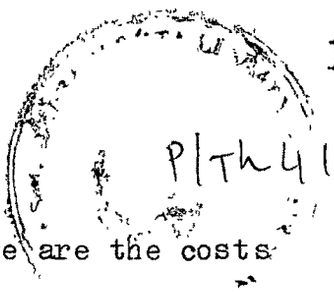
CHAPTER IV

COST OF IRRIGATION BY ELECTRIC MOTOR

In this chapter as also in the following two chapters we shall attempt to compute the costs of irrigation for sample modes of lift of different types, i.e., electric motors, Oil engines and the bullock-operated lifts selected in two sets of villages. The following points need be noted in this context :

(i) Costs of irrigation are worked out only for the sample modes of the cultivators. Since the study relates to economics of different modes and as the sampling of cultivators is mode-wise, the costs are worked out for the particular mode of the cultivator for which he got selected in the sample. Thus, it is possible that the same cultivator got selected in the sample under two different sample modes of lift (or the two units of the same mode of lift). Even in such cases the costs are worked out for the two modes independently of each other and separately.



(ii) Costs of irrigation referred to here are the costs incurred by way of irrigating the crops during one year, i.e., June 1965 to May 1966, on the sample modes.

(iii) 'Costs' are not to be equated with 'expenditure' on the mode of irrigation during the year. Most of the fixed costs like depreciation and interest rate charges are imputed costs, while most of the variable costs like the cost of maintenance and operation are the actual expenses incurred during the year by the cultivator concerned. In the case of bullock-operated lift, some elements of even the variable costs are imputed.

(iv) The problems pertaining to measurement of cost for each mode of lift are different from those of the other and, therefore, we have worked out the costs of irrigation for each mode separately. In Chapter VII we have tried to reduce the costs of different modes to a common standard so as to facilitate the comparison of costs of different modes of lift.

(v) There are two factors external to the mode of irrigation which affect the costs of lifting water from the wells. These are (i) sub-soil water table which depends on rainfall during the year and (ii) the type of crops which determine the intensity and frequency of irrigation.

Rainfall during the Period of Reference

We may briefly comment here on the rainfall in the district during the year, June 1965 to May 1966 (i.e., reference period). The supply of water to the well depends upon the rainfall, as the acquifer lowers down with a meagre rainfall, thereby affecting the level of water in the well. The number of irrigations given to a crop also depend on rainfall. In the Annexure 4A, we have presented data on rainfall during the year June 1965 to May 1966 for the talukas in which the sample villages are located.[1] We have also presented for each of these talukas the figures for normal rainfall provided by the Metereological Department. If we compare the rainfall for the year June 1965 to May 1966 for each taluka with its normal rainfall, it can be said that rainfall during the year in this region was by and large normal.

Irrigated Crops in the Region

It may be mentioned here that the cost of irrigation depends, among other factors, upon the level of operation of the mode expressed in terms of the number of hours of operation during the reference period. However, the number of hours of operationof a mode during any particular period depends upon the intensity of irrigation required which varies

1 This data was obtained from metereological office in Poona which has its rain gauge stations at all the taluka head-quarters in the district.

according to the nature of crops. In the Annexure to this chapter (Annexure Table 4B2), a list of irrigated crops in the region, as also in the sample villages and, by different modes of lift in the sample is enclosed. It may be observed from the aforesaid table that the crops irrigated by different modes of lift in the sample broadly conformed to crops irrigated in the villages covered by the sample modes as well as those in the region.

The intensity of irrigation of major crops irrigated by the sample modes was of a varying nature. For instance, whereas irrigational requirement, both in terms of number of irrigations and the quantum of water per irrigation, of major crops like jowar and wheat is moderately low, that of fruits and vegetables (Onion and Potato) is moderately high. The intensity of irrigation of two other major crops, i.e., Sugarcane and lucern-grass (miscellaneous non-food crop) is quite high with their crop seasons lasting for one full year and requiring around 36 to 40 irrigations of 1 to 1.5 hectre inches each. A more detailed analysis of major crops irrigated by sample modes of irrigation is undertaken in Chapter VII.

Sample of Electric Motors

As stated earlier in the Chapter III, the sample of electric motor was geared to the purpose of explaining the

time-lag in the development of irrigational use of electricity. The pump-sets connected in the village were therefore grouped by the time-lag (expressed in terms of number of years) in their dates of connection from the dates of electrification of the village in which they are located. Table 4.1 gives the year of connections of the sample pump-sets in the selected villages. To facilitate the comparison between the years of connections of sample pump-sets with those of total pump-sets, connected in the selected villages, we have given in table 4.2 the distribution of total number of pump-sets in the selected villages by their years of connection. If we compare the table, relating to the distribution of all pump-sets connected in the villages with the table relating to the distribution of sample pump-sets, it can be seen that pump-sets connected in all the years in the selected villages are proportionately (roughly 40 per cent) represented in the sample.

It may be pointed out here that the cost functions which are fitted here are related to this particular sample design of modes of irrigation.

Various components of costs, concepts employed and the methods of computation are discussed in the following pages.

Table 4.1 : Distribution of Sample pump-sets by horse power and their year of connection in the respective villages.

	Vadagaon	Chikhali	Phursungi	Dawadi	Narayan-gaon	Retawadi	Walunj	Narodi	Total
Date of Electrification	13-12-1957	27-6-1960	11-12-1961	30-6-1962	16-12-1962	26-1-1964	21-10-1963	31-8-1964	
Total No.of pump-sets by horse power									
3	2	16	12	3	31	2	12	13	91
5	-	22	21	26	20	3	5	1	98
Other	-	1	2	-	2	-	1	-	6
Total No.of Sample pumpsets by horse power									
3	-	6	3	1	8	1	6	6	31
5	-	10	7	14	7	2	1	1	42
Other	-	1	-	-	1	-	-	-	2
Distribution of sample pumpsets by their year of connection :									
1958-59									
3	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
1959-60									
3	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-

cont...

Table 4.1 (contd.)

	Vadagaon	Chikhali	Phursungi	Dawadi	Narayan-gaon	Retawadi	Walunj	Narodi	Total
1960-61									
3	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
1961-62									
3	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
1962-63									
3	-	-	1	-	-	-	-	-	1
5	-	4	3	-	1	-	-	-	8
Other	-	1	-	-	-	-	-	-	1
1963-64									
3	-	2	1	-	-	-	3	-	6
5	-	1	3	-	3	-	1	-	8
Other	-	-	-	-	-	-	-	-	-
1964-65									
3	-	4	-	1	8	1	3	6	23
5	-	5	1	14	3	2	-	1	26
Other	-	-	-	-	1	-	-	-	1
1965-66									
3	-	-	1	-	-	-	-	-	1
5	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-

Table 4.2 : Distribution of total pumpsets by horse power [illegible] by their years of connection in the respective villages.

	Vadagaon	Chikhali	Phursungi	Dawadi	Narayan-gaon	Retawadi	Walunj	Narodi	Total
Date of Electrification	13-12-1957	27-6-1960	11-12-1961	30-6-1962	16-12-1962	26-1-1964	21-10-1963	31-8-1964	
Total no.of pump-sets connected in the village	2	39	35	29	53	5	18	14	195
Distribution of pump-sets connected by their year of connection :									
1958-59									
3 HP	1	-	-	-	-	-	-	-	1
5 HP	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
1959-60									
3HP	-	-	-	-	-	-	-	-	-
5HP	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
1960-61									
3HP	-	-	-	-	-	-	-	-	-
5HP	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
1961-62									
3HP	-	-	-	-	-	-	-	-	-
5HP	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-

cont...

Table 4.2 (contd.)

	Vadagaon	Chikhali	Phursungi	Dawadi	Narayan-gaon	Retawadi	Walunj	Narodi	Total
1962-63									
3HP	-	1	1	-	-	-	-	-	2
5HP	-	8	9	-	3	-	-	-	20
Other	-	1	2	-	-	-	-	-	3
1963-64									
3HP	-	3	2	-	2	-	6	-	13
5HP	-	2	8	-	5	-	1	-	16
Other	-	-	-	-	-	-	1	-	1
1964-65									
3HP	1	12	4	3	26	2	6	13	67
5HP	-	12	3	26	10	2	4	1	58
Other	-	-	-	-	1	-	-	-	1
1965-66									
3HP	-	-	5	-	3	-	-	-	8
5HP	-	-	1	-	2	1	-	-	4
Other	-	-	-	-	1	-	-	-	1
Total number of pumpsets by Horse power :									
3HP	2	16	12	3	31	2	12	13	91
5HP	-	22	21	26	20	3	5	1	98
Other	-	1	2	-	2	-	1	-	6

Fixed cost. The fixed cost is divided into two parts : (i) the depreciation charges on electric motor, pump-set and other accessories, (ii) interest rate charges on the written down value of the investment at the beginning of the year of reference (viz., June 1965-May 1966). For computing these components we have to estimate the total investment.

Initial Total Investment

We shall now give the costs of different items of investments of an electrically operated pumpset as reported by the cultivators. Different items of investment are : (a) electric motor, pumpset and other accessories such as pipes, starter and switch-board, etc., (b) transportation cost of motor and accessories, (c) installation charges i.e., cost of construction of foundation and wiring, (d) constructing pump-house, and (e) service connection charges and deposit paid to M.S.E.B.

To start with, we shall give briefly the method of collection of data on these investment costs and discuss their limitations.

In the case of the cultivators who had financed their equipment through loans from the Co-operative Land Development Bank or the Block Development Office, the receipts or the cash memos of the equipment were maintained with the

taluka office of these Banks or the Block Development Office. For those cultivators, therefore, the amount stated in the receipts were considered for estimating the investment costs. The other cultivators, who had financed the equipment of their own, were asked to produce the cash memos if they had. In most of the cases the cultivators did not have such receipts. However, many of these cultivators had purchased their equipment from the dealers in electric motors of different makes in Poona City, and in some cases from the dealers at the taluka headquarters whose local addresses they could give. For these cultivators, therefore, the dealers were contacted and were requested to produce the counter-receipts of the equipment sold to these cultivators. Since the dealers were contacted through the Office of the Directorate of Industries, Maharashtra State, they produced the required receipts, though grudgingly. The authencity of these receipts were checked from the total amount reported by the cultivators to have been spent on the investment. Fortunately, in all the cases the receipts produced by the deadlers were authentic. However, the purpose of approaching the dealers in these equipments and the office of the Co-operative Land Development Bank was not entirely served. The purpose was not only to have correct estimate of the initial investment costs, but also to have as many details as possible on the different items of costs

such as motor, pump, pipes, starter, etc. Unfortunately, these details were not stated in the cash memos either at the office of the Land Development Bank or Block Development Office or even in the receipts with the dealers. For example, the amount charged for pump, motor, the pipes and other ancillary things like wires etc. was stated together and not separately. All the dealers appeared to be reluctant to state the quantities of pipe purchased by the customer and further stated that the prices of the pipes varied with the quality of the pipe purchased, which was fair enough. But, then they had not specified the description of the pipe purchased by the particular cultivator such as 'galvanized' or thickness of circumference in centimetres etc. in the receipt. Later on, the plausible explanation for not giving the details in the receipt by the dealers was obtained through the discussions with the office-bearers of the Land Development Bank.

The Land Development Bank did not give cash to loanee but issued a certificate of the loan amount in the name of the dealer from whom the cultivator desired to buy the equipment. Furthermore, it may be observed that the prices of motor and the pump to be sold as part of 'tacquavi loan' were fixed by the Government and as such the prices were below the open market prices of the equipment. Therefore, once the cultivator produced the certificate of the Land

Development Bank, the dealer had to sell to the customer at the price fixed by the Government. The dealers, therefore, suffered a loss in selling the equipment on the invoice certificate of the Land Development Bank. To make good for such loss, the dealer charged exhorbitant prices for other items of investment like pipes, starter, switch board, wires, etc. To conceal this, the receipt was prepared without giving the details either of quantity or the quality of the items purchased. Unfortunately, there was not enough evidence to prove this conclusively. However, there were other anomalies observed in respect of the installation of pumpsets by the dealers which are briefly described below.

In one of the sample villages, i.e., Chikhali, most of the motors were purchased from a dealer in Poona city dealing in the motors of the make 'Jyoti'. The village is about 16 miles from Poona city. When the dealer was requested to produce the counterfoils of the cash memos of the motors sold in the village Chikhali, he gave it after some hesitation. It was observed in the receipts that the transportation charges of the equipment entered therein were not uniform for all the motors sold in the village. On clarification, the dealer reported that the charge for transportation was fixed at 4 per cent of the value of the equipment purchased, which meant Rs.55 to Rs.60 and Rs.65 to Rs.80 for 3 H.P. and 5 H.P. motors,

respectively, for a distance of 16 miles. Even this 4 per cent was also not uniformly charged to all the customers. In case of some customers, not even 1 per cent of the value was charged for transportation by the same dealer. It may be stated here that wherever the motors were purchased of some other make, the transportation charges had come to only Rs.25 to Rs.30, irrespective of the size of the motor in Horse-Power.

In the sample village Dawadi, (Taluka Khed) an irregularity of altogether different nature was observed causing a lot of wasteful expenditure for the cultivators using electric motors. The village was an 'Inam' village belonging to one of the ex-Princely State rulers in India. The ex--ruler had constructed a palacial building in the village which was looked after by the estate manager known locally as 'Sardar' (a knight). With the less frequentation of the Princely State ruler to the village, the Sardar Became almost a monarch since many of the cultivators in the village were indebted to the Princely ruler and Sardar being the estate--manager threatened to act on behalf of the ruler. Subsequently, the 'Sardar' was elected on the "Taluka Panchayat Samiti" and was member of the Consultative Committee of the District Co-operative Land Development Bank.

When the village was electrified for domestic lighting, the Sardar was approached by one of the representatives of

a company manufacturing electric motors with an offer of 10 per cent commission on each of the motors sold, plus a free electric motor for every ten motors sold in the village. The Sardar, in turn, forced some of his debtors to go for electric motors of the said company. As a member on the Consultative Committee of the Land Development Bank, he got the loans sanctioned for the cultivators through the Land Development Bank. The work regarding the sanction of loans and the setting up of motors at sites was done so expeditiously by the Sardar that the electric motors were lying idle waiting just for the connection from the M.S.E.B. for as many as 10 months. Finally, the concerned cultivators had to file a representation to the Land Development Bank to defer the first repayment instalment of the loan by one year since the motors were not actually put to use when the notice regarding the first repayment instalment was received. All this apart, within one month of commissioning of motors, all the motors were burnt one after the other. The cultivators had to get them repaired from Bombay, but, after re-installation they burnt again. One of the cultivators of the village, who was an employee of Zilla Parishad, got the motor inspected by a third party mechanic who found out a manufacturing defect in the motor which was causing the damage to the motor from the slightest fluctuation in the voltage of current. The cultivator somehow got the motor sold

and replaced it by a motor of different make. At the time of survey of the village, as many as 9 motors in the village were totally out of use and their owner-cultivators had reverted back to the bullock-operated lift.

In yet another sample village, Retawadi, where the cultivator had installed a 3 HP motor and financed it through the loan from the Land Development Bank, he was charged more by the Dealer than his fellow cultivators in the village who had installed 5 HP motor and had used more of pipes in length.

All these point out to a need of close supervision by the Land Development Bank over the prices charged by dealers for different items of cost of installation of motor, and also to give guidance to the cultivators in the selection of motors. The Land Development Bank should have also ensured that the same quality motors are supplied to loanees of Land Development Bank as are supplied on the open market. In the absence of it, the entire spirit of subsidization of motors was lost in some cases.

However, in the selected sample of motors these irregularities had led to an artificial increase in the investment costs of motor to the cultivator. But these reported costs under the circumstance represented the actual costs of installation of sample motors to the concerned cultivators,

and hence the same were taken for the purpose of computation.

Table 4.3 and 4.4, summarize for 3 HP and 5 HP motors, the investment cost incurred by cultivators on different items of cost. As the sample covers motors connected in different financial years, we have provided the average costs on each item for motors connected in each year separately.

As stated earlier, not many breakdowns of the investment could be given because of the manner of presentation of the costs in receipt-books of the dealers, and in the vouchers with the Land Development Bank. It should be noted that the tables average out the investment costs of motors of different makes which were found in the sample. Since the number of motors of each make within the sample of each size of motor was small, separate tables could not be given for each make. Further, the mode of presentation of data in receipt books by one of the dealers (in not giving the details of costs for motor, pump, pipe and other accessories) acted as a constraint in furnishing the details. We have, therefore, clubbed together the costs of motor, pump, pipes, starter and switch for presentation in the Tables although for some dealers the details of the costs were available for each of these items.

Table 4.3 : Investment cost of sample motors - 3 Horse power.
(Cost in Rs.)

Year of installation	No.of sample motors installed	Average cost of motor, pump, pipes and other accessories	Average cost of installation charges	Average cost of other charges	Average cost of pump-house	Average Total investment
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1962-63	1	1200.00	120.00	166.00	600.00	2086.00
1963-64	6	1542.25	136.83	154.88	725.00	2558.96
1964-65	23	1495.14	177.15	141.99	295.15	2109.43
1965-66	1	1134.82	300.00	136.00	10.00	1580.82
Total	31	1483.11	171.47	145.07	378.98	2178.63

Table 4.4 : Investment cost of sample motors - 5 Horse power.
(Cost in Rs.)

Year of installation	No.of sample motors installed	Average cost of motor, pump, pipes and other accessories	Average cost of installation charges	Average cost of other charges	Average cost of pump house	Average Total investment
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1962-63	8	2092.22	270.00	208.14	563.75	3134.11
1963-64	8	1636.41	265.00	171.79	282.50	2355.70
1964-65	26	1790.15	213.23	169.95	192.50	2365.83
Total	42	1818.40	233.91	177.58	280.35	2510.24

It can be observed from these tables that as the time-span covered by the sample is small, i.e., three and half years only, the total investment costs do not show any increase over the period. On the contrary, it shows a decline in the total investment costs for the motors of both the sizes - 3 HP and 5 HP. However, the decline in the investment-costs is more apparent than real. Strictly speaking, the investment costs between the years for the same sizes of motors are not comparable with each other. The quantities as well as the quality of the equipments differ for sample motors installed of the same size in different years. For example, the average sizes of the pipes purchased along with the sample motors of 3 HP in the years 1962-63, 1963-64, 1964-65 and 1965-66 were 30 feet, 61 feet, 71 feet, and 31 feet, respectively. These differences in the average sizes of pipes partly explain for the differences between the years in column 3 of tables. The same is true with respect to 5 HP motors where also the average sizes of pipelines per sample motor installed in 1962-63, 1963-64 and 1964-65 were 172 feet, 65 feet and 55 feet, respectively. Partly the difference is also due to the quality of the equipment installed. In some cases the accessories such as starters[1] and pipes which were installed

1 Starter is a device which guards the motor from damages due to fluctuations in the voltage of current. It automatically cuts the supply of energy to the motor when the voltage of current falls or rises beyond a certain range.

by the cultivators were of such high quality that they had cost almost one and half times of those used by the other cultivators. For example, one of the motors in the sample had a starter and a main switch worth Rs.231 while most of the cultivators had spent Rs.160 on starter and main switch. Similarly, while some of the cultivators had used pipes costing as much as Rs.5.50 to Rs.6 per foot, the other had used pipes costing only Rs.3.50 to Rs.4 per foot. Both these factors thus had accounted for the difference in average cost of motor, pump and pipes, etc.

It can be further observed from these tables that the variations over years are comparatively less in respect of average installation charges (Column 4) and other charges (Column 5) for the motors of both the sizes. This is because most of the dealers had a fixed rate of installation charges which was then Rs.100 for 3 HP and Rs.150 for 5 HP motor. The excess (in some cases) over the above-stated installation charges were due to the additional cost (a) for different types of foundations and (b) for girders (rail poles) fixed inside the well to facilitate the vertical movement of motor and pump which was sometimes necessary to cope up with the fall in the level of water during the summer.

Similarly, the average cost of other charges (Column 5) include the deposit which the cultivator had to pay to the

Maharashtra State Electricity Board and the costs incurred by him to transport the equipment from the dealers shop to the site of installation. For all these years, i.e., 1962-63 to 1965-66, the amount required to be paid to the Board in the form of a refundable deposit remained the same, i.e., Rs.15 per horse power and a non-refundable sum of Rs.81/- towards service connection charges. Thus the total amount which the cultivator had to pay came to Rs.126 (3 x 15 + 81) for 3 HP and Rs.156 (5 x 15 + 81) for 5 HP motor. The variations between the years in the average cost of other charges in the tables are due to different transport costs obtaining for cultivators for reasons explained earlier.

The variations in the average cost of pump-house are the largest between the years. This is due to the various types of construction undertaken by the cultivators to house the pump-set. The types of construction ranged in the case of sample cultivators from a bare wooden box covering the motor and pump or a single-brick-wall "katcha" construction (sometimes even tin-walls) with a thatched roof to a full-fledged reinforced concrete structure with stone-walls having a floor area of about 150 square feet. In the latter case the pump-house was also used to store other implements and put to such other ancillary uses. But, since the main purpose of construction, as was revealed from the location of the house, was to

house the pumpset, no apportionment of the cost towards other uses was done. The cost of construction, thus, varied from Rs.10 in case of a wooden-box to Rs.200 or Rs.250 in case of 'katcha' construction, and as much as Rs.1,000 in case of reinforced concrete structure.

In the following the method of computing depreciation charges which are considered to work out the irrigation cost by this mode of irrigation during the year, is briefly discussed.

Depreciation Cost

For computing depreciation charges for one year, the straight line method of depreciation is followed. The assumptions regarding the life-span of motor, pump and other accessories and pump-houses are discussed when the sample data are described. Interest is charged on the value of the depreciated capital at the beginning of the year, i.e., 1st June 1965; the value of depreciated capital in case of each sample pumpset is calculated with respect to its date of connection.[1] If the pumpset is connected in the latter half of any month the depreciation is not calculated for that month, but if it is connected in the first half of the month the depreciation is charged for that month. Thus, it is assumed

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1 As stated in Chapter III, the dates of connection of individual pumpset were available in the meter-cards maintained at the sub-divisional office.

that the cultivator takes a fortnight's time to adjust to the electrically operated pumpset so as to use it effectively.

The life of the motor is taken as ten years, and hence in each individual case one-tenth of the total investment cost on motor, pump, pipes, starter etc. is taken to be the investment cost for the year. It may be noted here that the transportation charges and installation charges are also taken into account, and included in the total investment to work out the depreciation cost for the year. In the case of deposit paid to the Maharashtra State Electricity Board, the refundable amount, i.e., security deposit at the rate of Rs.15 per HP is not considered while calculating the depreciation charges, although interest has been charged on this amount.

The depreciation charges are worked out separately for the pump-house because the life of the pump-house, depending as it was on the type of construction undertaken by the cultivator, differed from ten years which was assumed for the motor and the pump-set. The estimate of the life of the pump-house was based on the expectation of the cultivator which was confirmed by witnessing the type of construction. In Table 4.5 we have given the lives of pump-houses of sample motors as reported by the cultivators. The constructions are classified broadly into five categories and the average cost of construction are given with the average expectation of life as

reported by the cultivators for each type of construction.

Table 4.5 : Average life and investment costs of pump-houses constructed on motors in the sample.

Type of construction	No.of pump-houses	Range of investment cost (In Rs.)	Average investment cost Rs.	Average life of pump-house reported (In years)
Wooden box	8	0-10	10.00	1.00
Tin shed	2	11-99	60.00	5.50
Single-brick/tin wall construction	43	100-350	200.20	12.40
Brick-wall with plastering etc.	18	400-750	525.00	21.75
Stone-wall construction with plastering etc.	4	1000 & above	1350.00	32.00

The range of investment cost has been given in the table to indicate the variations in the construction cost within the same type due to change in the size of construction. For installation of motor, sometimes the ground area near the well was dug up for laying the foundation for the motor (this was done specially where the well was deep and the installations at the ground level would prohibit the use of motor and pump during summer when the water-level receded). The construction of pump-house, under such circumstances, entailed the construction of walls from the level of founda-

tion upto the ground level which increased its size and consequently the cost.

Interest Rate Charges

Different rates of interest are charged depending upon the originating source of finance for the investment in the electrically operated pumpset. Wherever the finance was borrowed, the market rate of interest, i.e., the actual cost of the borrowing is charged. In respect of motors in the sample, generally, the finance was borrowed from the State Cooperative Land Development Bank and hence the rate of interest of 4.5 per cent per annum (the then prevailing lending rate of the State Cooperative Land Development Bank for the long term finance) is charged. In some cases, the finance for installation of motor was borrowed from the Block Development Office by the cultivators. However, the rate of interest charged per annum by this agency was also 4.5 per cent to the cultivators for the purchase of electric motors and hence the same is taken for the computation of interest costs.

Source of Finance

Table 4.6 gives the sources of finance for pumpsets in the sample. It may be noted that in some cases, specially where the finance was borrowed, the sources of finance for the installation of a pumpset were more than one, i.e., partly

borrowed and partly owned (self-financed).Since differential rates of interest is charged depending upon the sources of finance, the pumpsets having two sources of finance are given separately.

Table 4.6 : Source of finances for pumpsets in the sample.

Source of finance	No.of pumpsets
(A) Borrowed	18
(B) Owned	34
(C) Partly borrowed and partly owned	23

It may be further observed here that wherever the borrowed funds were supplemented by owned capital, the extent of owned capital invested in the installation of pumpset varied with the quantum of loan made available to the cultivator from the District Cooperative Land Development Bank. In Table 4.7 we have presented the distribution of category 'C' of table 4.6 (23 pumpsets) by 'average amount of owned capital' and 'borrowed capital invested' in the installation of pumpsets.

It can be observed from table 4.7 that at the aggregative level, the proportion of borrowed capital to owned capital invested is roughly 4:1. For more than half of the motors

Table 4.7 : Details of source of finance in respect of motors financed partly out of owned funds and partly out of borrowed funds.

(Amount in Rs.)

Amount of owned capital invested	No.of motors	Average HP connected per pump-set	Average amount of owned capital invested	Average amount of borrowed capital invested	Average amount of total investments	Average borrowed capital + Average owned capital
0-200	3	3.00	106.67	1933.33	2040.00	18.12
200-400	10	3.60	268.76	1772.50	2041.26	6.60
400-600	3	3.67	445.67	1667.67	2113.34	3.74
600-1000	5	4.25	561.40	2070.80	2632.20	3.69
1000 & above	2	4.00	1674.88	2250.00	3924.88	1.34
Total	23	3.69	456.58	1886.05	2342.63	4.13

(13 out of 23), the proportion of borrowed to owned capital invested is 7.8 to 1. It is only in the last two groups that the proportion of borrowed to owned capital has declined to 2.4 to 1. It may be noted that in these two groups the total amount invested for installation is also more than the first three groups. This was not only due to higher horse power connected in these groups, but also because of larger amount spent on the construction of pump houses for which only owned capital was invested. It is notable that there is a systematic relationship between the horse power connected, the total amount of investment and the proportion of borrowed capital.

It is seen that higher the amount of total investment, smaller is the proportion of borrowed capital.

Thus it can be seen that out of the sample of 75 electrically operated pumpsets, 34 were financed out of owned funds and 18 out of borrowed funds. Of the remaining 23 which were financed out of both borrowed and owned funds, 16 were predominently financed out of borrowed funds, while in the case of 7 pumpsets the borrowed funds were supplemented to a greater degree by owned funds. On the whole, therefore, both the sources of finance, i.e., borrowed and owned, had an equally important role in the installation of sample pumpsets. Hence, for the computation of interest rate charges for the use of capital, two different rates of interest are considered, one for owned source of finance and another for the borrowed source of finance. Where the financing is fully out of either borrowed or owned funds, only one of the relevant interest rate charge is made applicable, while in the case of mixed financing both the rates are made applicable for their respective parts in the total invested capital. The particular rates of interest adopted for these two sources of finance are discussed below.

Rate of Interest : In the case of borrowed funds the interest rate charged is the same as that charged by the Land Development Bank or the Block Development Office for the long-term loans.

The interest rate charged by these agencies was 4.5 per cent and hence the same is taken for computing interest costs. Where the source of finance was owned, the rate of interest considered for computing interest rate charges is less than that charged by the above-mentioned agencies.

The rate of interest to be charged has to be uniform for all the modes of lift. To keep the parity of rates of interest considered for the self-financed motors and other modes like oil engine and traditional bullock operated lift which were found to be more readily disposable, a short-term rate of interest is considered for computing interest costs for electric motor also. The fact that over 45 per cent of the sample motors were financed wholly out of owned funds despite the availability of institutional finance at subsidised rates is taken as an indicator of lower opportunity cost of owned funds in rural areas. For these reasons, the rate of interest on owned funds was taken as 3.5 per cent - one per cent less than L.D. Bank rate - which was the short-term Savings Bank rate of Commercial banks.

Assumptions in Computing Interest Costs : We shall now describe the procedure adopted and the underlying assumptions in the computation of interest costs and later on give the details of different items of investment costs.

As stated earlier, we have charged interest on the depreciated value of the investment at the beginning of the reference period. Furthermore, the depreciation of initial value of investment in the case of each of the pumpsets is worked out from the month of its connection upto 1st June 1965, for all completed months based on 'straight line method' of depreciation with an assumption that the life of the motor and the pumpset with all its accessories is ten years. In respect of the pump-house, the life is taken to be as stated by the cultivator and also depending upon the nature of construction such as reinforced concrete structure or a thatched brick-house or a tin-structure or a wooden box. For working out depreciated value of pump-house, a straight line method is adopted. Thus, annual depreciation is equal to one-tenth of the book value of investment and the monthly depreciation is equivalent to one-twelfth of annual depreciation. In this manner, after accounting for depreciation upto 1st June 1965, from the book value of investment, the depreciated value of the investment at the beginning of period of reference is arrived at. On this value of the capital, we have charged interest for the use of capital during the year depending upon the source of finance. Where the entire investment (pumpset plus pump-house) was financed out of owned funds there was no problem in computing interest costs, since the depreciated value could be charged at

3.5 per cent. However, where the investment was financed out of borrowed funds, either partly or entirely, some assumptions had to be made to compute interest costs. The nature of these assumptions is discussed below.

In all cases where the finance was borrowed, it was either from the Land Development bank or the Block Development Office. It is therefore, pertinent to describe the procedure of repayment of the loan availed of from these agencies as the interest rate in these cases has to be charged on outstanding amount of loan as on 1st June 1965 and not on the original amount.

In case of such loans, the loanee was required to pay the loan back in ten equal instalments with first instalment commencing from the end of first year from the drawal of the loan. This meant in the initial repayment instalments, the share of the interest rate charges was more and that of principal amount was less while in the latter instalments, the share of interest rate charges declined and that of principal amount increased. From this normal practice of repayment of loans, we have deviated and made assumptions to suit our procedure of charging, interest rates on depreciated value of equipment.

Two following assumptions are made as regards the repayment of loans -

(A) Although it was observed that there was a time lag between

the drawal of loan and installation of pumpset, (installation meaning here the commencement of electric supply) it is assumed that the drawal of loan and the installa tion of pumpset coincides. In other words, it is assumed that the first repayment instalment is paid by the loanee after the completion of one year of installation. This assumption regarding the simultaneous occurence of availment of loan and installation of pumpset is made so as to have the same outstanding amount of loan as well as depreciated value of equipment on 1st June 1965.

(B) In the normal practice, the repayment of loan to these agencies was in ten equal instalments with every instalment falling due on the completion of year from availment of loan - first, second, third and so on upto ten years. However, in computing depreciation of equipment, we have calculated the depreciation for completed months also. To avoid the divergence between the depreciated value of the loan and that of equipment, we have assumed as if the principal amount was repaid every month. Thus we have totally disregarded the actual practice of repayment. It may however be noted that even under this assumption the total amount repaid by the loanee would be the same as under ten annual repayment instalments, the only difference being that, whereas in actual practice the proportion of principal amount repaid in the instalment increases with every instalment, under our assumption, the principal amount repaid

would remain the same while the interest amount paid would decline with every repayment instalment.

Secondly, wherever the equipment was financed out of two sources namely, borrowed and owned, this assumption made it easy to determine the component of borrowed funds in the depreciated value of the equipment.

Interest costs and its contribution in total costs [1] : Thus, as discussed above, the interest costs for each pumpset depend upon the following parameters: (i) the number of years completed by the pumpset on 1st June 1965, (ii) the initial total investment costs for the pumpset, (iii) the source of finance for the pumpset. The first two would determine the depreciated value of the initial investment upto 1st June 1965, while the third would determine the rate of interest which would be considered for computing the costs. Tables 4.8 and 4.9 present the distribution of sample motors of two predominent sizes, namely, 5 HP and 3 HP, respectively on the above-stated parameters.

It can be observed from the table that interest costs for the year 1965-66 are the least where the finance is entirely owned since it is subject to only 3.5 per cent rate of interest. Similarly, the interest costs are the highest where the

1 The remaining components of fixed cost and total cost are worked out in the latter sections of this chapter.

Table 4.8 : Age-wise distribution of pumpsets, average investment by category of finance, and interest cost : 5 HP Electric Motor.

(cost in Rs.)

No.of years completed on 1st June 1965	Number of Motors			Initial average investment cost per motor(Category A&B)		Initial Average Investment cost per motor (category C)			Average Interest rate charges		
	Own finance (Cat. A)	Borrowed finance (Cat. B)	Mixed (Cat. C)	(Cat.A) Average investment cost	(Cat.B) Average investment cost	Investment out of borrowed finance	Investment out of own funds	Total investment	Cat.A	Cat.B	Cat.C
0.0-0.25	-	-	-	-	-	-	-	-	-	-	-
0.25-0.50	4	13	3	2256.82	2203.70	2133.33	378.23	2511.56	76.08	99.06	105.32
0.50-0.75	2	-	1	2385.05	-	2000.00	470.00	2470.00	72.34	-	102.12
0.75-1.00	-	-	1	-	-	2500.00	1057.75	3557.75	-	-	138.73
1.00-1.25	3	-	1	2359.59	-	2000.00	395.31	2395.31	74.71	-	92.48
1.25-1.50	2	-	-	2761.00	-	-	-	-	83.58	-	-
1.50-1.75	1	-	-	2323.50	-	-	-	-	70.84	-	-
1.75-2.00	-	1	2	-	1828.00	2000.00	433.50	2433.50	-	69.25	86.78
2 & above	7	1	-	3200.98	2201.00	-	-	-	90.36	77.52	-
Total	19	15	8	2690.96	2178.48	2112.50	468.10	2580.60	81.25	95.64	102.86

Cat. = Category

Table 4.9 : Age-wise distribution of pumpsets, average investment costs by category of finance, and interest costs : 3HP electric motor.

(Cost in Rs .)

No.of years completed on 1st June 1965	Number of motors			Initial average investment cost per motor (Category A & B)		Initial Average Investment cost per motor (Category C)			Average interest rate charges		
	Own finance (Cat. A)	Borrowed finance (Cat. B)	Mixed (Cat. C)	Category A	Category B	Investment out of borrowed finance	Investment out of own funds	Total investment	Category A	Category B	Category C
0.0-0.25	-	1	-	-	1580.82	-	-	-	-	70.00	-
0.25-0.50	3	-	3	1351.53	-	1900.00	285.25	2185.25	68.94	-	92.09
0.50-0.75	4	-	3	1965.27	-	1866.67	217.67	2084.34	65.62	-	87.30
0.75-1.00	4	-	5	2731.81	-	1475.82	368.17	1843.99	92.00	-	74.28
1.00-1.25	-	-	1	-	-	2000.00	256.00	2256.00	-	-	88.01
1.25-1.50	1	-	1	1590.00	-	2000.00	2292.00	4292.00	47.98	-	158.14
1.50-1.75	2	-	1	2073.38	-	1800.00	143.00	1943.00	62.98	-	72.65
1.75-2.00	-	-	1	-	-	2000.00	716.00	2716.00	-	-	97.77
2 & above	-	1	-	-	2086.00	-	-	-	-	58.52	-
Total	14	2	15	2041.41	1833.41	1765.27	450.44	2215.71	72.23	64.26	88.41

Cat. = Category.

financing of the motor is partly out of borrowed funds and partly out of owned funds. This is not only because the average investment cost is on the high side where the financing is through multiple sources, but also because the distribution of sample motors under this group is in favour of comparatively recent connections, which means less accounting for depreciation upto 1st June 1965. For the same reason in the case of motors with 3 HP size, the average interest rate charges for the year 1965-66 are the least for the motors which have been financed entirely out of borrowed funds, although the rate of interest in such cases is higher than where it is financed out of owned funds. In the case of these motors not only the average investment cost is less than that of the motors having entirely owned source of finance but also the distribution of sample motors under this group (having entirely borrowed source of finance) is evenly matched between recent and older connections. Distribution of sample motors under the other group (having entirely owned source) is skewed in favour of recent connections.

The contribution of interest-rate charges (in percentage terms) in the total fixed costs as well as in the total costs of irrigation by electric motor during the year 1965-66, is presented in tables 4.10 and 4.11 for 5 HP and 3 HP motors, respectively.

Table 4.10 : Contribution (in percentage terms) of interest costs in fixed costs and total costs of operation of Motors of 5 horse power.

No.of years completed on 1st June 1965	Number of motors			Average share of interest costs in fixed costs			Average share of interest costs in total costs			Average number of hours of operation during the year		
	Own finance (category A)	Borrowed finance (category B)	Mixed (category C)	Category A	Category B	Category C	Category A	Category B	Category C	Category A	Category B	Category C
0.0-0.25	-	-	-	-	-	-	-	-	-	-	-	-
0.25-0.50	4	13	3	26.42	31.17	31.18	10.95	16.72	19.05	591.42	230.40	221.18
0.50-0.75	2	-	1	26.02	-	29.88	13.38	-	11.51	321.85	-	954.96
0.75-1.00	-	-	1	-	-	29.85	-	-	13.11	-	-	1025.74
1.00-1.25	3	-	1	25.07	-	29.41	9.18	-	17.78	903.93	-	153.35
1.25-1.50	2	-	-	23.45	-	-	11.29	-	-	655.63	-	-
1.50-1.75	1	-	-	26.17	-	-	5.67	-	-	2023.59	-	-
1.75-2.00	-	1	2	-	29.52	26.92	-	12.30	11.84	-	592.49	695.44
2 & above	7	1	-	25.92	26.71	-	12.18	8.53	-	630.42	1164.34	-
Total	19	15	8	25.65	30.76	29.57	11.14	15.88	15.40	708.84	316.80	523.43

Table 4.11 : Contribution (in percentage) of interest costs in fixed costs and total costs of operation of electric motors of 3 horse power.

No.of years completed on 1st June 1965	Number of motors			Average share of interest costs in fixed costs			Average share of interest costs in total costs			Average number of hours of operation during the year		
	Own finance (Category A)	Borrowed finance (category B)	Mixed (Category C)	Category A	Category B	Category C	Category A	Category B	Category C	Category A	Category B	Category C
0.0-0.25	-	1	-	-	30.14	-	-	17.03	-	-	520.11	-
0.25-0.50	3	-	3	25.39	-	30.55	17.10	-	16.57	343.76	-	501.34
0.50-0.75	4	-	3	26.85	-	30.70	12.77	-	17.01	861.33	-	288.80
0.75-1.00	4	-	5	25.25	-	31.69	13.39	-	13.49	495.89	-	1052.46
1.00-1.25	-	-	1	-	-	29.42	-	-	20.50	-	-	304.74
1.25-1.50	1	-	1	23.69	-	37.39	12.71	-	20.77	222.00	-	922.70
1.50-1.75	2	-	1	25.62	-	27.60	13.96	-	16.95	463.81	-	383.82
1.75-2.00	-	-	1	-	-	30.28	-	-	12.78	-	-	1235.92
2 & above	-	1	-	-	24.12	-	-	11.61	-	-	497.77	-
Total	14	2	15	25.68	27.13	31.13	14.04	14.32	15.95	543.55	508.94	698.65

It can be observed from these tables that interest rate charges contribute about 25 to 31 per cent of the fixed cost depending upon the source of finance and age of motor. The variations due to source of finance appear to be more significant than variations due to age. In the total costs of irrigation, however, the share of interest costs is roughly about 15 per - cent for the motors of both the sizes. But there are larger variations in the percentage contribution to the total cost of irrigation within each category of source of finance. This is primarily due to the variations in the number of hours worked during the year by the motors as well as the average investment cost per motor.

The Variable Costs

We shall now describe the method adopted to work out the variable cost, i.e., the cost of running the pump and motor during the reference period viz., June 1965-May 1966. Since the description of the motors in the sample would facilitate the understanding of the method adopted, we would first give some more details about the motors selected for study.

Tables 4.12 presents the respondents' ownership rights in the sample motors.

It can be seen from Table 4.12 that the respondents did not have 100 per cent ownership rights in all the sample

Table 4.12 : Ownership rights of respondents in sample motors.

Ownership right of the respondent in the sample motor (in percentage)	Number of sample motors
100-	46
99-75	2
74-50	8
49-25	9
24-10	9
9 or less	1

motors. In nearly 40 per cent of motors the respondents shared the ownership rights with other farmers. In such cases, their uses of the motors were restricted to certain specific period,[1] and hence, the particular respondent could not furnish all the details pertaining to operation and maintenance of the motor which he shared with others. For this very reason, the dealers of the electric motors and the Land Development Bank were approached for getting the details of the investment. It may be noted here that where the sample motor was shared by more than one person, it was not possible to contact all the co-partners in the motor to get all the details of operation

1 Where the motor was shared by cultivators who were co-partners in the well, the operation of motor by each person sharing it was subjected in most of the cases to rotation. Thus every cultivator got his turn after fixed interval, while the duration of this turn depended upon his share in the investment costs of the motor. The electricity bills and the maintenance cost, of course were shared by each cultivator in proportion to his right in the motor.

and maintenance because in some cases they were as many as 15 to 20. Since the operation and maintenance costs were shared in proportion to one's share in investment, these costs were estimated on the basis of details furnished by the user-respondent who was having his turn on the day of visit.[1]

Components of Operation & Maintenance Costs

Operation costs of an electric motor during the year 1965-66 (June 1965-May 1966) were the charges paid by the cultivator/cultivators to the Maharashtra State Electricity Board for the use of electricity. For motors under study, there was no difficulty in estimating these charges as the month-wise amount billed for each of the sample motors was available in the meter-card of the motor at the sub-divisional office. However, two points need to be elaborated. They pertain to : (i) coverage of time-span of the meter-readings[2] in relation to the period of study ... (ii) the apportionment of the total hours and thereby total operation costs between different co-partners where the motor was shared.

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1 It may be noted that in respect of jointly-owned motors, besides the user-respondent, the senior-partner (i.e., partner maintaining accounts and paying the energy charges) was invariably contacted for ascertaining the information obtained from user-respondent as also to get certain other information (analysed in Chapter VIII) on motivation for shifting to electrically operated device.

2 The operation costs for the year were based on meter-readings during the year which give the units consumed by motor for the period of reference. It may be noted that this information on units consumed was correlated with the duration of crops irrigated during the period of reference, as reported by the respondents.

(i) Coverage of Time-Span of Meter-Reading : The meter-reading of every electrically operated pump was undertaken, then, every month. Every meter-reader of the Maharashtra State Electricity Board had in his jurisdiction about 200 consumers, spread, on an average, in 4 to 5 villages. The consumers of each village, therefore, were covered in a particular week of every month. For sample villages the period of meter-reading in every month is given below.

Name of the village	Period of meter-reading in every month
1. Phursungi	First week
2. Chikhali	First week
3. Narodi	First week
4. Narayangaon	Second week
5. Retawadi	Second week
6. Walunj	Second week
7. Dawadi	Third week

It can thus be seen that although we have stated that the period of reference for the computation of costs is 1st June 1965 to end of May 1966, it is impossible to have such a clear-cut picture of consumption of electricity during this period due to the timing of meter-readings in different sample villages. Three points may be noted in this connection.

First, the kharif season starts roughly from second or

third week of June and, therefore, the meter-readings taken in second and third week of June coincided with the beginning of kharif season and hence for such villages correlating the two periods - one demarcated by meter-readings and the other an agricultural year beginning with kharif season - did not present a problem.For such of the villages where the meter-reading was taken in the first week of June the correlation of two periods did present a problem. We have, therefore, allowed on either side a difference of 5 per cent between the estimate of working of motor based on the reporting of the cultivator and the other estimate based on meter-reading.

Lastly, where the first meter-reading of the year (in June 1965) or the last meter-reading of the year (in May 1966) was entered as'Lock'[1], the hours were estimated for that particular month on the basis of the reporting of the cultivator using the sample motor. This estimate was then added to the hours arrived at from the meter-readings for the remaining 11 months to get the total hours of operation of motor in the year on the basis of meter-reading.[2] In other words, the estimates derived from two different sources were compared for 11 months only in such cases.

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1 The reading 'Lock' is stated in the meter-card when the consumer's meter-box is found locked on the day of visit by the meter-reader. Such phenomena as stated above, i.e., Lock either for the first or the last month of the year viz., for June 1965 or May 1966 was observed in case of six sample motors.

2 In respect of meter reading being stated as 'locked' for the first and the last month of the period of reference, the bill

(ii) Apportionment of Total Hours of Sample Motor where the Motor was partly owned:

Where the motor was shared by many cultivators having the right to draw water from the well, the following two practices of sharing the operational costs were observed :

(a) Sharing of costs in proportion to one's right in the well, which was expressed locally as "annas in a rupee".

(b) Sharing costs in proportion to the use of the motor calculated on the basis of the record wherein the units consumed by each co-partner were stated for all his turns during the month.

Out of 29 sample motors jointly owned, the first practice was followed in case of 26 motors, while the other practice was observed only in case of 3 motors.

However, in the case of former practice of sharing the operation costs, it was observed in respect of all the sample motors that the estimate of hours operated by one of the users (who was contacted in each such case) on the basis of the waterings given by him to the crops was comparable with the estimate of his share in the total hours of operation of the motor, on the basis of meter-reading. In other words, each co-partner was found to be sharing the total hours of operation of

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for consumptions of electricity for the relevant month was computed on the basis of estimate of hours of operation during that month as reported by the cultivator to arrive at total electricity charges for the period of reference.

sample motor during the year in proportion to his ownership right. This was due to the arrangement between the co-partners that the motor would be operated for fixed number of hours in a day (say, 4 hours in the morning and 4 hours in the afternoon), and that it would be switched on and off by only one of the co-partners who would be in-charge of the keys of the switch-board.

It may be noted that for both the practices of sharing the operation costs, the fixed cost,i.e., the initial cost of investment was shared between all the co-partners in proportion to one's right in the well where the motor was to be installed. Since one of the aims of the study was to analyse the cost per hour of operation at different scales of operation for different modes, some adjustment in the fixed cost of the motor apportionable to the particular co-partner (who was interviewed), was made where the second of the two practices of sharing the operational cost was observed. In such cases, the fixed cost apportionable to the respondent was re-adjusted in proportion to his share of hours operated in the total hours of the motor during the year. In short, his share of fixed cost in the total fixed costs and his share of operational costs in the total operational costs were brought in the same proportion. Incidentally, it may be noted that where the operational costs were being shared on the basis of actual units consumed by each

partner, the partner consuming units in a proportion greater than his ownership right derived more advantages vis-a-vis other partners who consumed proportionately less.

Tariff Structure

The then existing tariff structure varied for different uses of electricity such as lighting, industrial, agricultural, etc. Since we are interested only in tariff for agricultural purposes, we are giving the tariff for that purpose only. It may be noted that agricultural tariff is applicable to operating a cane crusher or fodder cutter besides the use of electricity for irrigational purpose. The tariff which was structured on different slabs of consumption, read as follows :

(1)	For the first 50 units consumed in a month per HP of connected load	13 paise per unit i.e. KWh 1*
(2)	For the next 150 units consumed during the month per HP of connected load	12 paise per unit
(3)	For all additional units consumed during the month	10 paise per unit.

Minimum bill: Rs.40 per annum per HP of connected load. Besides this, there was meter-rent of Re.1 per month and a surcharge of 10 per cent on the total bill.

With this tariff structure in force, sometimes, for the

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1 * KWH= Kilo watt of energy consumed for one hour. As 1 HP = 0.746 KW, 3 HP motor run for one hour would consume 3 x 0.746 KWH = 2.238 KWH. Similarly, 5 HP motor would consume 3.73 units for its one hour use.

same number of units consumed over a period of time by two motors, different amount was charged for each depending upon the frequency of meter-reading in each case. In table 4.13, we present hypothetical case for two motors of 3 HP each having the same consumption of 800 KWH (units) for the period of two months, but the meter having been read twice in the first case, giving the break-down of the units between the months as 350 KWH and 450 KWH; while in the other case the meter having been read only once in the months, the first time being found 'Locked' by the meter-reader. The amount billed for each motor would be as follows for these two months.

Table 4.13 : Comparison of amounts billed for a hypothetical case - Two motors with identical consumption but with different number of meter-readings over a period of 2 months.

Frequency of Meter Reading in two months' period	1st month		2nd month		Total for two months (amount billed in Rs.)
	Units	Amount billed (Rs.)	Units	Amount billed (Rs.)	
Case I: Meter-reading twice					
(A) Energy charges					
Total units consumed of which :	350	43.50	450	55.50	
Units charged at the rate of 13 paise per unit	150	19.50	150	19.50	
Units charged at the rate of 12 paise per unit	200	24.00	300	36.00	
Units charged at the rate of 10 paise	-	-	-	-	

cont...

Table 4.13 (contd.)

Frequency of meter reading in two months' period	1st month Units	1st month Amount billed (Rs.)	2nd month Units	2nd month Amount billed (Rs.)	Total for two months (amount billed in Rs.)
(B) Meter rent(Re.1 per meter)	-	4.00	1.00	4.00	
(C) Sub-total (A+B)	-	44.50	-	56.50	
(D) Surcharge at the rate of 10% of 'C'	-	4.45	-	5.65	
(E) Total Bill (C+D)	-	48.95	-	62.15	111.10
Case II : Meter-reading once					
(A) Energy charges					
Total units consumed of which	Meter found 'locked'		800	93.50	
Units charged at the rate of 13 paise per unit.	-	-	150	19.50	
Units charged at the rate of 12 paise per unit	-	-	450	54.00	
Units charged at the rate of 10 paise per unit	-	-	200	20.00	
(B) Meter rent (Re.1 per month)	-	1.00	-	1.00	
(C) Sub-total (A+B)	-	1.00	-	94.50	
(D) Surcharge at the rate of 10% of 'C'	-	0.10	-	9.45	
(E) Total bill (C+D)	-	1.10	-	103.95	105.05

Thus it can be seen that under the then existing regulations and tariff structure, the lesser number of actual meter-readings led to a smaller amount billed per month,

since the number of units to be charged at the rate of 10 paise per unit increased with the lesser number of meter-readings. However, this advantage must be weighed against the incidence of a larger amount of bill on the cultivator under an infrequent meter-reading, and, therefore, the opinion was divided among the users as regards the frequency of meter-reading and billing of energy charges. Out of a sample of 75 motors, the users of 55 sample motors wanted a monthly accurate reading of meters while the users of other 20 wanted quarterly reading and billing of energy charges.

Maintenance Cost

We shall now discuss the other part of variable costs viz., the maintenance costs of sample motors as reported by their users. The maintenance costs have been divided into three parts, as follows :

i) Greasing or daily upkeep,
ii) Minor repairs and overhauling, and
iii) Major breakdown and spare parts.

Greasing or daily upkeep : The pump was usually greased before the operation. The grease is a type of lubricatnt made of petroleum product and is used to ease out the friction between the bearings of the pump. Also, it was applied to the bearings of the motor when overhauled. At the time of survey

a kilogram of grease (in weight) was costing about Rs.2.25 to Rs.3. The users of sample motors were asked to state the amount spent by them on grease during the year.

Where the ownership of the motor was held jointly by a group of cultivators, two practices prevailed as regards the sharing of cost of grease : (i) either it was purchased for common use or (ii) each co-partner purchased separately. In the case of latter practice, the estimate of expenditure on this item has been slightly on the higher side since we have assumed that the total expenditure on this item for the sample motor is in the same proportion to the expenditure of the particular co-partner as are total rights to the ownership rights of that co-partner. However, share of expenditure on this item in total expenditure on maintenance and operation varied between only 0.68 per cent to 2.15 per cent depending upon the hourse of operation of motors of both 3 HP and 5 HP.

Minor Repairs and Overhauling : The repairs which could be undertaken at the site without much delay and for which no replacement of major spare parts, such as shaft of a pump, bearings of a motor, rewinding of motor etc. were required, are treated as minor repairs. The minor repairs, therefore, relate to small repairs of pump or starter or replacement of fuses and bulbs etc. It may be pointed out here that, although, replacement of a fused wire is not a skilled job, many of the

users (users of 28 motors in a sample of 75) got it done through the lineman of the Board for which 25 paise to 50 paise were charged by the lineman. These charges related to fuses inside the switch-box within the premises of consumer. Where the replacement of pole fuse was involved, (which is expected to be done free of cost by the employees of the Board since pole is the property of the Board) the cultivator was charged Rs.2 to Rs.5 depending upon the urgency of his need by the lineman.

The annual overhauling of the machinery, i.e., the motor and the pumpset, was done in many cases. Out of 75 sample motors, 46 motors were overhauled during the period under reference. The charge for overhauling was reported in the range of Rs.10 to Rs.20, depending upon the parts replaced at the time of overhauling. However, the cultivators were not able to state which particular parts were replaced at that time.

Major Breakdown and Spare Parts : The repairs which caused delay and which could not be carried out at the site of the pumpset (for example, rewinding of motor) or for which major spare parts had to be replaced (e.g., bearings of motor, shaft of pump etc.) are taken as major repairs or breakdowns. These repairs, therefore, relate mostly to rewimding of coils of motor burnt due to fluctuations in the voltage of electricity and malfunctioning of starter, replacement of

bearings of motor, replacement of fans or the shaft of the pump and lastly, the replacement of starter.

It may be noted that for the computation of annual costs under this head, a different method than the one adopted for the other two components viz., Greasing and Minor Repairs, is followed. While for the first two components (Greasing and Minor Repairs) the actual costs purported to have been incurred during the year 1st June 1965 - end of May 1966 are considered, in this case, the total costs incurred were collected from the period of installation upto the time of survey and then total amount on these items was apportioned for one year. This was done for the following reasons :

(i) The amount required to be spent for repairs under each of these items was considerable when compared to amount spent under the other two components of maintenance costs viz., Greasing and Minor Repairs. The breakdown themselves being of accidental nature, strict adherence to a particular period for the estimates of costs would have vitiated the true picture of annual costs since accidents are likely to occur for one motor quite frequently during a particular period while they are not likely to occur at all for another in the same period and the sample is not large enough to even out these differences in the occurence.

(ii) During the pilot survey, the cultivators showed a tendency to state the expenditure on these items as having been incurred during the period of reference although it was actually incurred in an early year. In short, the expenditure under this item was not of recurrent nature and, therefore, the memory of a cultivator could not be relied upon to state the expenditure on this item in a particular period.

As stated earlier, the expenditure on major repairs mostly pertained to rewinding of coils of motor. Out of a sample of 75 motors, 46 motors were reported to be burnt since their installation. Some of the motors were even burnt twice or thrice. The expenditure for rewinding the coil was to the tune of Rs.300 to Rs.500 depending upon the quality of coils. The other expenditure under this item pertained to expenditure incurred to remove the damage caused to the starter[1], to replace the pump-shaft, and for repairing damages to the switch-box. The expenditure incurred was of the order of Rs.85 to Rs.100 for the starter, Rs.50 to Rs.60 for pump-shaft and Rs.40 to Rs.50 for switch box.

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1 As stated earlier, the starter is an automatic device which cuts off the supply of electricity to motor by tripping off whenever there is a fluctuation in the voltage. However, it was observed that some cultivators disallowed the normal functioning of starter by tieing it, so that it may not trip of. This was done particularly when the cultivator had employed casual labour for transplantation of certain crops which required well-water. Under such circumstances, whenever the voltage fluctuated beyond certain range, the motor was burnt. Sometimes it simultaneously caused damage to the starter and the switch-box.

In tables 4.14 and 4.15 we have presented data on per hour expenditure on different items of maintenance as also operational cost for 3 HP and 5 HP motors, separately for different levels of operation.

It can be observed from these tables that per hour cost under the item 'greasing and minor repairs' declines in absolute terms as the number of hours operated by motors increase. The expenditure under these items was of a fixed nature as the cultivators generally undertook overhauling once a year. While the expenditure under the item 'major breakdown and spare parts' does not indicate any such relationship with the hours operated by motor, which shows the chanced occurrence of accidents. Perhaps the occurrence of accidents during the year and the delay in getting the repairs done might have precluded the greater use of motors which had worked for less than 400 hours during the year. The operation cost of motors shows a sudden fall in the first two size-groups of hours of operation and then the rate of fall gradually declines as number of hours increase. This was due to the then existing tariff schedule, described above, stipulating a minimum charge of Rs.120 for 3 HP and Rs.200 for 5 HP motor thus requiring a minimum of 300 to 325 hours of working during the year. Although tariff is structured for different levels of units consumed

Table 4.14 : Per hour maintenance and operation cost of electric motors of 3 horse power.

(Cost in Rs.)

Hours of operation during the year	No.of motors	Average no.of hours of operation	Average per hour cost on maintenance of electric motor				Average per hour operation cost	Average per hour total variable cost
			Greasing	Minor repairs + Over-hauling	Major breakdown and spare parts	Total maintenance cost		
0-200	3	94.78	0.0301 (1.77)	0.0530 (3.11)	0.3476 (20.40)	0.4307 (25.28)	1.2728 (74.72)	1.7035 (100.00)
200-400	10	267.69	0.0139 (2.15)	0.0534 (8.43)	0.1086 (17.14)	0.1759 (27.72)	0.4579 (72.28)	0.6335 (100.00)
400-600	8	484.81	0.0059 (1.18)	0.0262 (5.26)	0.1282 (25.73)	0.1603 (32.17)	0.3380 (67.83)	0.4983 (100.00)
600-1000	4	878.13	0.0048 (1.24)	0.0217 (5.58)	0.0332 (8.54)	0.0597 (15.36)	0.3290 (84.64)	0.3887 (100.00)
Above 1000	6	1459.48	0.0041 (1.00)	0.0095 (2.34)	0.0816 (20.07)	0.0952 (23.41)	0.3114 (76.59)	0.4066 (100.00)
Total (overall average)	31	616.37	0.0064 (1.36)	0.0219 (4.63)	0.0899 (19.01)	0.1182 (25.00)	0.3547 (75.00)	0.4729 (100.00)

Note: Figures in brackets indicate share (in percentage) in total.

Table 4.15 : Per hour maintenance and operation cost of electric motors of 5 horse power.

(cost in Rs.)

Hours of operation during the year	No.of motors	Average no.of hours of operation	Average per hour cost on maintenance of electric motor				Average per hour operation cost	Average per hour total variable cost
			Greasing	Minor repairs + overhauling	Major breakdown and spare parts	Total maintenance cost		
0-200	11	85.45	0.0423 (1.52)	0.0677 (2.42)	0.3441 (12.31)	0.4541 (16.25)	2.3405 (83.75)	2.7946 (100.00)
200-400	4	312.06	0.0137 (1.43)	0.0769 (7.96)	0.2323 (24.06)	0.3229 (33.45)	0.6425 (66.55)	0.9654 (100.00)
400-600	12	512.65	0.0106 (1.75)	0.0202 (3.31)	0.0442 (7.25)	0.0750 (12.31)	0.5345 (87.69)	0.6095 (100.00)
600-1000	10	757.75	0.0053 (0.85)	0.0164 (2.61)	0.0702 (11.19)	0.0919 (14.65)	0.5353 (85.35)	0.6272 (100.00)
Above 1000	5	1297.96	0.0037 (0.68)	0.0143 (2.61)	0.0286 (5.23)	0.0466 (8.52)	0.5003 (91.48)	0.5469 (100.00)
Total (overall average)	42	533.51	0.0083 (1.17)	0.0223 (3.15)	0.0716 (10.10)	0.1022 (14.42)	0.6067 (85.58)	0.7089 (100.00)

Note: Figures in brackets indicate share (in percentage) in total.

during the month, due to different number of meter-readings in different size-groups, the impact of tariff structure in reducing the per hour operation cost with the increase in the number of hours operated is not much seen.

However, it may be observed that the percentage contribution of each item to total variable costs does not show any particular trend. This is mainly due to chance occurrence of major breakdowns and the different number of meter-readings for motors in different size-groups of hours of operation.

Total Cost

As stated earlier, we have computed for each of the sample motors the different components of costs, namely, the fixed cost consisting of depreciation and interest rate charges and variable costs consisting of maintenance cost and operation costs. The addition of these costs viz., fixed and variable, are taken as the total costs of irrigation by electric motor for one year. These total costs are divided by the total number of hours operated by the motor to obtain the cost per hour of operation.

Tables 4.16 and 4.17 present data on per annum costs of irrigation by sample electric motors of 3 HP and 5 HP, respectively. To perceive behaviour of cost of irrigation at different levels of operation, electric motors of these two sizes have been grouped by their number of hours of operation during the year 1965-66.

Table 4.16 : Cost of Irrigation by electric motors : 3 horse power.

(cost in Rs.)

Hours of operation during the year (in size groups)	No.of electric motors	Average No.of hours of operation	Cost of irrigation per electric motor			Cost per hour of operation
			Fixed	Variable	Total	
0-200	3	94.28	291.83 (64.50)	160.61 (35.50)	452.44 (100.00)	4.80
200-400	10	267.69	252.32 (59.81)	169.57 (40.19)	421.89 (100.00)	1.58
400-600	8	484.81	248.30 (50.68)	241.60 (49.32)	489.90 (100.00)	1.01
600-1000	4	878.13	295.23 (46.38)	341.35 (53.62)	636.58 (100.00)	0.73
Above 1000	6	1459.48	338.75 (36.34)	593.33 (63.66)	932.08 (100.00)	0.64
Total	31	616.37	277.37 (48.76)	291.47 (51.24)	568.84 (100.00)	0.92

Note: Figures in brackets indicate share (in percentage) in total cost.

Table 4.17 : Cost of irrigation by electric motors : 5 horse power.

(Cost in Rs.)

Hours of operation during the year (in size groups)	No.of electric motors	Average no.of hours of operation	Cost of irrigation per electric motor			Cost per hour of operation
			Fixed	Variable	Total	
0-200	11	85.45	329.68 (57.99)	238.80 (42.01)	568.48 (100.00)	6.65
200-400	4	312.06	360.99 (54.51)	301.27 (45.49)	662.26 (100.00)	2.12
400-600	12	512.65	291.87 (48.30)	312.45 (51.70)	604.32 (100.00)	1.18
600-1000	10	757.75	316.33 (39.96)	475.29 (60.04)	791.62 (100.00)	1.05
Above 1000	5	1297.96	324.84 (31.39)	709.93 (68.61)	1034.77 (100.00)	0.80
Total	42	533.51	318.11 (45.69)	378.18 (54.31)	696.29 (100.00)	1.31

Note: Figures in brackets indicate share (in percentage) in total cost.

The following observations emerge out of tables 4.16 and 4.17 :

(a) Per annum fixed costs (depreciation charges and interest costs) of irrigation vary between certain range for motors of both the sizes, and do not bear any relationship to level of operation of the motors. The variation in fixed costs per motor over different size groups of hours of operation is accounted for by the difference in initial investment in motor and pumphouse as also interest costs due to different sources of finance. Economies of scale in costs of irrigation by motor are discernible from the progressive decline in the share of fixed costs in total costs of irrigation with the increase in the level of operation.

(b) Although variable costs of irrigation tend to rise with the scale of operation of motor, the increase in variable costs is proportionately less as compared to that in the hours of operation of motor during the year. This is mainly due to (i) tariff structure prescribing minimum consumption during the year as also certain variable costs (overhauling) being of fixed nature, and (ii) relatively less occurence of major break-downs (burning of motor) in respect of motors operated beyond 600 hours.

(c) As a result, the cost per hour of operation decline progressively with the increase in the level of operation of electric motor.

The cost functions fitted for these 2 sizes of sample motors typically represent the above-mentioned behaviour of costs of irrigation by electric motor.

Cost Functions

We shall now proceed to derive cost function for [illegible] 3 HP and 5 HP motors separately. For 31 number of 3 HP motors and 42 number of 5 HP motors we have attempted to fit a cost function taking number of hours operated as independent variable and cost per hour of operation as dependent variable. Double log function and quadratic function were attempted, the results of which are presented in Annexure 4C.

As can be seen from the results of costs functions fitted for each size of motor, i.e., 3HP and 5HP, larger percentage variation is explained by double log function than a quadratic function in each case, and hence double log function is a better fit for each size of motor. It may be noted that for each size of motor, the value of t and F are highly significant for double log function.

The shape of the curve (graphs presented in Annexure 4D) is asymptotic to both the axes, with a steep fall upto 300 hours of operation and then smoothening of curve beyond 300 hours of operation. This is due to the fact that part of variable costs viz., operational costs are constant over this range (i.e., upto 300 hours) because of the regulations stipulating

minimum guarantee of consumption for motor users. Beyond this range, although the distribution of fixed costs over a larger number of hours contribute to its tapering down, the variable costs (i.e., maintenance + operational costs) do not further contribute to its tapering, since these costs increase more or less at a constant rate with the increase in the number of hours. Due to a limited number of observations with respect to hours operated during the year, the curve and the function show a continuous tendency to fall for both the sizes of motor and as such optimum level of operation cannot be defined. However, the objective of the study is to work out the economics of different modes at different levels of operation and, therefore, we shall be making use of these curves for comparing them with the cost functions of other modes viz., oil engine and bullock-operated lift. Lastly, it may be observed that since the minimum consumption guarantee is lower for 3 HP than for 5 HP motor, at extremely low level of operation, i.e., less than 300 hours, the use of 3 HP is economical than 5 HP, all other things being equal viz., depth of well, size of holding etc. This is reflected in the constant terms of two equations pertaining to double log functions of 3 HP and 5 HP.

ANNEXURE 4A[1] : Taluka-wise normal rainfall and rainfall during June 1965 to May 1966.

(Rainfall in Milli-metre)

Month		Ambegaon		Haveli		Junnar		Khed	
		A	B	A	B	A	B	A	B
June	1965	41.4	119.6	25.6	107.4	29.3	113.5	11.8	114.8
July	1965	605.3	241.1	203.8	168.9	350.6	231.6	221.7	174.2
August	1965	158.0	130.1	159.7	106.5	108.8	133.6	122.3	100.8
Sept.	1965	79.6	123.9	31.6	130.1	29.8	118.9	22.4	135.6
Oct.	1965	9.9	67.8	10.3	76.2	12.0	66.0	35.1	69.1
Nov.	1965	-	37.6	-	30.5	-	39.6	7.7	35.8
Dec.	1965	14.4	3.1	15.3	4.3	28.5	4.1	40.2	4.3
January	1966	-	2.0	-	2.5	-	2.5	-	2.5
February	1966	-	0.3	-	1.3	-	1.5	-	1.0
March	1966	-	2.3	-	2.0	-	2.0	-	2.0
April	1966	-	10.9	-	14.2	-	10.7	-	8.9
May	1966	20.0	22.3	74.3	27.4	53.8	19.1	43.6	23.9
Total		928.6	761.0	520.6	571.3	612.8	742.6	504.8	672.9

		Mawal		Mulshi		Purandhar		Sirur	
		A	B	A	B	A	B	A	B
June	1965	84.1	159.8	235.2	215.7	58.5	88.7	95.2	106.9
July	1965	391.4	429.5	854.9	687.5	135.7	110.7	94.0	74.4
August	1965	142.7	243.6	313.4	368.1	227.1	64.0	120.8	48.3
Sept.	1965	44.2	149.3	50.0	161.8	104.6	112.0	89.0	144.5
October	1965	39.1	76.5	19.8	68.3	3.9	82.5	1.7	61.5
November	1965	0.4	27.4	5.0	30.7	3.3	33.8	9.8	33.3
December	1965	7.9	4.3	35.5	3.3	25.4	5.3	18.0	7.1
January	1966	-	1.8	-	1.8	-	2.0	-	4.1
February	1966	-	1.0	-	0.8	-	1.0	-	2.8
March	1966	-	1.5	10.0	2.8	22.0	2.3	-	2.0
April	1966	-	9.4	-	9.9	-	15.2	-	7.1
May	1966	22.0	20.1	53.0	18.8	150.9	35.1	103.0	18.3
Total		731.8	1124.2	1576.8	1569.5	731.4	552.6	531.5	510.3

A = Actual rainfall during the year; B = Normal rainfall in the taluka.

Source: Metereological Department, Poona.

ANNEXURE 4B : List of Crops irrigated in the region/sample villages and by the sample modes of lift.

List of irrigated crops in 8 talukas*	Irrigated crops in the sample villages+	Irrigated crops reported by sample modes of lift	Major crops irrigated by sample modes
Rice	✓	✓	
Wheat	✓	✓	✓
Jowar (Rabi)	✓	✓	✓
Bajra	✓	✓	
Ragi	✓	✓	
Gram	✓	✓	
Sugarcane	✓	✓	✓
Condiment & spices			
Fruits & vegetables	✓	✓	✓
Cotton	✓	✓	
Ground-nut	✓	✓	
Tobbaco£			
Miscellaneous food crops	✓	✓	
Miscellaneous non-food crops	✓	✓	✓

* Source : District Socio-Economic Survey, District Statistical Office, Poona.

\+ Source : Village Records of Sample villages.

£ = Area irrigated was nominal. In all the 8 talukas together, the area irrigated under tobacco was 44 hectares.

ANNEXURE 4C

COST FUNCTIONS

I. Double-log Function - 5 HP Electric Motor

No.of observations = 42

x - Independent variable: No.of hours operated (in log.)

y - Dependent variable : Cost per hour of operation (in Rs.) (in log)

	Coefficients	t-test
Constant (log a)	5.7713	
Regression coefficient (b)	-0.8730	34.48 t_{40}=2.021 at 5% level (Table value)

Analysis of Variance

Source	Degrees of freedom	Sum of squares	Mean E.S.S.	F-test
Regression	1	37.9569		1188.97
Error	40	1.2770	.03192	$F_{1,40}$=4.08 at 5% level (Table value)
Total	41	39.2339		

$r^2 = 0.9673$

Percentage variation explained = 96.73

Function: $\log y = \log a + b \log x$

Fitted function : $\log y = 5.7713 - 0.8730 \log x$

$y = 320.9318\ x^{-.8730}$

II. Quadratic Function - 5 HP Electric Motor

No. of observations = 42

x - Independent variable : No. of hours operated

y - Dependent variable : Cost per hour of operation (in Rs.)

		Coefficients	t-test	
Constant (a)		11.1188		
Regression coefficients	b_1	-0.0217	6.47)	t_{39}=2.08 at 5% level (Table value)
	b_2	0.0000091	4.62)	

Analysis of Variance

Source	Degree of freedom	Sum of squares	M.E.S.S.	F-test
Regression	2	663.4146		25.67
Error	39	503.8269	12.9186	$F_{2,39}$=3.24 at 5% level (Table value)
Total	41	1167.2415		

$r^2 = .56836$

Percentage variation explained = 56.84

Function : $y = a + b_1x + b_2x^2$

Fitted function: $y = 11.1188 - .0217x + .0000091x^2$

III. Double log Function 3 HP Electric motor

No. of Observations = 31

x - Independent variable : No. of hours operated (In log)

y - Dependent variable : Cost per hour of operation (in Rs.) (In log)

	Coefficient	t-test
Constant (log a)	5.0931	
Regression coefficient	-0.8063	16.74 t_{29}=2.045 at 5% level (table value)

Analysis of variance

Source	Degrees of freedom	Sum of squares	Mean E.S.S.	F-test
Regression	1	18.4178		280.51
Error	29	1.9041	0.0657	$F_{1,29}$=4.18 at 1% level (Table value)
Total	30	20.3219		

$r^2 = 0.9063$

Percentage variation explained = 90.63

Function : $\log y = \log a + b \log x$

Fitted function : $\log y = 5.0931 - .8063 \log x$

$y = 162.8553\ x^{-.8063}$

IV. Quadratic Function - 3 HP Electric Motor

No. of observations = 31

x - Independent variable - No. of hours operated

y - Dependent variable - Cost per hour of operation (in Rs.)

		Coefficient	t-test	
Constant (a)		12.2970		
Regression coefficients	b_1	-0.0335	3.11	t_{28}=2.048 at 5% level (table value)
	b_2	0.0000178	2.71	

Analysis of Variance

Source	Degrees of freedom	Sum of squares	Mean E.S.S.	F-test
Regression	2	454.9419		5.45
Error	28	1166.7339	41.6691	$F_{2;28}$=3.34 at 5% level (Table value)
Total	30	1621.6758		

$r^2 = 0.28054$

Percentage variation explained = 28.054

Function $y = a + b_1x + b_2x^2$

Fitted Function $y = 12.2970 - .0335x + .0000178x^2$