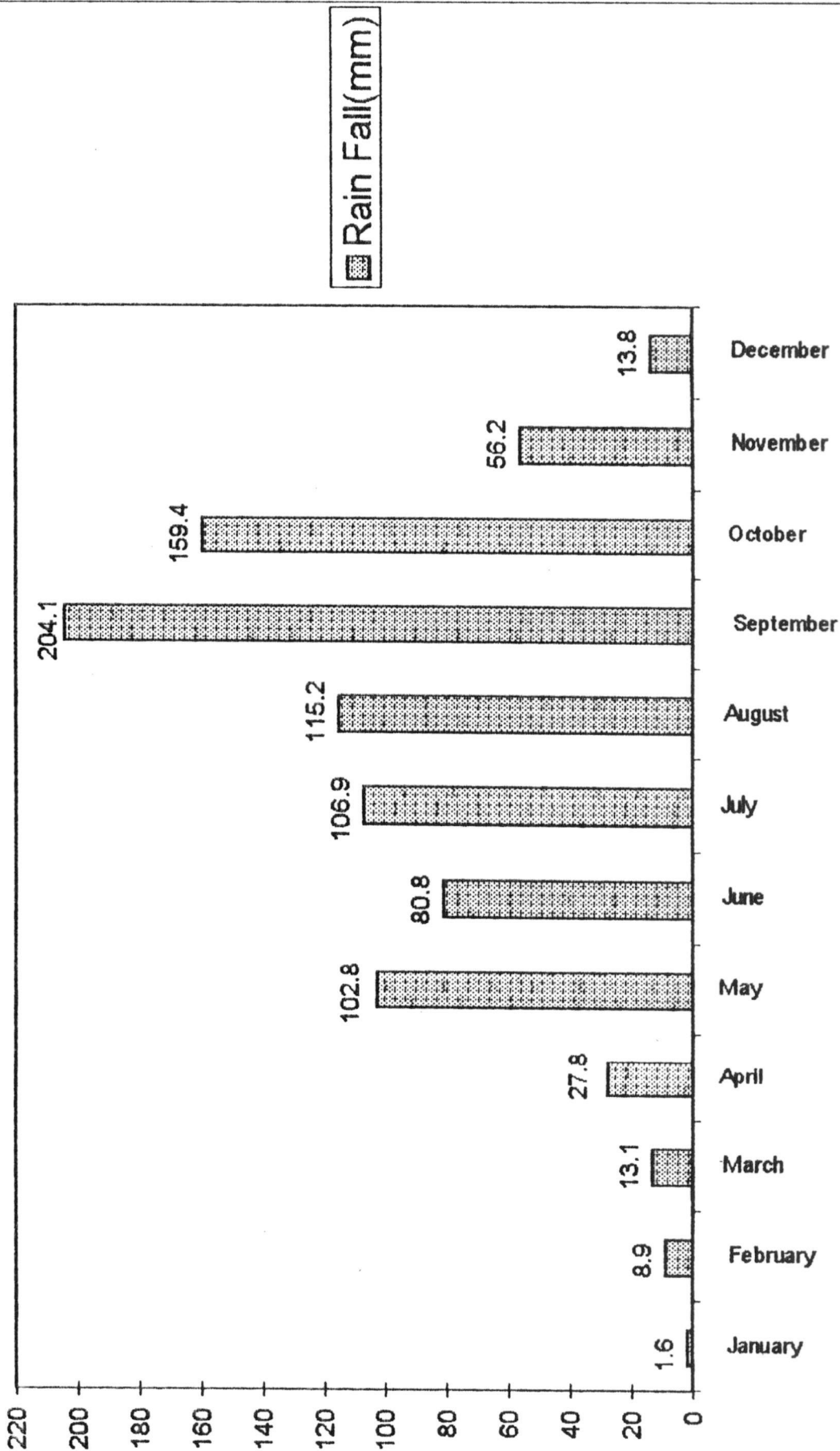
### **3.2. Weather Condition :**

Weather data for a period of the years (1975-95) is presented in the table and graphically shown in fig 3.1,3.2,3.3 and 3.4.

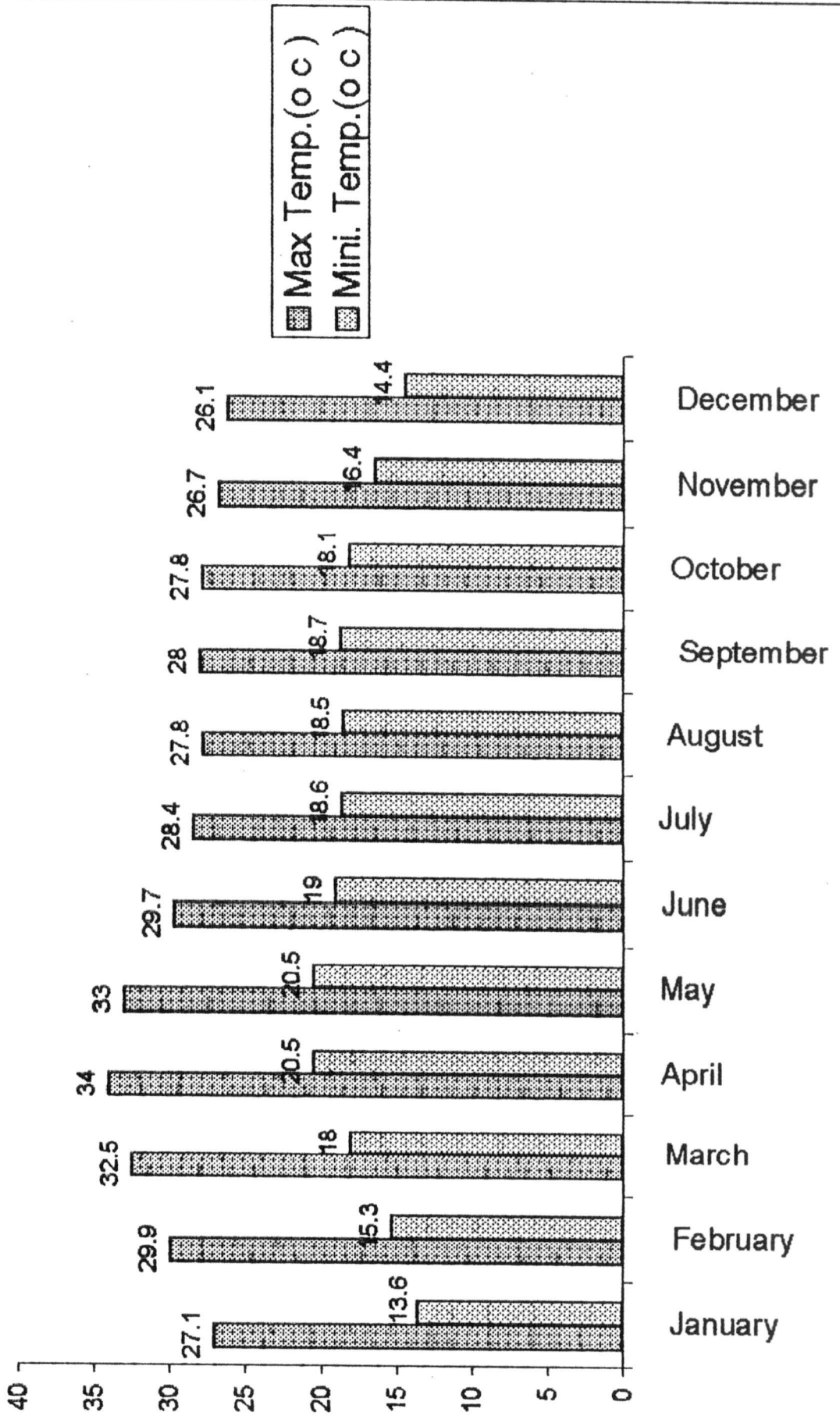
**Table : 3.1. Monthly Mean Weather Over A period from 1975 to 1995 at Experimental Site.**

Month	Rainfall (mm)	Temperature(°C)		Evaporation (mm)	Relative Humidity %
		Max	Min		
January	1.6	27.1	13.6	5.6	62
February	8.9	29.9	15.3	6.6	56
March	13.1	32.5	18.0	7.8	49
April	27.8	34.0	20.5	7.8	54
May	102.8	33.0	20.5	7.4	58
June	80.8	29.7	19.0	6.4	67
July	106.9	28.4	18.6	5.8	72
August	115.2	27.8	18.5	5.5	73
September	204.1	28.0	18.7	5.3	73
October	159.4	27.8	18.1	5.2	70
November	56.2	26.7	16.4	4.7	70
December	13.8	26.1	14.4	4.9	67

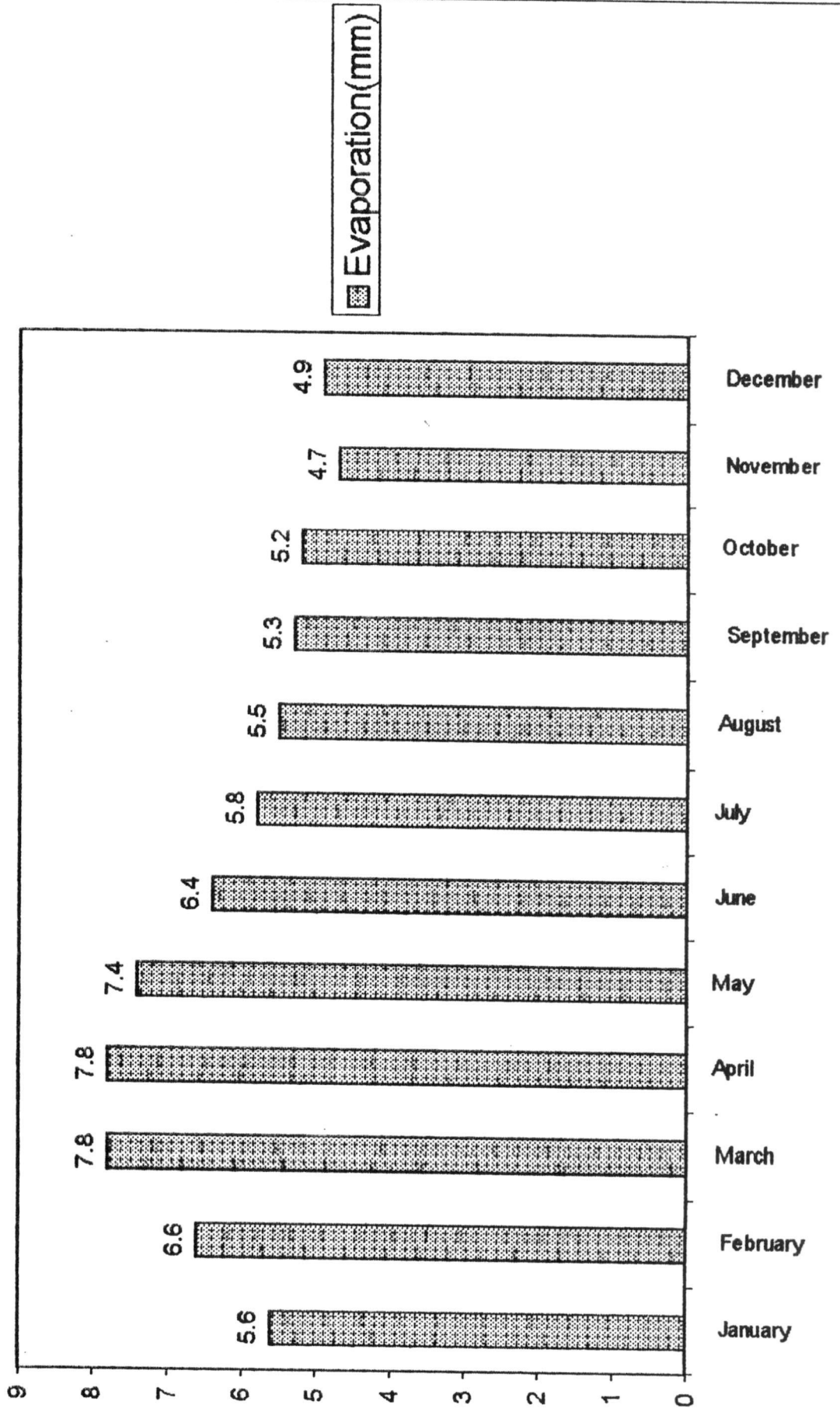
**Fig.3.1. Monthly Mean Rainfall**



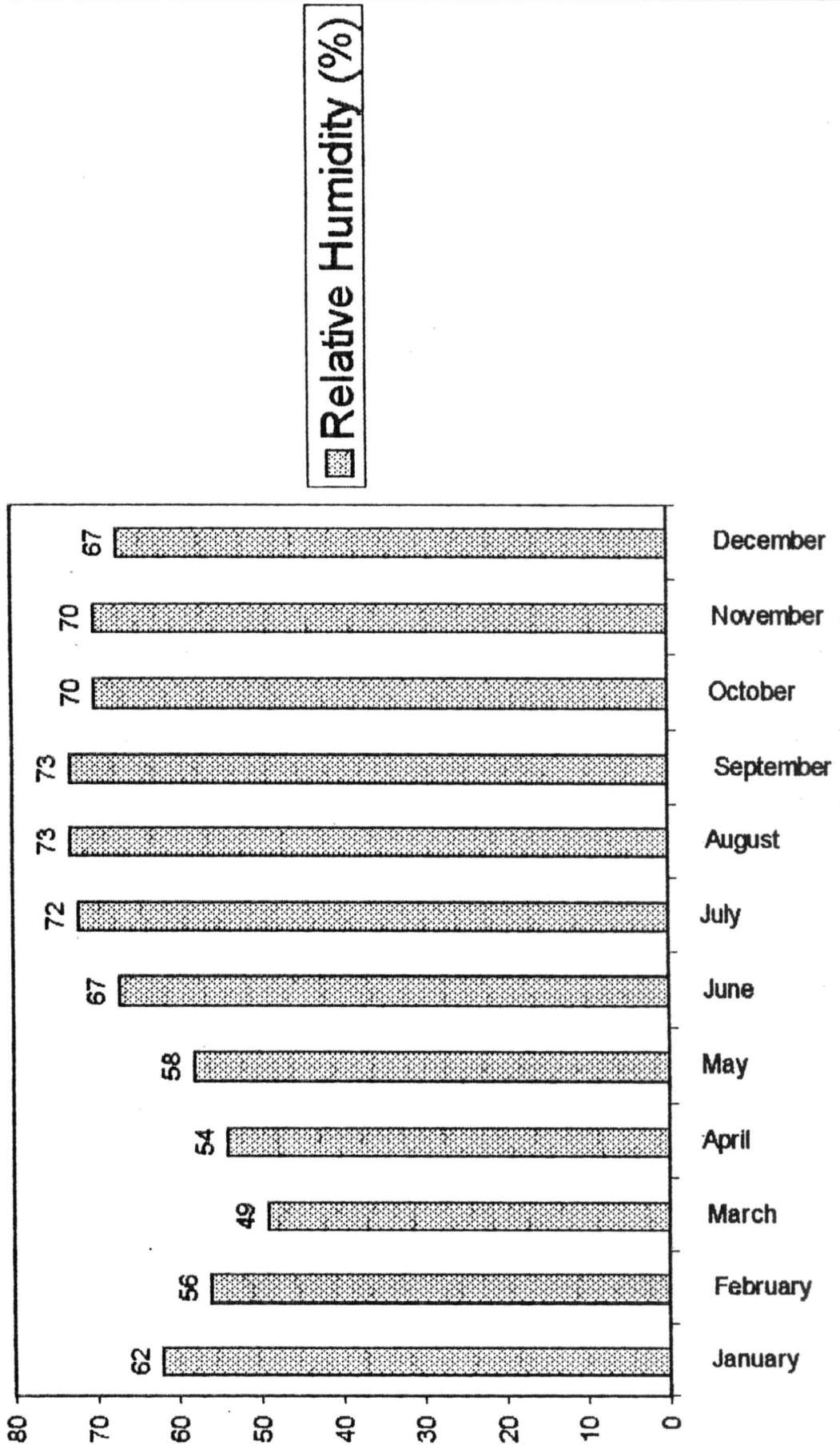
**Fig.3.2.Monthly Mean Temperature (Max & Mini)**



**Fig.3.3.Monthly Mean Evaporation**



**Fig3.4.Monthly Mean Relative Humidity**



1. Performance of Existing pedal operated  
Low lift pump

(For suction heads 0.25, 0.50, 0.75, 1.00, 1.25  
1.50 and 1.75m )

2. Performance of Modified pedal operated  
Low lift pump

(For suction heads 0.25, 0.50, 0.75, 1.00, 1.25  
1.50 and 1.75m )

Fig.3.5 LAYOUT PLAN OF AN EXPERIMENT

### **3.3. Experimental Details :**

One underground water tank of size 2.30 x 2.30 x 2.00m was selected for conducting an experiment. Pedal operated low lift pump and modified pedal operated low lift pumps were evaluated for different suction heads. The experiment was laid out in split plot design. For the pump study following treatments were selected.

#### **Main treatments :**

##### **Two main treatments are :**

1. Existing pedal operated low lift pump
2. Modified pedal operated low lift pump

#### **Sub treatments :**

Seven sub treatments are 0.25, 0.50, 0.75 1.00, 1.25, 1.50 and 1.75 m suction heads for two pedal operated low lift pumps.

#### **3.3.1. Existing pedal operated low lift pump :**

Pedal operated low lift pump consisting of following parts (shown in fig 3.5).

**i) Barrels and junction box :**

Barrels are made of mild steel, to cover plunger and circular in shape of size 120mm dia and height 178mm. Junction Box is a box to accommodate barrels

**ii) Stand :**

Stand is made of mild steel bar, this will reduce friction to the minimum and increases in lift of pump. Length of stand is 500mm, two bars are used for stand. The spacing between two bars is 160mm.

**iii) Pedals :**

Pedals are made of mild steel of length around 600mm. Function of pedals are to operate plungers in upward and downward direction.

**iv) Pedal equalizer and pedal pins :**

Pedal equalizer consists of sleeve, equalizer bar, drop bars and pedal pins. Pedals are parallel to the stand.

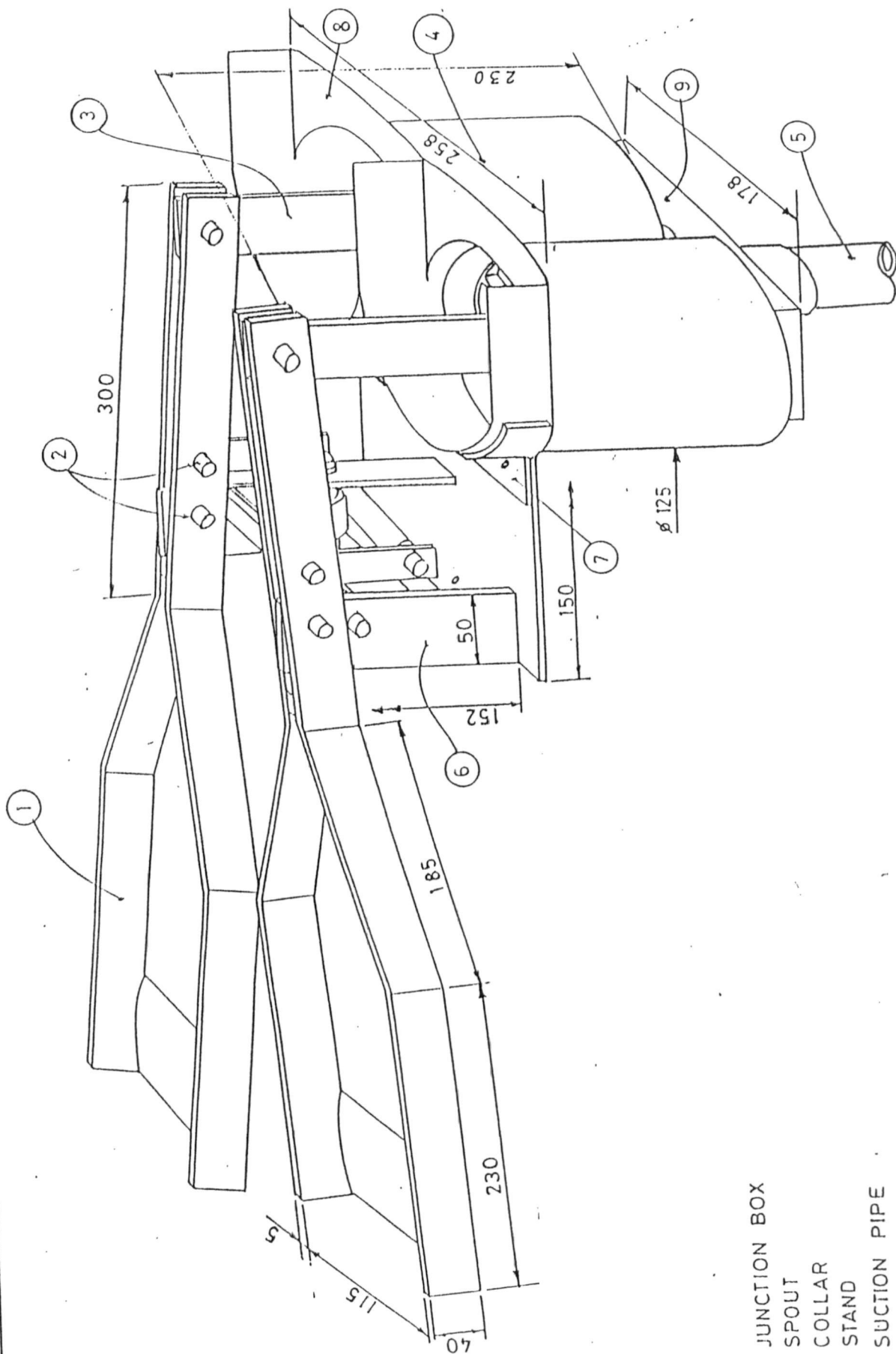


FIG:3.5 EXISTING PEDAL OPERATED PUMP.

- 9. JUNCTION BOX
- 8. SPOUT
- 7. COLLAR
- 6. STAND
- 5. SUCTION PIPE
- 4. BARRELS
- 3. PLUNGERS
- 2. PEDALS PINS
- 1. PEDALS



1. Existing pedal operated low lift pump.



2. Existing pedal operated pump in operation.

**v) Plunger rods :**

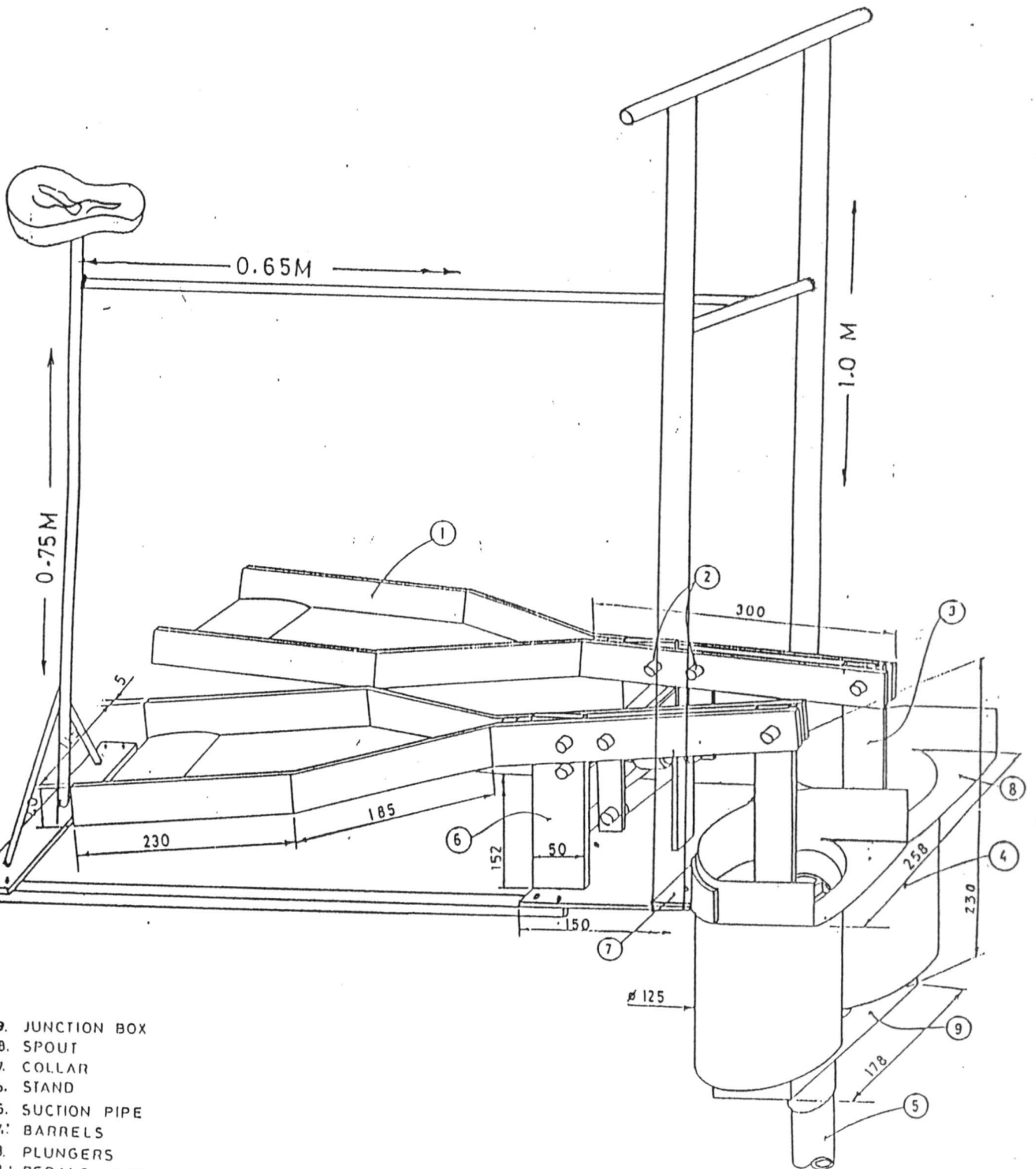
Plunger rods consists of circular plunger plate of 115 mm dia and plunger ring. The function of plunger rod is to suok the water by creating vacuum.

**vi) Valves :**

Valves are of Poly vinyl chloride or rubber to have better gripping between plunger and cylinder.

**3.3.2. Modified Pedal operated low lift pump (shown in fig 3.6) :**

For existing pedal operated low lift pump, the modification incorporated are the seating arrangement and a handle. To operate pump longer time with operators comfort. A handle was provided near the junction box by using a mild steel flat of size 25 x 5mm at a height of 1.00m. A Galvanised iron pipe of dia 12mm is used to provide handle and welded to the mild steel flat at a height of 1.00m, seating arrangement was made behind the pedals, two angle iron of size 25 x 25 x 3mm are used to house a seating arrangement on mild steel plate of size 180 x 180 x 5mm welding was done on mild steel angle irons to mild steel plate. A galvanised iron pipe of size 12mm dia was used to



- 9. JUNCTION BOX
- 8. SPOUT
- 7. COLLAR
- 6. STAND
- 5. SUCTION PIPE
- 4. BARRELS
- 3. PLUNGERS
- 2. PEDALS PINS
- 1. PEDALS

FIG:-3.6 MODIFIED PEDAL OPERATED PUMP.



3. Modified pedal operated low lift pump



4. Modified pedal operated low lift in operation.

house a bicycle seat at a height of 0.75m. The seating arrangement is adjustable, it can be adjusted according to height of a person up to 15cm.

### **3.3.3. Suction heads at 0.25, 0.50, 0.75, 1.00, 1.25, 1.50 and 1.75m :**

Existing pedal operated low lift pump and modified pedal operated low lift pump were evaluated for the suction heads of 0.25, 0.50, 0.75, 1.00, 1.25, 1.50 and 1.75 m.

Each suction heads are replicated for five times.

### **3.4. Observations :**

A survey was conducted in Dakshina Kannad District of Karnataka to know the status of low lift water lifting devices. Different observations were recorded from existing pedal operated low lift pump and modified pedal operated low lift pump.

#### **3.4.1. Survey of low lift water lifting devices :**

For this study, 110 farmers from Dakshina Kannada district of Karnataka are selected and are interviewed regarding farm category, socio economic status, implements and low lift water lifting devices available with each

farmers. The questionnaire was developed (presented in Appendix V). Depending on their land holdings, the farmers are categorised into marginal (less than one hectare), small (more than one hectare and less than two hectares) and big (more than two hectares). They were differentiated into marginal, small and big farmers and are mentioned in numbers and percentage for farm size, socio-economic status, animals available, bullock drawn implements, power operated implements and low lift water lifting devices.

#### **3.4.2. Discharge :**

Existing pedal operated low lift pump and modified pedal operated low lift pump were operated by feet and water was conveyed into a channel of size 30cm top width and 25cm bottom width and a depth of 30cm., a 90° V notch was fixed in a channel and height of water above the crest of 90° V notch was noted by a hook gauge. Discharge was measured from discharge tables (Appendix I).

### **3.4.3. Maximum time of operation :**

Maximum time of operation is the time of operation, an operator can operate the pumps without any trouble this was noted by using stop watch and asking questions to the operator. The questionnaire is presented in the Appendix II.

### **3.4.4. Constraints during the Operation :**

Constraints during the period of studies of existing pedal operated low lift pump and modified pedal operated lift pump are recorded and suitable solutions and replacements are carried out.

### **3.4.5. Economics :**

Operating cost for existing pedal operated low lift pump and modified pedal operated low lift pumps are calculated per hour and is presented in Appendix III. Time required to irrigate for one hectare of land and operating cost per hour was multiplied by time required to irrigate one hectare of land and then cost per hectare was calculated.

### 3.4.6. Efficiency :

Number of strokes per minute was calculated by using stop watch and by counting strokes per minute. Water input per stroke is calculated and discharge through pedal operated low lift pumps are calculated by using  $90^\circ$  V notch. Efficiency is the ratio of output and input, that ratio multiplied by 100. Efficiency calculations are presented in Appendix IV.

# EXPERIMENTAL RESULTS

## CHAPTER IV

### EXPERIMENTAL RESULTS

An experiment on "Evaluation improvement and adoption of low lift pumps for marginal farmers" was conducted during 1997 and results obtained are presented in this chapter under following headings :

- 4.1. Survey of low lift water lifting devices
- 4.2. Performance of pedal operated low lift pumps for different suction heads.
- 4.3. Performance of pedal operated low lift pumps for different durations.
- 4.4. Constraints during the operation and suitable mechanism for pedal operated low lift pumps.
- 4.5. Economics of operation of pedal operated low lift pumps.
- 4.6. Efficiency of existing pedal operated low lift pump and modified pedal operated low lift pump.

#### **4.1. Survey of low lift water lifting devices :**

#### **4.1.1. Agricultural land holdings in Dakshina Kannada District :**

Farm category and land holdings are presented in the table 4.1. Least are big farmers 27 Nos., (24.55%) and highest and highest are small farmers 51 Nos., (46.36%).

#### **4.1.2. Socio-economic characters of farmers in Dakshina Kannada District :**

Socio-economic characters of farmers of Dakshina Kannada district are presented in table 4.2 caste wise least are schedule caste farmers 8 Nos (7.27%) and highest are backward caste 74 Nos., (67.27%). Educationally college educated farmers are least 10 Nos., (9.10%) and highest are primary educated 53 Nos (48.18%). Family size wise farmers with family size more than five members are 59 Nos., (53.64%) and farmers with family size less than five members are 51 Nos., (46.36%). Least number of farmers 4 Nos.(3.64%) are residing in pakka houses, highest number of farmers 95 Nos., (86.36%) farmer are residing in katcha houses. Subsidiary occupation, least number of farmers 2 Nos., (1.82%) are doing service and agriculture highest number 39 Nos (35.45%) are doing other subsidiary occupation.

**Table : 4.1. Agricultural land holdings in  
Dakshina Kannada District**

Farm Category	Holdings	
	Number	Percent
Marginal	32	29.09
Small	51	46.36
Big	27	24.55
Total	110	100.00

**Table : 4.2. Socio – Economic Characters of Farmers in Dakshina Kannada District**

Indicators	Nos.	Percent
(A) Caste :		
Schedule Caste	08	07.27
Schedule tribe	09	08.18
Backward caste	74	67.27
Others	19	17.28
(B) Education :		
Illiterate	23	20.90
Primary	53	48.18
Secondary	24	21.82
College	10	09.10
(C) Family size :		
Upto Five members	51	46.36
More than five members	59	53.64
(D) House type :		
Hut	11	10.00
Katcha	95	86.36
Pakka	04	03.64
(E) Subsidiary Occupation :		
Dairying	28	25.45
Poultry	24	21.82
Business	15	13.64
Service	02	01.82
Sericulture	02	01.82
Others	39	35.45

#### **4.1.3. Distribution of animals in Dakshina Kannada District :**

Distribution of animals in Dakshina Kannada District are presented in the table 4.3. Bullocks are least 38 Nos in case of marginal farmers, highest 54 Nos in case of small farmers, cross breed cows least 04 Nos in case of marginal farmers, highest 10 Nos in case of small farmers. Local cows least 12 Nos in case of marginal farmers and highest 32 Nos in case of small farmers, cattles are least 8 Nos in case of marginal farmers and highest 18 Nos in case of small farmers He-buffaloes least 45 Nos in case of big farmers and highest 78 Nos in case of marginal farmers.

#### **4.1.4. Distribution of bullock drawn implements in Dakshina Kannada District :**

Distribution of bullock drawn implements in Dakshina Kannada District are presented in the table 4.4. Wooden ploughs are least 33 Nos in case of marginal farmers and highest 61 Nos in case of small farmers. Iron ploughs are least 10 Nos in case of marginal farmers and highest 36 Nos in case of small farmers. Levellers are least 8 Nos in case of marginal farmers and highest 23 Nos in case of small farmers. Hoes are 3 Nos each in case of marginal and small

**Table : 4.3. Distribution of animals (Nos) in Dakshina Kannada District**

Animals	Farm Category			Total
	Marginal	Small	Big	
Bullocks	38	54	49	141
Cows :				
a) Cross Breed	04	10	06	20
b) Local	12	32	18	62
Cattles	08	18	12	38
He-Bufferaloes	78	69	45	192
Donkeys	--	--	--	--

**Table : 4.4. Distribution of Bullock drawn implements (Nos) in Dakshina Kannada District**

Implements	Farm Category			Total
	Marginal	Small	Big	
Wooden ploughs	33	61	49	143
Iron ploughs	10	36	29	75
Levellers	08	23	20	51
Hoes	03	03	--	06
Seed drills	--	01	01	02
Bullock drawn puddlers	02	02	04	08

farmers seed drills are 1 No. each in case of small and big farmers. Bullock drawn puddlers are least 2 Nos each in case of marginal and small farmers and highest 4 Nos in case of big farmers.

#### **4.1.5. Distribution of farm machineries in Dakshina Kannada District :**

Distribution of farm machineries in Dakshina Kannada District are presented in the table 4.5. Tractors are only 2 Nos in case of big farmers. Power tillers are least 2 Nos in case of marginal farmers and highest 8 Nos in case of big farmers. Sprayer least in case of 6 Nos in case of marginal farmers and highest 28 Nos in case of small farmers. Dusters are 3 Nos only in case of big farmers oil engines are least 5 Nos in case of marginal farmers and highest 24 Nos in case of small farmers.

#### **4.1.6. Distribution of low lift water lifting devices in Dakshina Kannada District :**

Distribution of low lift water lifting devices are presented in table 4.6. Only hand operated low lift hand pumps are available with farmers. Least 9 Nos in case of marginal farmers and highest 19 Nos in case of small farmers.

**Table : 4.5. Distribution of Farm machinaries  
(Nos) in Dakshina Kannada District**

Machinaries	Farm Category			Total
	Marginal	Small	Big	
Tractors	--	--	02	02
Power tillers	02	04	08	14
Sprayers	06	29	24	59
Dusters	--	--	03	03
Oil Engines	05	24	17	46

**Table : 4.6. Distribution of Low Lift Water Lifting Devices (Nos) in Dakshina Kannada District**

Low Lift Water Lifting Devices	Farm Category			Total
	Marginal	Small	Big	
Swing Bucket	--	--	--	--
Don	--	--	--	--
Archemedian screw	--	--	--	--
Persian Wheel	--	--	--	--
Self emptying type rope & bucket	--	--	--	--
Circular two bucket lift	--	--	--	--
Counterpoise bucket lift	--	--	--	--
Rope & bucket lift	--	--	--	--
Low lift hand pump	09	19	12	40
Pedal operated low lift pump	--	--	--	--

#### **4.2. Performance of pedal operated low lift pumps for different suction heads :**

The different suction heads (m) and corresponding discharge (lits/min) for existing pedal operated low lift pump and modified pedal operated low lift pump are presented in the table 4.7.

In both existing pedal operated low lift pump and modified pedal operated low lift pumps, as suction head increases discharge decreases. In case of pedal operated low lift pump highest discharge of 148.20 lits/min for the suction head of 0.25m and lowest discharge of 88.80 lits/min was observed for the suction head of 1.75m. In case of modified pedal operated low lift pump the highest discharge is 192.00 lits/min was observed for the suction head of 0.25m and lowest discharge of 114.00 lits/min for the suction head of 1.75m.

#### **4.3. Performance of pedal low lift pumps for different duration :**

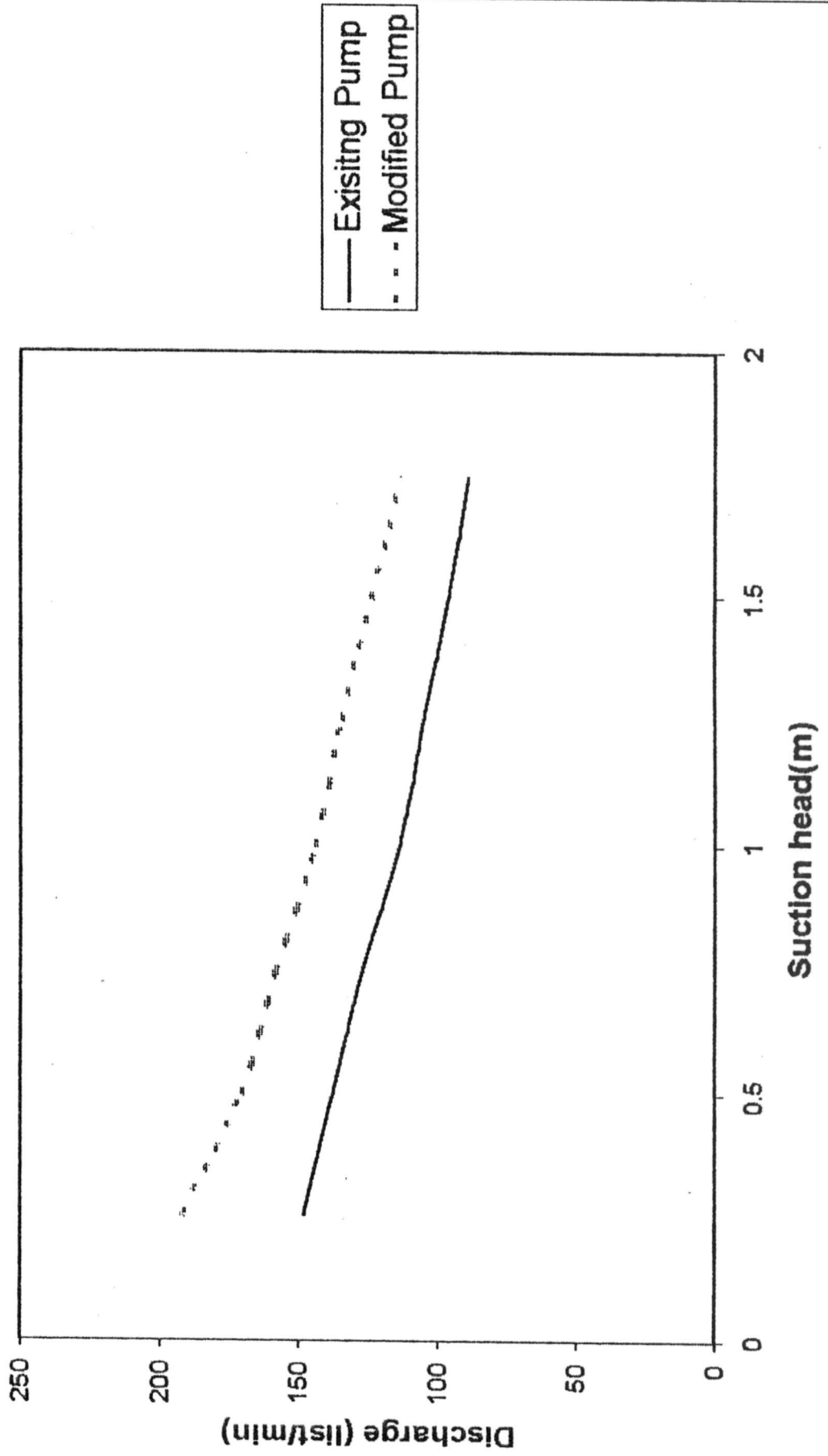
Different suction head (m) and corresponding maximum time of operation (hrs-min) by human labour are for existing

**Table : 4.7. Discharge of two pedal operated pumps.**

Suction heads (m)	Discharge lits/m in		Mean
	Existing pedal Operated pump	Modified pedal Operated pump	
0.25	148.20	192.00	170.10
0.50	138.00	171.00	154.50
0.75	127.00	158.00	142.80
1.00	113.40	144.00	128.70
1.25	105.00	135.00	120.00
1.50	96.00	124.20	110.10
1.75	88.00	114.00	101.40
F-Test	**	**	**
	Main plot	Sub plot	Subplot at Same levels Of main plot
SEM	0.613	1.331	1.882
CD (5%)	2.408	3.869	5.217

\*\* Significant at 5% level

**Fig.4.1.Performance of pedal operated pumps in relation to suction head & discharge**

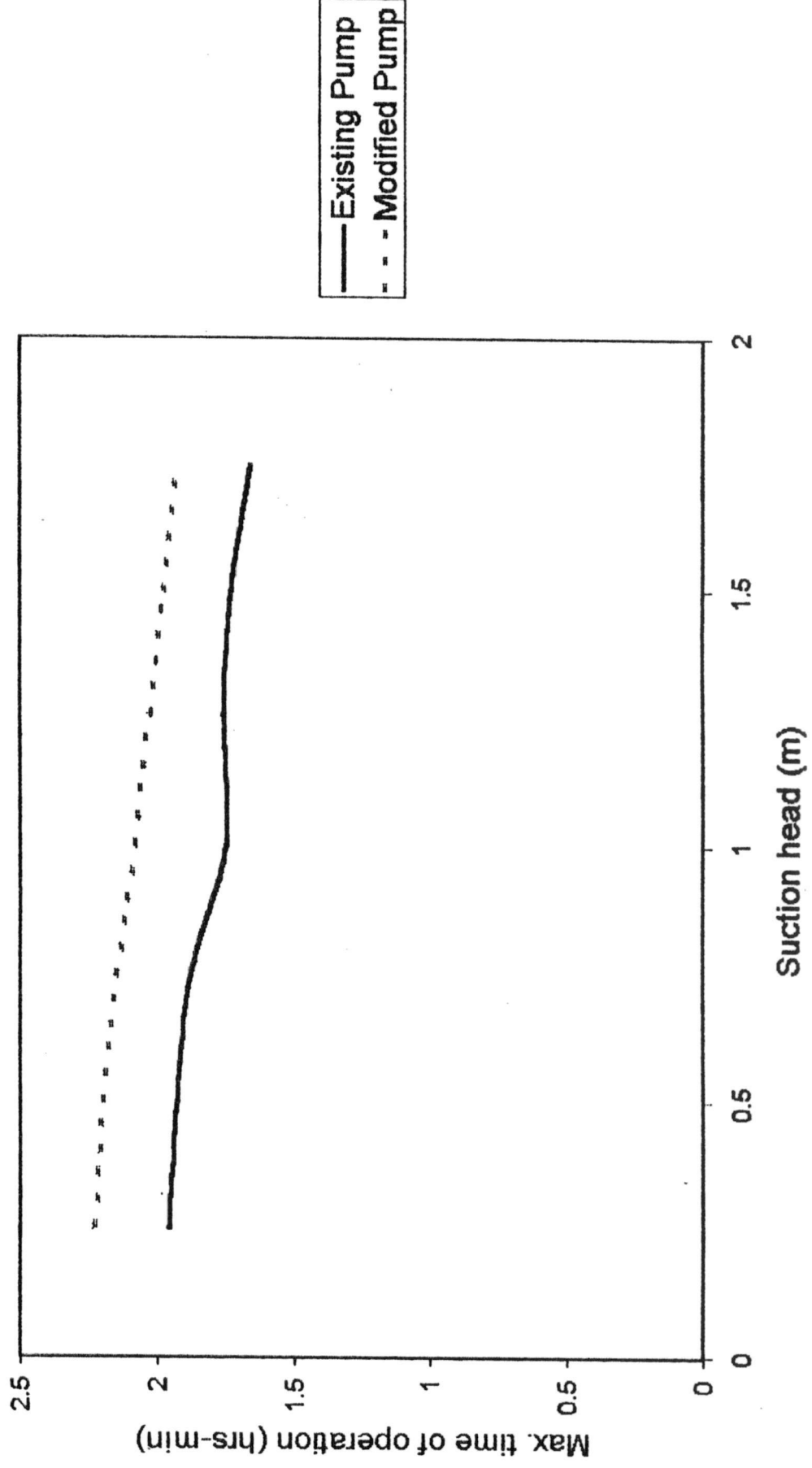


**Table : 4.8. Operation for duration.**

Suction heads (m)	Maximum time of operation (hrs-mins) (By Human Labour)		Mean
	Existing pedal Operated pump	Modified pedal Operated pump	
0.25	1 - 58	2 - 14	2 - 10
0.50	1 - 56	2 - 12	2 - 07
0.75	1 - 53	2 - 09	2 - 01
1.00	1 - 49	2 - 05	1 - 59
1.25	1 - 46	2 - 02	1 - 57
1.50	1 - 44	1 - 59	1 - 53
1.75	1 - 40	1 - 56	1 - 49
F-Test	**	**	**
	Main plot	Sub plot	Subplot at Same levels Of main plot
SEM	0.003	0.003	0.004
CD (5%)	0.011	0.009	0.012

\*\* Significant at 5% level

Fig.4.2.Relationship of suction head & maximum time of operation



pedal operated low lift pump and modified pedal operated low lift pumps are presented in table 4.8.

In both existing pedal operated low lift pump and modified low lift pumps, as suction head increases, maximum time of operation decreases. In case of existing pedal operated low lift pump the maximum time of operation was highest of 1hr 58 mins was observed for the suction head of 0.25m and lowest was 1hr 40 mins was observed for the suction head of 1.75m. In case of modified pedal operated low lift pump the maximum time of operation highest was 2 hrs 14 mins and lowest was 1 hr 56 mins.

#### **4.4. Constraints during the operation and suitable mechanism for pedal operated low lift pump :**

Constraints during the operation of pedal operated low lift pump are presented in the table 4.9.

During operation of existing pedal pump washer was torn out once and cost involved in repairs Rs.12.00, two bottom bolts worn out and cost of repair was Rs.6.00. During the operation of modified pedal operated low lift pump three cottor pins are broken and cost involved in repair is Rs.2.25.

**Table : 4.9. Constraints of pedal operated pumps.**

Name of the pump	Constraints during operation		
	Type of failure	No. of Times	Cost of repair
1. Existing pedal Operated pump	Washer torn out	1	12.00
	Bottom bolts Worn our	2	6.00
2. Modified pedal Operated pump	Cotter pins broken	3	2.25

#### **4.4.1. Suitable mechanism for existing pedal operated low lift pumps :**

A mechanism for seating arrangements and a handle was provided for the operators comfort. Details and cost involved in modification are presented in the table 4.10.

A handle was provided at a height of 1.00m and a bicycle seat was provided at a height of 0.75m. Materials required are 12mm dia galvanised iron pipe, bicycle seat, mild steel plate, cold twisted deformed bar and mild steel flat cost involved in modification is Rs.133.00 (including labour charges).

#### **4.5. Economics of operations of pedal operated low lift pumps :**

##### **4.5.1. Cost of operation of pedal operated low lift pumps :**

Comparative cost of operation per hour for existing pedal operated low lift pump and modified pedal operated low lift pump are presented in the table 4.11.

The cost of operation per hour for existing pedal operated low lift pump is Rs.6.35 and for modified pedal operated low

**Table : 4.10. Cost of modification (Rs).**

Sl.No.	Item and Materials	Qty	Rate	Amount
01.	Seat (Height 0.75m)			
	a) 12mm GI pipe	0.75m	21.33	16.00
	b) Seat (Bicycle)	1 Nos.	30.00	30.00
	c) MS plate (25 x 20 x 5mm)	1 Nos.	10.00	10.00
	d) CTD bars (8mm dia)	0.30m	10.00	03.00
02.	Handle (Height 1.00m)			
	a) MS flat (20mm x 1.2m)	2.24m	12.50	28.00
	b) Handle	1 Nos.	04.00	04.00
03.	Cross Bar CTD Bar (8mm dia)	0.80m	10.00	08.00
04.	Labour Charges	--	--	34.00
<b>Total (Rs.)</b>			<b>→</b>	<b>133.00</b>

**Table : 4.11. Operating cost of pedal operated pumps**

Item Cost	Existing pedal Operated pump (Rs/hr)	Modified pedal Operated pump (Rs/hr)
<b>A. Fixed Cost :</b>		
1. Depreciation	0.53	0.57
2. Interest	0.31	0.34
3. Housing	0.05	0.05
4. Repair & Maintenance	0.46	0.51
<b>B. Variable Cost :</b>		
1. Wages for labour Rs.40.00/day	5.00	5.00
<b>Total Cost (Rs/hr) →</b>	<b>6.35</b>	<b>6.47</b>

lift pump is Rs.6.47, maintenance cost of pedal operated pumps are taken as 10% of capital cost.

#### **4.5.2. Irrigation cost of pedal operated low lift pumps :**

The comparative irrigation cost (Rs/ha) for existing pedal operated low lift pump and modified pedal operated low lift pumps are presented in the table 4.12.

The irrigation cost (Rs/ha) for existing pedal operated low lift pump is lowest of Rs.71.60 for the suction head of 0.25m and highest of Rs.118.58 for the suction head of 1.75m. In case of modified pedal operated.

#### **4.5.3. Estimated area to be irrigated per day :**

Comparative performance for area to be estimated irrigated (ha) per day (8 hrs) of existing pedal operated low lift pump and modified pedal operated low lift pump are presented in table 4.13.

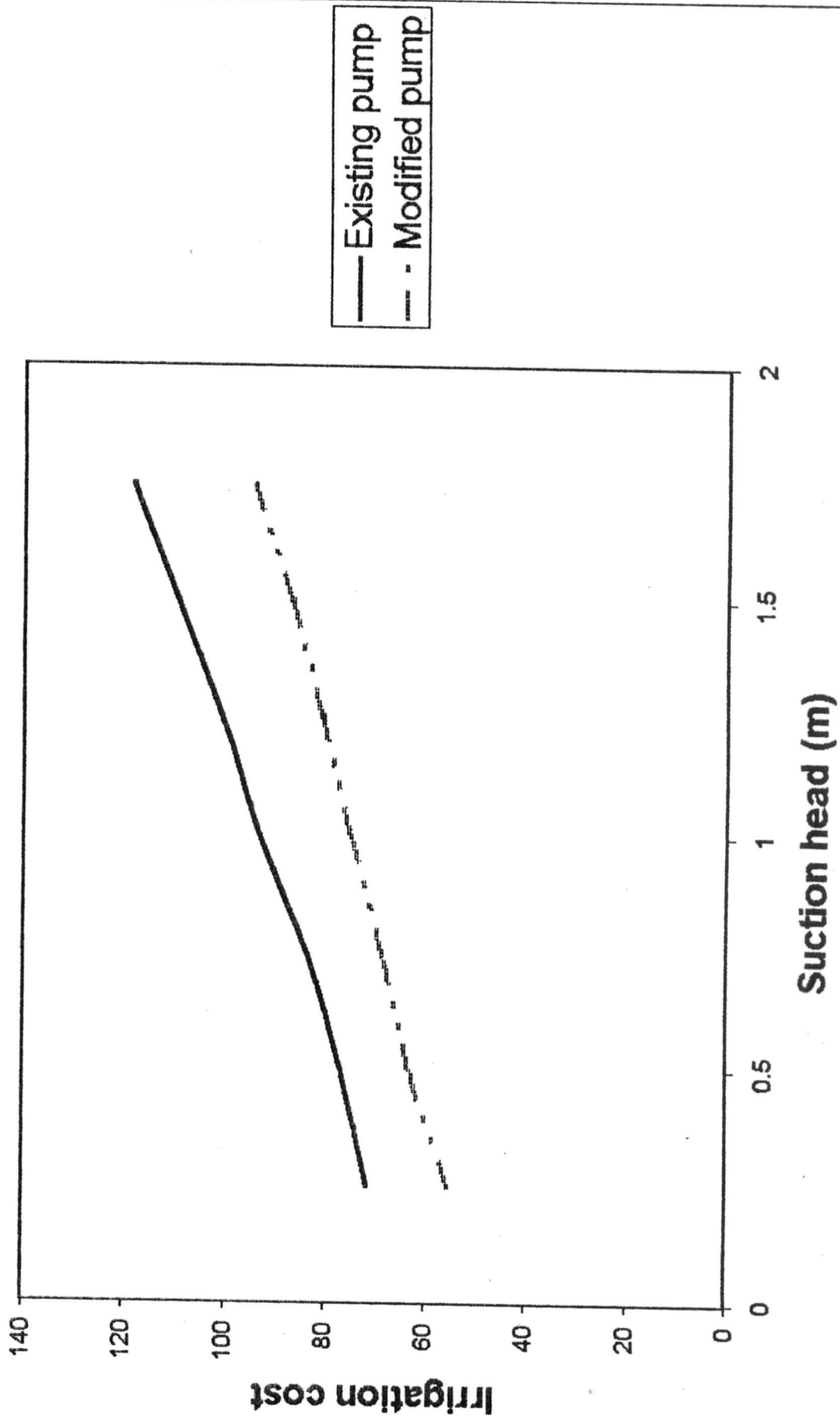
Estimated maximum area to be irrigated for existing pedal operated low lift pump is 0.710 hectares was observed for the suction head of 0.25m and minimum estimated area to be irrigated is 0.428 hectares was observed for the suction head of 1.75m. Estimated maximum area to be irrigated for

**Table : 4.12. Irrigation cost per hectare.**

Suction heads (m)	Irrigation cost (Rs/ha) (1cm depth)		Mean
	Existing pedal Operated pump	Modified pedal Operated pump	
0.25	71.60	52.20	63.411
0.50	76.86	62.99	69.922
0.75	83.62	68.36	75.990
1.00	93.20	74.90	84.092
1.25	100.86	80.83	90.849
1.50	109.63	86.88	98.256
1.75	118.58	99.49	105.645
F-Test	**	**	**
	Main plot	Sub plot	Subplot at Same levels Of main plot
SEM	0.475	0.837	1.184
CD (5%)	1.864	2.320	3.281

\*\* Significant at 5% level

**Fig.4.3.Relationship of irrigation cost & suction head**

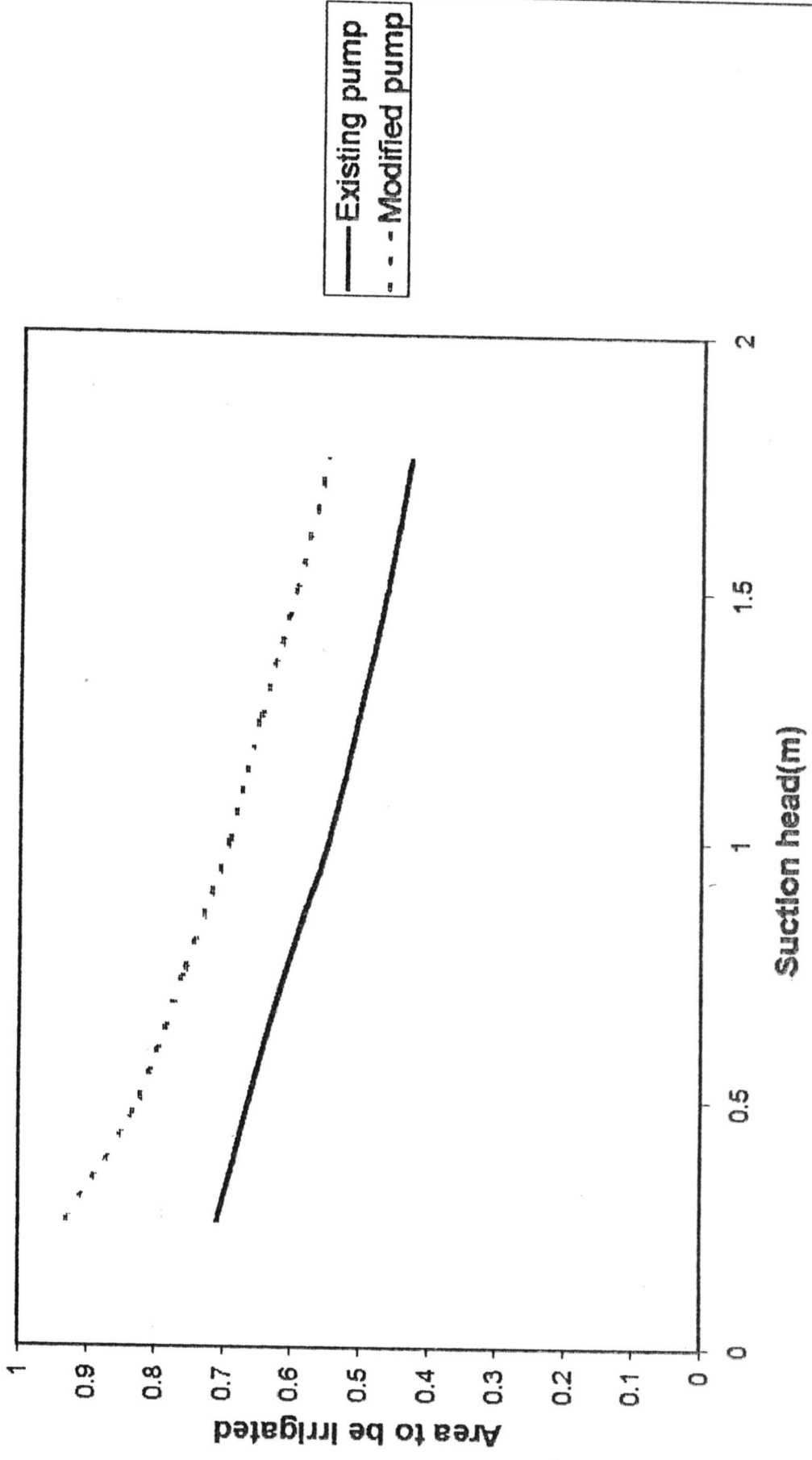


**Table : 4.13. Estimate Area to be Irrigated  
1cm depth per day (8hrs) in hectare.**

Suction heads (m)	Estimated area to be irrigated		Mean
	Existing pedal Operated pump	Modified pedal Operated pump	
0.25	0.710	0.932	0.821
0.50	0.662	0.824	0.743
0.75	0.608	0.758	0.683
1.00	0.546	0.692	0.619
1.25	0.504	0.648	0.576
1.50	0.464	0.596	0.530
1.75	0.428	0.548	0.488
F-Test	**	**	**
	Main plot	Sub plot	Subplot at Same levels Of main plot
SEM	0.004	0.008	0.012
CD (5%)	0.016	0.023	0.032

\*\* Significant at 5% level

**Fig.4.4.Relationship between suction head & estimated area to be irrigated**



modified pedal operated low lift pumps is 0.932 hectares was observed for the suction head of 0.25m and minimum area to be irrigated is 0.548 hectares was observed for the suction head of 1.75m.

#### **4.6. Efficiency of existing pedal operated pump and modified pedal operated low lift pumps :**

##### **4.6.1. Number of strokes per minute :**

Comparative performance for number of strokes per minute of existing pedal operated low lift pump and modified pedal operated low lift pump are presented in the table 4.14.

Number of strokes per minute for existing pedal operated low lift pump is maximum of 50 strokes per minute was observed for the suction head of 0.25m and minimum of 36 strokes per minute was observed for the suction head of 0.25m and minimum of 45 strokes per minute was observed for the suction head of 1.75m.

##### **4.6.2. Efficiency of existing pedal operated low lift pump and modified pedal operated low lift pump:**

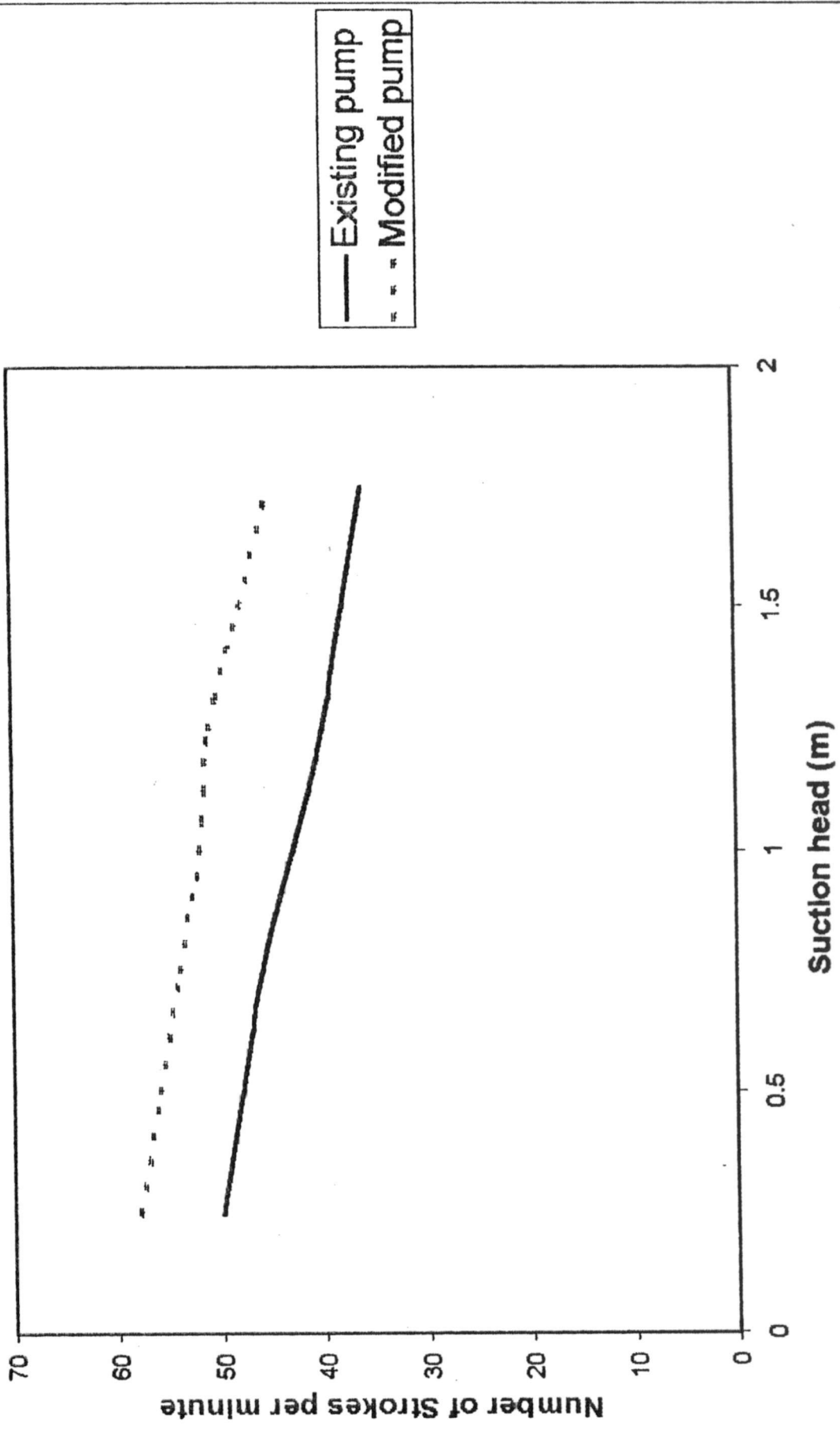
Efficiency has decreased as suction head increases in both existing pedal operated low lift pumps are presented in the table 4.15.

**Table : 4.14. Number of Strokes.**

Suction heads (m)	Number of Strokes per minute		Mean
	Existing pedal Operated pump	Modified pedal Operated pump	
0.25	50	58	54.00
0.50	48	56	52.00
0.75	46	54	50.00
1.00	43	52	47.50
1.25	40	51	45.50
1.50	38	48	43.00
1.75	36	45	40.50
F-Test	**	**	**
	Main plot	Sub plot	Subplot at Same levels Of main plot
SEM	0.440	0.008	1.182
CD (5%)	1.729	0.023	3.276

\*\* Significant at 5% level

**Fig.4.5.Relationship between suction head & number of strokes**



**Table : 4.15. Efficiency of Pedal operated pumps.**

Suction heads (m)	Efficiency (%)		Mean
	Existing pedal Operated pump	Modified pedal Operated pump	
0.25	72.14	81.36	77.054
0.50	70.65	75.19	72.920
0.75	67.96	71.57	69.766
1.00	64.77	66.03	65.405
1.25	64.56	65.21	64.899
1.50	62.15	63.65	62.899
1.75	60.71	61.96	61.309
F-Test	**	**	**
	Main plot	Sub plot	Subplot at Same levels Of main plot
SEM	0.504	0.712	1.006
CD (5%)	1.980	1.973	2.790

\*\* Significant at 5% level

**Fig.4.6.Relationship of Suction head and efficiency**

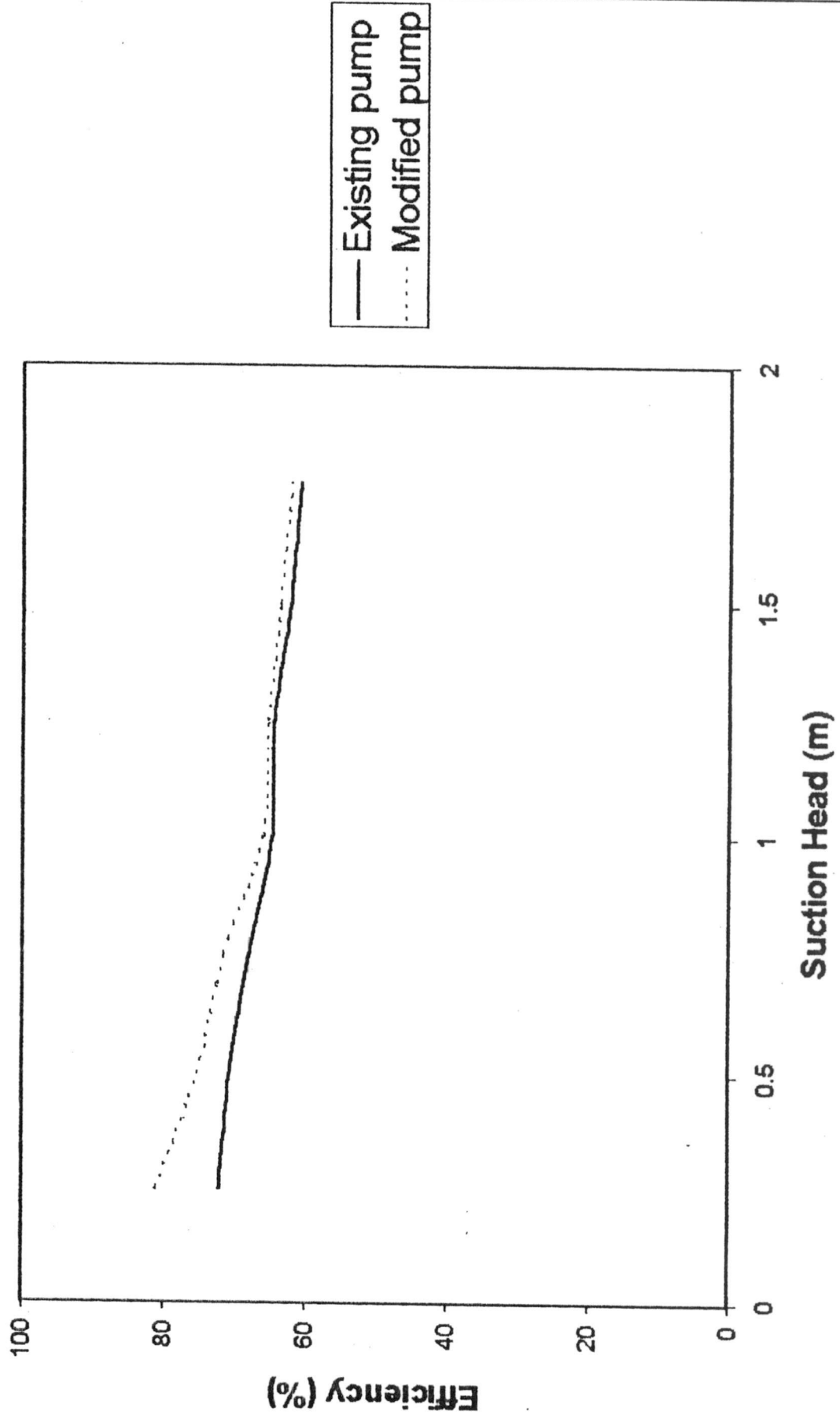


Fig.4.7. Relationship of number of strokes per minute & efficiency

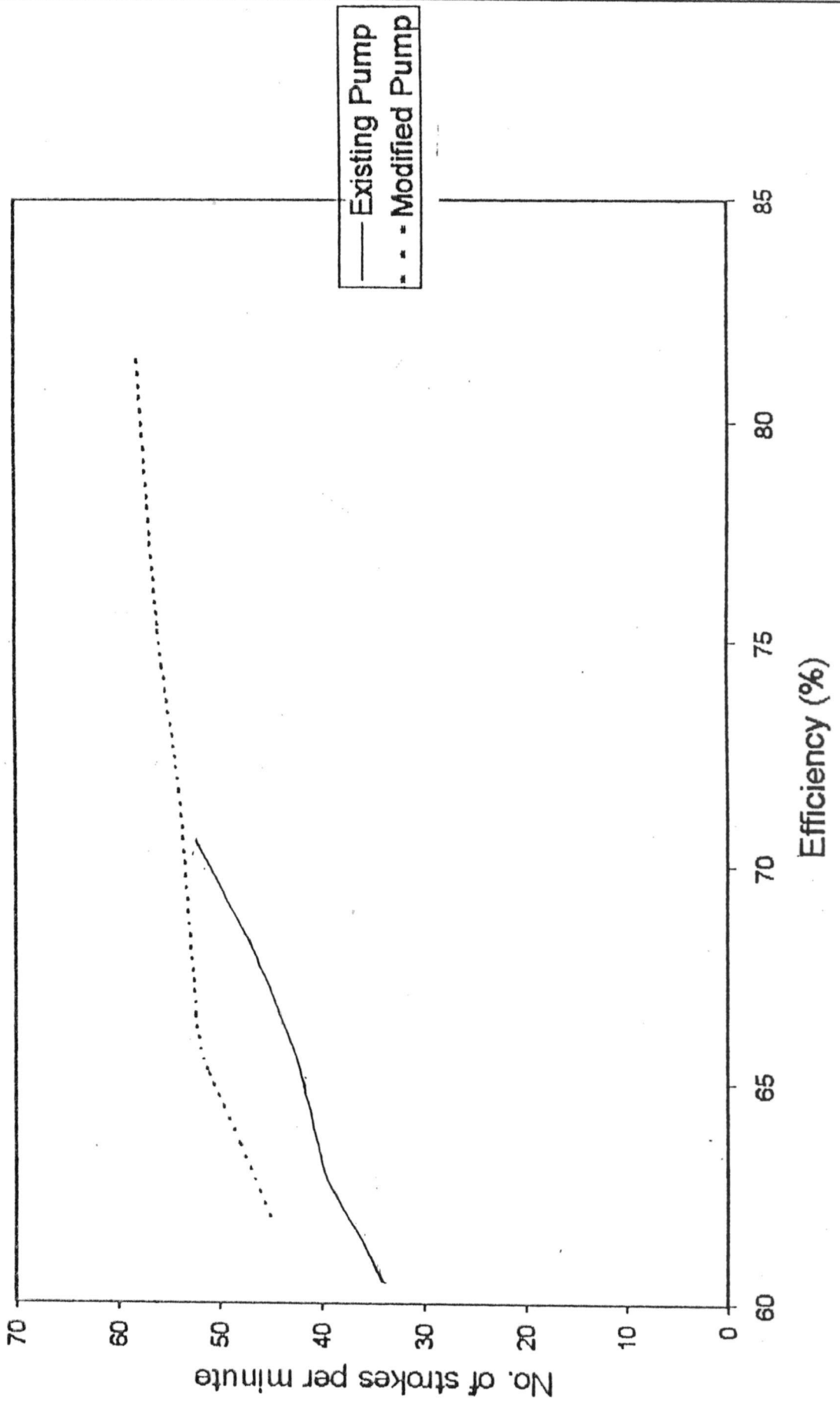
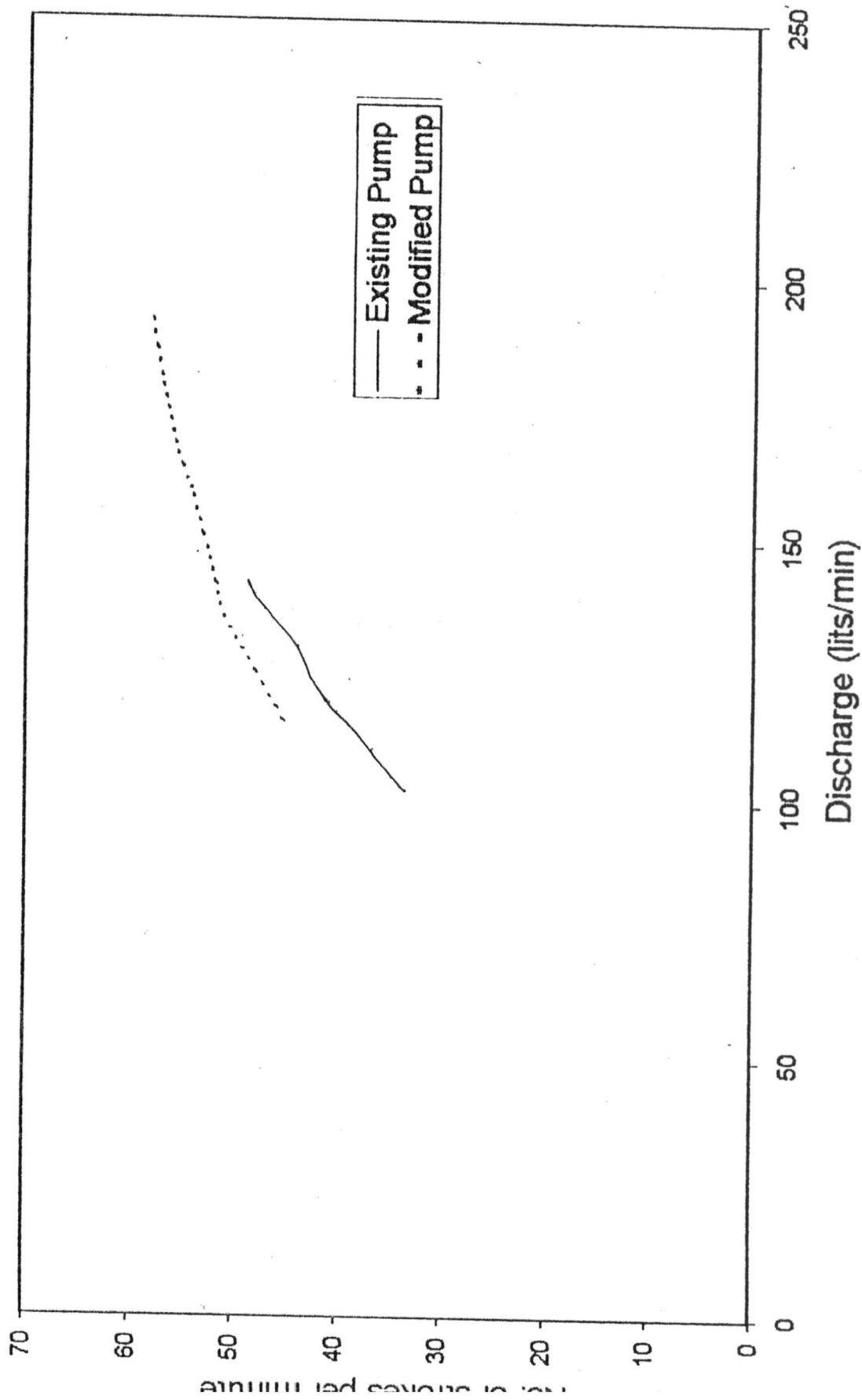


Fig.4.8.Relationship of number of strokes per minute & discharge



Efficiency has decreased as suction head increases maximum efficiency 72.14% was observed for the suction head of 0.25m and minimum efficiency of 60.71% was observed for the suction head of 1.75m in case of existing pedal operated low lift pump. Maximum efficiency of 81.36% was observed for the suction head of 0.25m and minimum efficiency of 61.96% in case of modified pedal operated low lift pump.

#### **4.6.3. Portability of existing pedal operated low lift pump and modified pedal operated low lift pump :**

Portability of existing pedal operated low lift pump and modified pedal operated low lift pumps are presented in the table 4.16.

Weight of existing pedal operated low lift pump is 16.80Kg and modified pedal operated low lift pump is 24.20Kg.

**Table : 4.16. Portability of pedal operated pumps.**

Sl.No.	Name of the pump	Weight in (Kgs)
01.	Existing pedal operated pump	16.80
02.	Modified pedal operated pump	24.20

## DISCUSSION

## CHAPTER V

### DISCUSSION

The results obtained from the experiment on "Evaluation, improvement and adoption of low lift pumps for marginal farmers" are discussed in this chapter under following heads.

- 5.1. Survey of low lift water lifting devices.
- 5.2. Performance of pedal operated low lift pumps for different suction heads.
- 5.3. Performance of pedal operated low lift pumps for different duration.
- 5.4. Constraints during the operation and suitable mechanism for pedal operated low lift pump.
- 5.5. Economics of pedal operated low lift pumps.
- 5.6. Efficiency of existing pedal operated low lift pump and modified pedal operated low lift pump.

#### **5.1. Survey of low lift water lifting devices :**

Survey was conducted in Dakshina Kannada District to assess the status of low lift water lifting devices. The details of survey is discussed on the following headings :

### **5.1.1. Agricultural land holdings in Dakshina Kannada District :**

Land holdings pattern in Dakshina Kannada district is 29.09% marginal farmers, 46.36% small farmers and 24.55% farmers under small holding category are the highest in Dakshina Kannada. The reason is, land is divided in to smaller plots.

### **5.1.2. Socio economic characters of farmers :**

**a) Caste :** Caste wise distribution of farmers are presented in table 4.2.

7.27% of the farmer belongs to schedule caste, 8.18% belongs to schedule tribe, 67.27% of the farmer belongs to backward caste and 17.28% belongs to other castes. Backward caste farmers are contribute the highest percentage in Dakshina Kannadas, population of bunts constitute major backward caste farmers in percentage.

**b) Education :**

In Dakshina Kannada, the study has revealed that 20.91% farmer are illiterate, 41.18% farmers have primary education 21.82% of the farmers have secondary education and

only 9.1% are having collage education. Dakshina Kannada being a educationally forward district illiterate farmers are very less.

**c) Family size :**

The study revealed that in Dakshina Kannada district 46.36% families have less than five members in a house and 53.65% have more than five members in a house. The reason is farmers are educated and aware of family planning.

**d) House type :**

Study also revealed that 3.64% of the farmers live in pakka house, 10.00% of the farmers live in huts and the remaining 86.36% of the farmers live in katcha house. This reveals that majority of the farmers of Dakshina Kannada have better economic status. The reason is Dakshina Kannada district is a heavy rainfall area hence katcha (tiled) houses are more in number.

**e) Subsidiary Occupation :**

In Dakshina Kannada District apart from their main occupation of agriculture, they do have subsidiary occupation such as, service and sericulture (1.82%), Petty Business

(13.64%), Poultry (21.82%), dairying (25.45%) and other subsidiary occupation such as fishing (35.45%). The reason is farmers want to enhance the income to lead better life hence they go for subsidiary occupation also.

### **5.1.3. Distribution of animals in Dakshina Kannada District :**

Due to the prevailing climatic condition, of Dakshina Kannada District majority of the draft animals are he buffaloes. Study indicates that the number of bullock possessed are 38 Nos in case of marginal farmers, 54 Nos in case of small farmers and 49 Nos in case of big farmers. As big farmers afford to have or hire farm mechinaries such as tractors, a power tillers etc., the number of bullocks are low in case of big farmers as compared to small farmers. Study also revealed that the number of local cows possessed are 12 Nos. in case of marginal farmers, 18 Nos. in case of big farmers and 32 Nos. in case of small farmers. The number of cross breed cows possessed by the farmers are 4 Nos. in case of marginal, 6 Nos. in case of big farmers and 10 Nos., in case of small farmers. Since the local cows are cheap they are found more in small farmers.

The number of cattle's possessed are 8 Nos in case of marginal farmers, 12 Nos in case of big farmers and 18 Nos in case of small farmers. As the climatic and cost factor prevailing in Dakshina Kannada, necessitate, the use of he-buffaloes in large number. Marginal farmers possess 78 Nos, small farmer possess 69 Nos and big farmer possess 45 Nos. The use of donkeys as draft animal is not found in Dakshina Kannada District. Animals are not used for lifting the water, the pedal operated low lift pump can be used for lifting water.

#### **5.1.4. Distribution of bullock drawn implements :**

Distribution of bullock drawn implements are presented in table 4.4. It is found that number of wooden ploughs possessed are, 33 Nos., in case of marginal farmers, 49 Nos in case of big farmers and 61 Nos in case of small farmers. Since the marginal farmer cannot afford to hire or own a farm machinery, the number of wooden ploughs possessed by small farmers are high. The number of iron plough possessed by marginal, big and small farmer are 10, 29 and 36 numbers respectively. As the soils of Dakshina Kannada district are laterite and heavy rainfall area, the

wooden plough are more popular as compared to that of iron ploughs. Since Dakshina Kannada district is a paddy growing area, the levelers are being used by the farmers for leveling land for better water management. The number of levellers according to the study is 8 Nos in case of marginal farmers, 20 Nos in case of big farmers and 23 Nos in case of small farmers. The use of hoes and seed drill are limited because in Dakshina Kannada district the main crop is paddy and it is heavy rainfall area hence seed drill are not popular in Dakshina Kannada District. There are hoes 3 Nos each in case of marginal and small farmers and seed drills are 1 No each in case of small and big farmers. In Dakshina Kannada district paddy is main crop it requires puddling operation, now a days bullock drawn puddlers becoming popular and are being used. Bullock drawn puddlers used by the farmer are 02 Nos each in case of marginal and small farmers, 04 Nos in case of big farmers.

#### **5.1.5. Distribution of farm machineries :**

Distribution of farm machineries are presented in table 4.5. The sample survey indicate 2 Nos of tractor with big farmers as the land holdings are small tractors are not so popular. The number of power tillers possessed are 2 Nos in

case of marginal farmers, 4 Nos in case of small farmers and 8 Nos in case of big farmers power tillers are using for puddling the land and for ploughing. The high cost of tractors and power tillers did not permit to own by marginal farmers. The use of plant protection equipments to control pest and diseases in paddy and cashew crops, necessitate, to own them. The number of sprayers are 6 Nos in case of marginal farmers, 24 Nos in case of big farmers and 29 Nos in case of small farmers. Duster are possessed only with big farmers (3 Nos). The oil engines are used for lift irrigation from well and river and are 5 Nos in case of marginal farmers, 17 Nos in case of big farmers and 24 Nos in case of small farmers. As small and marginal farmers cannot afford oil engines and electric motors, the pedal operated low lift pump can be popularized in those areas because of low cost.

#### **5.1.6. Distribution of low lift water lifting devices :**

Distribution of low lift water lifting devices is presented in table 4.6. The manually and bullock drawn low lift water lifting devices such as Swing Bucket, Don, Archimedian Screw, Persian Wheel, Self emptying tube rope and bucket, Circular two bucket lift, Rope and bucket lift are not in vogue. Only low lift hand pumps are being used to lift water.

As low lift hand pumps popular, the pedal operated low lift pump can be popularised.

### **5.2. Performance of pedal operated low lift pumps for different suction heads :**

Performance of pedal operated low lift pumps are presented in table 4.7. The discharge was measured in both existing pedal operated low lift pump and modified pedal operated low lift pump for suction head ranging from 0.25 to 1.75m at an interval of 0.25m. Discharge decreases with the increase in suction head. In case of existing pedal operated low lift pump the discharge is 148.20 lpm for 0.25m suction head and decrease to 88.80 lpm for 1.75m suction head. In modified pedal operated low lift pump the discharge is 192.00 lpm for 0.25m suction head and decrease to 114.00lpm for 1.75m suction head (table 4.7 and fig.4.1). These results are in agreement with of Mohammed Abdul Baqui (1980), Shirazul Islam et al., (1981), Choudhury Md Amiruddin Khan (1983) and A.M.Azizul Huq et al., (1992).

The same operator was engaged to operate both type of low lift pumps. The existing pump was operated in a standing position. A seating arrangement was incorporated in a modified pump this enabled the operator to perform

more strokes per minute hence 29.72% increase in discharge is achieved for a suction head of 0.25m and 28.38% increase in discharge is achieved for as suction head of 1.75m.

### **5.3. Performance of pedal operated low lift pumps for different duration.**

The maximum time the operator can operate the pump for different suction heads ranging from 0.25 to 1.75m was recorded. The maximum time of operation ranges from 1 hr 58 mins for a suction head of 0.25m and 1 hr 40 mins for a suction head of 1.75m in case of existing pedal operated low lift pump. In case of modified pedal operated low lift pump the maximum time of operation ranges from 2 hrs 14 mins for a suction head of 0.25m and 1 hr 56 mins for a suction head of 1.75 m (table 4.8 and fig 4.2). These results are in agreement with P.K.Moitra *et al.*, (1978) on rotary pump.

The maximum time of operation in case of modified pedal operated low lift pump has been increased by 13.55% for suction head of 0.25m and 16.00 % for suction head of 1.75m. This increase in maximum time of operation is due to the comfort incorporated in the pump.

#### **5.4. Constraints during the operation and suitable mechanism for pedal operated low lift pump :**

During the study constraints were also recorded. In case of existing pedal operated low lift pump the washer costing Rs.12.00 was torn out once and bottom bolts costing Rs.6.00 2 Nos are worn out once. Where as in case of modified pedal operated low lift pump cotter pins costing Rs.2.25 3 Nos broken once (table 4.9). The minimum breakage were noticed in case of modified pedal operated low lift pump is may be due to uniformity in operation. These results are in arrangements with Md.Mizzammil Huq et al., (1994).

##### **5.4.1. Modification of pedal operated low lift pump :**

In the existing pedal operated low lift pump, two wooden poles has to be fixed which will be held by the operators hand to provide grip to operate the pedals from both legs by standing. In the modified pedal operated low lift pump a suitable frame made of mild steel flat and galvanised iron pipe is fabricated and attached with bolt and nut to the front of the pump a seating arrangement was also provided at the back of the base at a height of 0.75m. This involves extra cost of Rs.133.00. If a person stands at work, fairly little work, fairly little force and fairly infrequent operation of foot

controls should be required, because during these exertions, the operator has to stand on the other leg alone. For a seated operator, however operation of foot controls is much easier because the body is largely supported by the seat thus, the feet can move more freely and given suitable conditions, can exert large forces and energy. All energy is transmitted from leg muscles through the feet to pedals. As pedals are located underneath the body. So that the body weight above them provides the reactive force to the force transmitted to pedals.

## **5.5. Economics of pedal operated low lift pumps :**

### **5.5.1. Cost of operation :**

The cost of operation per hour of existing pedal operated low lift pump and modified pedal operated low lift pump were calculated and are found to be Rs.6.35 and Rs.6.47 respectively. The slightly higher cost of operation per hour is due to the modification incorporated for operator's comfort and improving pump performance (table 4.10). These cost of operation in agreement with Mohammed Abdul Baqui (1980) on diaphragm pump and Md.Muzzammil Haq *et al.*, (1994).

### 5.5.2. Irrigation Cost :

Irrigation cost (Rs/ha) also influenced by suction heads. As suction head increases irrigation cost (Rs/ha) also increases. The results of the irrigation cost (Rs/ha) for existing pedal operated low lift pump and modified pedal operated low lift pump are presented in the table 4.12. It is observed that irrigation cost (Rs/ha) was Rs.71.60 for a suction head of 0.25m and Rs.118.58 for a suction head of 1.75m in case of existing pedal operated low lift pump. In case of modified pedal operated low lift pump, the irrigation cost Rs.55.22 for a suction head of 0.25m and Rs.94.99 for suction head of 1.75m. Since the discharge observed is more in case of modified pedal operated low lift pump, the irrigation cost (Rs/ha) is much less compared to the existing pedal operated pump even though the cost of operation per hour of modified pedal operated pump is slightly more than the existing pump. These results are in agreement with Mohammed Abdul Baqui (1980).

The reduction in irrigation cost (Rs/ha) for modified pedal operated low lift pump is 29.65% for a suction head of 0.25m and 25.50% for a suction head of 1.75m.

### 5.5.3. Estimated Area to be irrigated 1 cm depth hectare per day :

Estimated area to be irrigated 1 cm depth hectare per day is influenced by suction head in both existing pedal operated low lift pump and modified pedal operated low lift pump are presented in table 4.13.

As suction head increases estimated area to be irrigated 1 cm-depth-hectare/day decreases. For a suction head 0.25m and 1.75m, estimated area to be irrigated 1cm depth - hectare/day is 0.710 ha and 0.428 ha respectively in case of existing pedal operated low lift pump. For a suction head of 0.25m and 1.75m, estimated area to be irrigated 1cm depth hectare/day is 0.932 ha and 0.548 ha respectively in case of modified pedal operated low lift pump. The relation between estimated area to be irrigated per day and suction heads are as shown in fig 4.5. These results are in agreement with A.M.Azizul Huq *et al.*, (1992). Comparative performance between existing pedal operated low lift pump and modified pedal operated low lift pump, the modified pedal operated low lift pump has given better results.

The increase in estimated area to be irrigated 1 cm depth hacter per day is 31.26% and 28.03% for the suction heads of 0.25m and 1.75m respectively.

### **5.6. Efficiency of existing pedal operated low lift pump and modified pedal operated low lift pumps.**

#### **5.6.1. Numbers of strokes per minute :**

Number of strokes per minute are influenced by suction heads, the results are presented in the table 4.14.

The number of strokes per minute reduces with increase in suction head. In case of existing pedal operated low lift pump 50 strokes per minute is required for a suction head of 0.25m and reduces to 36 strokes per minute for a suction head of 1.75m and 45 strokes per minute for a suction head of 1.75m where as in case of modified pedal operated low lift pump 56 strokes per minute for a suction head of 0.25m and 45 strokes per minute for a suction head of 1.75m. These results agree with A.M.Azizul Huq *et al.*, (1992) for the treadle pump.

The increase in number of strokes per minute is 16.00% and 25.00% for the suction heads of 0.25 and 1.75m

respectively in case of modified pedal operated low lift pump. This is mainly due to the modification incorporated to the existing pump.

### 5.6.2. Efficiency of pedal operated low lift pumps :

Efficiency of existing pedal operated low lift pump and modified pedal operated low lift pumps are influenced by suction heads. The results are presented in the table 4.15. The efficiency of both the type of pumps decrease with increase in suction head. The relation between suction head (m) and efficiency (%) are as shown in fig 4.7. The efficiency of the existing pedal operated low lift pump decreases from 72.14% to 60.71% as the suction head increases from 0.25 to 1.75m. Where as the efficiency decreases from 81.36% to 61.96% as the suction head increases from 0.25m to 1.75m in the modified pedal operated low lifts pumps. These results agree with the Mohammed Abdul Baqui (1980) for Diaphragm pump and A.M.Azizul Huq *et al.*, (1992) for hand pump.

The increase in efficiency in case of modified pedal operated low lift pump is again attributed to the changes incorporated to remove the deegry in operation. The increase

in efficiency is 9.22% and 1.25% for the suction heads of 0.25 and 1.75m respectively.

### **5.6.3. Relation between number of strokes per minute and efficiency :**

The relation between number of strokes per minute and efficiency are as shown in fig 4.8. In both the type of pumps efficiency decreases with decrease in number of strokes per minute. The efficiency of the existing pedal operated low lift pump reduces from 72.14% to 60.17% with a reduction in number of strokes per minute 50 to 36. Where as the efficiency decreases from 81.36% to 61.96% with a reduction in number of strokes per minute 58 to 45. These results are supported by A.M.Azizul Huq *et al.*, (1992) for hand pump and Rower pump.

The increase in efficiency mainly due to increase in number of strokes per minute giving higher discharge resulting in higher efficiency.

### **5.6.4. Relation between number of strokes per minute and discharge :**

The relation between number of strokes per minute and discharge is as shown in fig 4.9.

The discharge from both the type of pumps depends on number of strokes per minute. It is noted that the discharge being 148.20 lits/min decreases to 88.80 lits/min with a decrease in strokes per minute from 50 to 36 in case of existing pedal operated pump discharge decrease from 192.00 to 114 lits/min with decrease in number strokes per minute from 58 to 45. These results are supported by A.M.Azizul Huq *et al.*, (1992) for hand pump and Rower pump.

#### **5.6.5. Portability of pedal operated low lift pumps :**

The existing pedal operated low lift pump and modified pedal operated low lift pump weight 16.80 and 24.20 Kg respectively and can be transported easily with one or two persons wherever it has to be shifted. The increase in weight by 7.4 Kg of modified pump is due to the frame and seating arrangement incorporated for better comfort and performance.

# SUMMARY

# CHAPTER VI

## SUMMARY

An experiment on "Evaluation improvement and adoption of low lift pumps for marginal farmers" was conducted during 1997 at Gandhi Krishi Vignan Kendra, University of Agricultural Sciences, Bangalore.

- a) To know the status of low lift water lifting devices in Dakshina Kannada District.
- b) To know the discharge for different suction heads for existing pedal operated low lift pump and modified pedal operated low lift pump.
- c) To know the maximum time of operation for different suction heads for existing pedal operated low lift pump and modified pedal operated low lift pump.
- d) To know the construction during the operation of existing pedal operated low lift pump and modified pedal operated low lift pump.
- e) To know the operating cost (Rs/hr), irrigation cost (Rs/ha) and area to be irrigated (ha/day) in both the pumps.
- f) To know the number of strokes per minute, efficiency and portability of both existing and modified pedal operated low lift pumps.

The results obtained from an experiment can be summarised as follows :

1. Survey of farm category in Dakshina Kannada District have shown that the small farmers are highest in percentage and are 46.36% .
2. Socio-Economic characteristics of farmers in Dakshina Kannada district are, backward caste farmers are highest in percentage and are 67.27%, primary educated farmers are highest in percentage and are 48.18%, family size persons more than five persons are highest in percentage and are 53.64% . Farmers highest 86.36% are residing in Katcha houses and 35.45% of farmers are doing other subsidiary occupation. =
3. He-buffaloes are mostly used as draft animals and are highest 69 number in case of small farmers in Dakshina Kannada District.
4. Wooden ploughs are most popular implement and are highest 61 Nos in case of small farmers. Other bullock drawn implements such as iron plough, levellers, hoes, seed drills and bullock drawn puddlers are also present with the farmers of Dakshina Kannada District.
5. Among farm machinerie, sprayers are highest 29 Nos in case of small farmers. Other farm machineries like tractors, power tillers, dusters and oil engines are not so popular in the Dakshina Kannada District.
6. Among low lift water lifting devices only hand pumps are used for lifting water, and are highest 19 Nos in case of small farmers. Other indigenous water lifting devices like swing basket, Don, Archmedian Screw, Persian

Wheel, Self emptying type rope and bucket, Circular, two bucket lift Counter poise, Bucket lift, Rope and bucket lift, and Pedal operated low lift pump, are not all using in Dakshina Kannada District.

7. The discharge is maximum at a suction head of 0.25m in both existing pedal operated low lift pump and modified pedal operated low lift pump and are 148.20 and 192.00 liters per minute respectively.
8. Maximum time of operation was found to be minimum for a suction head of 1.75m in both existing pedal operated low lift pump and modified pedal operated low lift pump and are 1 hr 40 mins and 1 hr 56 mins respectively.
9. Constraints during operation are minimum in both existing and modified pedal operated low lift pumps, cost involved in repair is also very less. Suitable mechanism for seating arrangement and handle was provided for easy operation to existing pedal operated low lift pump.
10. Operating cost (Rs/hr) for both existing and modified pedal operated low lift pumps are Rs.6.35 and Rs.6.47 respectively.
11. Irrigation cost (Rs/ha) was lowest in both existing pedal operated low lift pump and modified low lift pump is minimum for a suction head of 0.25m and are Rs.71.60 and Rs.55.24 respectively.
12. Estimated area to be irrigated hectares per day for both existing pedal operated low lift pump and modified pedal operated low lift pumps are 0.710 ha and 0.952 ha for a corresponding suction head of 0.25m.

13. Number of strokes per minute in case of existing pedal operated low lift pump and modified pedal operated low lift pump is highest of 50 and 58 strokes per minute respectively for a corresponding suction head of 0.25m.
14. Efficiency of both existing and modified pedal operated low lift pumps are highest of 72.14% and 81.36% respectively for a suction head of 0.25m.
15. Both existing and modified pedal operated low lift pumps are portable can be transported from one place to other easily with the help of one or two person, weights are 16.80 Kg and 24.20 Kg respectively.

**Based on these results and discussion following conclusion are drawn :**

1. From survey conducted in Dakshina Kannada District of low lift water lifting devices, only hand pumps are available with farmers.
2. As suction head increase the discharge (lits/min), area to be irrigated (ha/day), number of strokes per minute and efficiency will decrease in both existing and modified pedal operated low lift pumps.
3. As suction head increases, irrigation cost (Rs/ha) also increase in both existing and modified pedal operated low lift pump.
4. As suction head increases, the maximum time of operation also (hrs and mins) decreases in both cases.

5. Due to comforts provided to operator in case of modified pedal operated low lift pump discharge (lits/min), area to be irrigated (ha/day), number of strokes per minute and efficiency are increased for a corresponding suction heads.
6. Efficiency of pedal operated low lift pump is increased by 9.22% due to modifications incorporated in lower suction heads.
7. Irrigation cost (Rs/ha) is also reduced by 29.60% for lower suction heads, due to modifications incorporated to the existing pedal operated low lift pump.
8. As electricity and fuel are scarce resources, by these manual water lifting devices can be done for marginal farmers.

#### **Limitations of the study and future line of work :**

1. As pedal operated low lift pumps are low head pumps, these cannot be used in all parts of the Karnataka.
2. Popularisation of pedal operated low lift pump is needed, where canals and shallow water table is there.
3. Pedal operated low lift pump helps in reducing costs on electricity and fuel.
4. Studies on increase in length of pedal and by using light materials like fiber, weight of pedal operated pump can be minimised.
5. As pedal operated low lift pump is manually operated only marginal and small farmers can have because of labour scarcity.

## REFERENCES

## CHAPTER VII

### REFERENCES

- Adam, O.S., 1963, Human performance and work rest schedule. Human factors in technology, chap - 5, PP-38-65.
- Azizul Huq, A.M., Ali, M.A.T., Das, T.K., Quamrul Islam; Sadrul Islam; A.K.M., 1992, Water lifting devices for irrigation in Bangladesh. *Agricultural Mechanization in Asia, Africa and Latin America* No.23 : 29-37.
- Baqui, M.A.; 1980, Development of Diaphragm Pump for low lift irrigation. *Agricultural Mechanization in Asia, Africa and Latin America*, Vol XI, No.1, P 43-46.
- Baqui, A. and Huq, K.A.; 1987, National Survey on performance of Different types of tube well and LLP equipment pp 19-28.
- Barnes, G., 1987, The twin treadle pump ; manual irrigation in, Bangladesh small farm equipments pp 19-28.
- \*Bellinger, L., 1969, Man Machine Compatibility *Journal of Agricultural Engineering* pp 17-19.
- Bhuiyan, S.I., 1977, Evaluation of Constraints to efficient Water utilization in small scale irrigation schemes in Bangladesh.
- Braumann and Fuller ; 1984, Manual Irrigation Bangladesh, Swiss Development Co-operation, Mirpur Agricultural workshop and training school, Dhaka, p.38.
- Choudhury Md.Amiruddin Khan ; 1983, Development of Wheel pump for flow lift irrigation. *Agricultural Mechanization in Asia, Africa and Latin America* No.14(2) : 55-58.

- Das, G. and Michael, A.M ; 1967, Evaluation of performance characteristic of circular two buckets lift. *Journal of Indian Society of Agricultural Engineers* 4(2), p. 1-8.
- Davson, H. and Eggleton, M. G., 1968, Principles of Human Physiology.
- Dixit, V.K., 1990, Macro Potential of pedal power irrigation pump for small productivity and self employment p.22-26.
- Edwin, R.E., 1949, The relation ship between leg strength , leg endurance and other body measurements. Department of physical education report.
- Franekel, P.L., 1986, Water lifting devices, FAO Irrigation and Drainage paper 43 Food and Agriculture organisation of United Nations, Rome. p.295.
- \*Ghani, A., Islam, T ; Humayun, K. and Haq, K.A, 1983, Comparative Study on different manually operated pumps available in Bangladesh.
- Griffin, R.E ; 1982, Irrigation Pumping, Planning Guide, Water Management synthesis project colorado State University, Ford Collins P-23.
- Hanuah ; 1971, Hand Pump irrigation in Bangladesh Development studies Vol.IV, No.4.
- Islam, S and Mazed, M. A ; 1980. Comparative performance of different types of pumps (Manual pumps only). *BARI Agricultural Engineering Division Report* P.22-28.
- Khan, H.R ; 1978. Prospects of manual water lifting in Bangladesh, 24th Annual conversion Institute of Engineers, Bangladesh P.98-104.

- Khan, M.H. and Nazrul Islam, S.M., 1983, Irrigation Equipment and their performances. A key note paper of the 1st National Symposium on Agricultural Research P.16-18.
- Khan, M.H. and Nazrul Islam ; S.M.1985, A case study of Agro support Industries for irrigation equipment of foreign Aid for Industrial Development of Bangladesh and its Impact on self Reliance. *IEB, Dhaka, Dec 13-14,1985.*
- Khepar, S.D., Kaushal, M.P. and Katyal, A.K ; 1975, Development of animal drawn lift irrigation pump. *Journal of Agricultural Engineering Vol XII, P.3-4.*
- Klaseen, G.D., 1979, The Power Pump MCC- Bangladesh.
- Kroemer, H.B., 1992, Ergonomics (How to design for ease and efficiency ) P.377-383.
- \*Md. Abdul Ghani. and Humayun Kabir Khandakar., 1983, Collection of different types of Manually Operated Pumps available in the country and Evaluation of their performance in order to carry further modification if necessary to improve performance. BARC Bhaka.
- Md. Muzzammil Haq., Md.Syedul Islam ; Md.Abu Taleb ; Tarufder Kamrul Islam ; 1988, Annual report on Evaluation and Extension of Different Manual pumps in the farmers field. Agricultural Engineering Division BRRI.
- Md. Muzzammil Haq ; Md.Abdul Baqui ; Md.Islam, T., Md. Islam, S; Haq, K.A., 1994, Feasibility study on different manual pumps in farmers fields. *Agricultural Mechanization in Asia, Africa and Latin America Vol.25, No.3 PP.29-33.*
- Md.Shiruzul Islam ; Mazed ; M.A., Kshirode Chandra roy ; 1981, Comparative performance of different types of Manual pumps. *Agricultural Mechanization in Asia, Africa and Latin America, PP. 65-68.*

- Michael, A.M ; Khepar, S . D ., 1989 , Water Well and pump Engineering. *TATA Mc GRAW HILL Publications* P.529-544.
- Mohammed Abdul Baqui ; 1980 , Development of Diaphragm pump for low lift irrigation . *Agricultural Mechanization in Asia* PP 43-45.
- Moitra, P.K.,Rao, V.K. and Yadav, B.G ., 1978 , Studies on Water pumping modes for operators comfort. *Journal of Agricultural Engineering*. Vol XII, No.2, PP. 13-18.
- Molenaar.,A ; 1956 , Water lifting device for irrigation. Agriculture Development Paper No.60. Food and Agriculture organisation of United Nations, P.71.
- Peterm Stern ; 1979, Sm all Scale Irrigation. Intermediate Technology publication Ltd., London and International Information Centre Volcani Centre, Bet Dagan , Israel , P.71.
- \* Sharma, S.C., Agarwal, R.L. and Lal, R., 1968 , Analysis of Power consumption in *Persian Wheel Journal of Irrigation and Power* 24(2), P.375-382.
- Sharma,V.K., and Jagdish Kumar, 1983, Water a limiting factor in crop production. *Indian farmers Digest* Vol.XVI,No.1,P.7.
- \* Singh , H and Kaul , R.N., 1972 , Human energy requirements of selected farm operation. *Journal Of Agricultural Engineering* Vol.9, No.3.
- Sivappan,R.K ; Chinnan Reddy,G ;1984, Irrigation equipment use for protective irrigation and dry land agriculture. Symposium on improved implements and equipments for *Agricultural Crops* May 21-22, P.1-7.
- Srivatsava, N.C., and Michael,A.M. 1965, Evaluation of performance characteristics of Archemedian Screw.

\* Wood, A.D, Ruff, J.F. and Richardson, E.V, 1977, pumps and water lifters for Rural Development Colorado State University Collins, Colorado USA P.189.

Witney,R.J,1958, The strength of lifting action in man, *Ergonomics* Vol.1. No.2 PP 101-128.

Yadav, R.J., 1979 , Development of a manually operated Reciprocating Don Pump for Irrigation. *Journal of Agricultural Engineering*, Vol XVI, No.4, P 101-194.

\* Original not seen.

# APPENDICES

## APPENDIX - I

### Discharge through a 90° V-notch, liters per second

Height of water over V-notch Cm	Discharge litre/sec	Height of water over V-notch Cm	Discharge litre/sec V-notch Cm	Height of water over	Discharge litre/sec
4.0	0.45	13.0	8.6	22.0	31.0
4.5	0.60	13.5	9.5	22.5	31.0
5.0	0.80	14.0	10.5	23.0	35.7
5.5	1.0	14.5	11.3	23.5	38.2
6.0	1.2	15.0	12.3	24.0	40.0
6.5	1.5	15.5	13.3	24.5	42.7
7.0	1.8	16.0	14.5	25.0	44.5
7.5	2.2	16.5	15.6	25.5	46.7
8.0	2.5	17.0	16.7	26.0	46.8
8.5	2.8	17.5	18.3	26.5	51.0
9.0	3.4	18.0	19.4	27.0	53.8
9.5	3.9	18.5	21.7	27.5	56.3
10.0	4.5	19.0	22.3	28.0	58.7
10.5	5.1	19.5	23.5	28.5	61.5
11.0	5.7	20.0	25.5	29.0	64.5
11.5	6.3	20.5	27.0	29.5	66.8
12.0	7.1	21.0	28.3	30.0	69.4
12.5	7.8	21.5	30.3	—	—

## APPENDIX - II

**Question :** How do you like to operate on this Pedal Operated low lift pump ?

**Answer :** This is a good pump it saves time and gives better discharge. But inconvenient for standing and operate. Better it would have been if modified and seating arrangement could give proper operation without much strain.

**Question :** Are you tired ?

**Answer :** Yes.

**Question :** How do you like to operate this pump using seating arrangements ?

**Answer :** I can work for longer duration than the old one. Though, one gets tired after some time with continuous work but could not get exhausted and one could re-reqope in short while for work again. Further one can get more comfort because he can sit while operating the pump as on cycling.

**Question :** Do you cycle daily for coming to your duty ?

**Answer :** Mostly

**Question :** Do you get frightened while operating this pump and looking down to empty tank?

**Answer :** Yes, Sometime.

**Question :** which one is the better operating mode to be used on the low lift hand pump?

**Answer :** Operation of pedal operated low lift pump is better and easier.

## APPENDIX - III

Cost of Operation of existing pedal operated low lift pump and modified pedl operated low lift pump.

A) Cost of operation of existing pedal operated low lift pump.

Cost of pump - Rs.1,400.00

Life of pump - 8 years.

Working hours per year - 300 hrs.

Fixed Cost :

$$a) \text{ Depreciation} - \frac{C - S_r}{L} \times \frac{1}{H}$$

C - Capital cost of pump (Rs)

S<sub>r</sub> - Salvage value (10% of capital cost)

L - Life of pump (yrs)

H - Working hours per year (hrs)

$$\frac{1,400 - 140}{8} \times \frac{1}{300}$$

$$= \text{Rs.}0.53$$

$$b) \text{ Interest} - \frac{C + S_r}{2} \times \frac{i}{100} \times \frac{1}{H}$$

C - Capital cost of pump (Rs)

S<sub>r</sub> - Salvage value (10% of capital cost)

i - Interest rate (12%)

H - Working hours per year (hrs)

$$\frac{1,400 + 140}{2} \times \frac{12}{100} \times \frac{1}{300}$$

$$= \text{Rs. } 0.31$$

c) Insurance - Nil

d) Tax - Nil

$$e) \text{ Hosuing} - \frac{C \times i}{100} \times \frac{1}{H}$$

C - Capital cost of pump

i - Housing cost (1%)

$$= \frac{1400 \times 1}{100} \times \frac{1}{300}$$
$$= \text{Rs.0.05}$$

f) Repair and maintenance

$$= C \times \frac{m}{100} \times \frac{1}{H}$$

C - Capital cost of pump

m - maintenance cost 10% of capital cost

H - working hours per year

$$= \frac{1400 \times 10}{100} \times \frac{1}{300}$$

$$= \text{Rs.0.46}$$

Variable Cost :

a) Fuel - Nil

b) Wages of labour - Rs. 40.00/day (8hrs)  
= Rs.5.00/hr

$$\text{Total operating cost} = 0.53 + 0.31 + 0.05 + 0.46 + 5.00$$
$$= \text{Rs.6.35 per hour}$$

B. Cost of operation of modified pedal operated low lift pump.

Cost of pedal operated low lift pump - Rs.1,400.00

Modification charges - Rs. 133.00

Cost of modified pedal operated :

Low lift pump - Rs.1,533.00

Life of pump - 8 years

Working hours per year - 300

Fixed Cost

a) Depreciation -  $\frac{C - S_r}{L} \times \frac{1}{H}$

C - Capital cost of pump (Rs)

S<sub>r</sub> - Salvage value (10% of capital cost)

L - Life of pump (years)

H - Working hours per year (hrs)

$$= \frac{1533.00 - 153.30}{8} \times \frac{1}{300}$$

$$= \text{Rs.0.34}$$

c) Insurancd - Nil

d) Tax - Nil

e) Housing -  $C \times \frac{i}{100} \times \frac{1}{H}$

C - Capital cost of pump (Rs)

i - Housing cost (1%)

H - Working hours per year

$$= 1533 \times \frac{1}{100} \times \frac{1}{300}$$

$$= \text{Rs.0.05}$$

$$f) \text{ Repair and Maintenance} - C \times \frac{m}{100} \times \frac{1}{H}$$

C - Capital cost of pump (Rs)

M - Maintenance cost (10% of capital cost)

H - working hours per year

$$= 1533 \times \frac{10}{100} \times \frac{1}{300}$$

Variable cost

a) Cost of Fuel - Nil

b) Laour wages - Rs.40.00/day (8hrs)  
Rs.5.00/hr

$$\begin{aligned} \text{Total operating cost (Rs/hr)} &= 0.57 + 0.34 + 0.05 + 0.51 + 5.00 \\ &= \text{Rs.6.47/per hour} \end{aligned}$$

## APPENDIX - IV

### Efficiency of pedal operated pump

#### a) Input Water :

No of cylincer x Dia of Cylinder(mts) x length of cylinder(m)

= In cumecs

Convert cumecs into liters, divide by 1000

= liters/stroke

Water input = No strokes / m in x liters / strokes  
= litres/m in

#### b) Water out put :

Discharge of pedal operated pumps in lits/m in

Efficiency(%) =  $\frac{\text{output} \times 100}{\text{input}}$

## APPENDIX - V

### SURVEY OF LOW LIFT WATER LIFTING DEVICES IN DAKSHINA KANNADA DISTRICT.

1. Village : \_\_\_\_\_ 2. Taluk : \_\_\_\_\_

3. Name of the farmer : \_\_\_\_\_

4. Age : \_\_\_\_\_ Years. \_\_\_\_\_

5. Caste : Sc / St / Others : \_\_\_\_\_

6. Education Qualification :

a. Illiterate : \_\_\_\_\_

b. Primary : \_\_\_\_\_

c. Secondary : \_\_\_\_\_

d. College : \_\_\_\_\_

7. Family size :

Sex : \_\_\_\_\_ No : \_\_\_\_\_

Male : \_\_\_\_\_

Femal : \_\_\_\_\_

Total : \_\_\_\_\_

8. Farm Size (hectares) : \_\_\_\_\_

9. Type of House : Hut/Katcha/pakka : \_\_\_\_\_

10. Details of Animals :

Sl.No.	Name of Animal	Nos.
1.	Bullocks	
2.	Cows : a) Cross breed : b) Local :	
3.	Cattles	
4.	He-Buddaloes	
5.	Donkeys	

11. Occupation : \_\_\_\_\_

Main Occupation : \_\_\_\_\_

Subsidiary occupation :

a. Diary : \_\_\_\_\_

b. Poultry : \_\_\_\_\_

c. Business : \_\_\_\_\_

d. Service : \_\_\_\_\_

e. Sericulture : \_\_\_\_\_

f. Others : \_\_\_\_\_

## 12. Details of Bullock drawn implements

Sl.No.	Name of the implement	Nos.
01.	Wooden ploughs	
02.	Iron ploughs	
03.	Levellers	
04.	Hoes	
05.	Seed drills	
06.	Bullock drawn puddlers	

## 13. Details of Farm machineries :

Sl.No.	Name of the farm machinery	Nos.
01.	Tractor	
02.	Power tillers	
03.	Sprayers	
04.	Dusters	
05.	Oil Engines	

14. Details of low water lifting devices :

Sl.No.	Name of the farm machinery	Nos.
01.	Swing Basket	
02.	Don	
03.	Archimedian Screw	
04.	Persian Wheel	
05.	Self emptying type rope & bucket	
06.	Circular two bucket lift	
07.	Counter poise bucket lift	
08.	Rope and bucket lift	
09.	Low lift hand pump	
10.	Pedal operated low lift pump	

ವಿಶ್ವವಿದ್ಯಾನಿಲಯ  
ವಿಶ್ವವಿದ್ಯಾನಿಲಯ ಗ್ರಂಥಾಲಯ  
ಗಾ.ಕೆ.ವಿ.ಕೆ, ಬೆಂಗಳೂರು-65  
27 SEP 1999  
ಇ. ಸಂ. 5313  
ಆ. ಸಂ. ಸಂ. ....  
ಬ. ಸಂ. ....