CHAPTER VI

IMPACT OF ELECTRIFICATION ON AGRICULTURE

6.1 Introduction:

In this chapter we propose to measure the impact of electrification on agricultural incomes of the sample farm families of this study. There are 149 cultivators who have set up electric pumps on their existing wells. To measure the impact of electrification, we have used, cultivators's using traditional motes and diesel engines as control groups; there were 8 cultivators, using motes and another 10 cultivators using diesel engines for lifting water from the wells as method of irrigation. Secondly these 18 cultivators (8 mote users + 10 diesel engine users); were considered as control group chiefly because, they did not use electric energy as a method of irrigation. Hence, we have a sample of 149 cultivators using electricity and a control sample of 18 cultivators, Using no electricity or using alternative source of energy.

6.2 Methodology Adopted for the Measurement of Impact on Agricultural Incomes:

One of the main objectives of this study, as mentioned in Chapter-IV, is to assess the impact of electrification on agricultural incomes of the sample farm families in Marathwada Region.

For this purpose, we have to compare the incomes of the electric pump users on the one hand and those using traditional
mots or oil-engines on the others. The first important aspect of the introduction of electric pump on the wells, would be the change in the cropping pattern adopted by the cultivators; the second change relates to the cost-reducing aspect of electric pumps. There are two cost reducing aspects of electric pumps; there(a) introduction of electric pumps reduces the use of bullock-power; and (b) as electric energy is relatively cheaper than the diesel, the electric pumps have relative advantage over the users of oil engines. Similarly, considering the annual operational and maintenance cost of oil engine and electric pumps, the latter has greater advantage over the former. This amply proves that, when compared to oil-engines, the electric pumps have large amount of cost-reducing effects. (which is considered as benefit).

The second major impact of electric pump is known as 'output raising' impact. It is common knowledge that the acreage irrigated area by mot is relatively very small when compared to the acreage of land irrigated by an electric pump. Therefore, the difference between the average acreage irrigated by a pumpset and the average acreage irrigated by mot would be considered as the net impact of electrification on the farm families.

Again, we must also consider the acreage irrigated by an oil-engine and compare it with the acreage irrigated by all electric pumps. The difference between the two would be considered as the impact of electrification.

One important point we have to take into account that at this stage, we have considered the impact of electrification
on pumps, which relates to the irrigated part of the
farms in all three cases, i.e. pumps, motes, and oil-engines. The unirrigated part of the farms as they are not affected by electrification or irrigation has not been taken into account. Hence, the gross costs and gross benefits flowing from the three alternative methods of irrigation have been considered. By using our survey data, we have estimated net income per acre as well as per cultivator in case of this study.

(i) **Net Incremental Incomes:**

After estimating the net income per acre, we have estimated net income per cultivator in case of pump users, mot users and oil engine users. The next step is to find out the 'Incremental income' per acre/or cultivator, to arrive at the net impact of electrification. To do this, we must deduct the net income per acre of mot users from the net income per acre of the pump-users. The difference between the two would be the 'net incremental income' due to introduction of electric pumps by the farmers. Similar method is followed for estimating net income between electric pumps and oil-engines.

(ii) **Financial Feasibility of the Pumps, Diesel Engines and Mots:**

In the final analysis, we have measured the financial feasibility of the three alternatives methods of irrigation adopted by the sample and control cultivators. For this purpose we attempted the following three well known methods: (i) Benefit-Cost Ratio, (ii) Net Present Worth and (iii) Rate of Return (IRR)
6.3 Land Use Pattern:

The change in land-use pattern in sample villages after energisation of wells is shown in table No. 6.1. The actual change and percentage change in net area cultivated, gross area cultivated, net irrigated area, gross irrigated area, fallow area etc. gives interesting picture. A casual inspection of table No. 6.1 shows that, considering almost all criteria the pumps users have greater advantageous position over those of mote and oil-engine users. For example, if we consider net cultivated area, the mote and oil-engine users have 85.7% and 86.43% of net cultivated area while in case of pump users, it is 92%. Similarly, the intensity of cropping is also highest in case of pump users (121.43%), while in case of mote and oil-engines it is 109.44% and 114.21%.

The net irrigated area to total owned area is however, lowest in case of pump users when compared to mote-users, mainly because, the average land holding in case of mote-users is relatively low. Secondly, the cropping pattern adopted by the pump-sets users, pertain chiefly to perennial crops like sugar-cane, banana and other fruits. However, if we consider intensity of irrigation, the pump-sets owners have again occupied the highest position (i.e. 163.44%) see Table No. 6.1.

In case of fallow lands also the minimum proportion of current fallow are kept by the pumpsets owners (8.0%). But in case of mote users it is 14.3% and for oil-engine users it is 13.57%
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Criteria</th>
<th>Mot users</th>
<th>Oil engine users</th>
<th>Electric pumpset users</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>per cultivator</td>
<td>Total</td>
</tr>
<tr>
<td>1.</td>
<td>No. of sample</td>
<td>8</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>2.</td>
<td>Owned Area</td>
<td>105</td>
<td>13.13</td>
<td>291</td>
</tr>
<tr>
<td>3.</td>
<td>Net cultivated area</td>
<td>90</td>
<td>11.25</td>
<td>251.5</td>
</tr>
<tr>
<td></td>
<td>(85.71)</td>
<td></td>
<td>(86.43)</td>
<td>(91.98)</td>
</tr>
<tr>
<td>4.</td>
<td>Gross cultivated area</td>
<td>98.5</td>
<td>12.31</td>
<td>287.25</td>
</tr>
<tr>
<td>5.</td>
<td>Intensity of cropping (%)</td>
<td>109.44</td>
<td>109.42</td>
<td>114.22</td>
</tr>
<tr>
<td>6.</td>
<td>Net irrigated area</td>
<td>11.0</td>
<td>1.38</td>
<td>59.0</td>
</tr>
<tr>
<td></td>
<td>(10.48)</td>
<td></td>
<td>(20.27)</td>
<td>(27.23)</td>
</tr>
<tr>
<td>7.</td>
<td>Net unirrigated area</td>
<td>70.0</td>
<td>9.88</td>
<td>192.5</td>
</tr>
<tr>
<td></td>
<td>(75.24)</td>
<td></td>
<td>(66.15)</td>
<td>(64.66)</td>
</tr>
<tr>
<td>8.</td>
<td>Gross irrigated area</td>
<td>12.5</td>
<td>1.56</td>
<td>67.75</td>
</tr>
<tr>
<td>9.</td>
<td>Intensity of irrigation (%)</td>
<td>113.64</td>
<td>113.04</td>
<td>114.83</td>
</tr>
<tr>
<td>10.</td>
<td>Current fallow land</td>
<td>15</td>
<td>1.88</td>
<td>39.5</td>
</tr>
<tr>
<td></td>
<td>(14.29)</td>
<td></td>
<td>(13.57)</td>
<td>(8.01)</td>
</tr>
</tbody>
</table>

**Note:** Figures in brackets indicate percentage of total owned area. Differences between intensities may occur due to rounding of figures.
6.4 **Cropping Pattern Adopted by the Sample Control cultivators**

Table No: 6.2 shows the cropping pattern adopted by the 149 sample pumpset users, 10 oil-engine users and 8 mote users of this study. We have used the cropping pattern method as is adopted by the Government of Maharashtra in their 'Season and Crop Reports'. The cropping pattern is classified into the following major groups, (i) Cereals (ii) Pulses, (iii) Others (iv) Condiments and Spices, (v) Fruits and Vegetables (vi) Fibres (vii) Oil-seeds.

Let us now consider the cropping pattern adopted by the sample and control cultivators.

(i) **Cereals**: Cereals include food crops like Wheat, Jawar, Bajra, Pady, Maize etc. Among cereals wheat appears to be the major food crop raised by all the three categories of cultivators. Mote-users have devoted 56% of their total irrigated area for raising wheat crop; while the oil-engine users and pump users have devoted 16.2% and 32.5% of their total irrigated area for the cultivation of wheat crops. The second major crop is Jawar. Hybrid Jawar has been cultivated only by pump-users (9.32%); while ordinary variety of Rabi Jawar is cultivated by mote and oil-engine users. It is obvious from the table, that only pump users have been able to cultivate food crops like Pady and Maize, and could diversify their cropping pattern. Of the total irrigated area by mote- pumps, and oil-engine users, the highest proportion of this area is devoted to alone by mote-users (i.e. 68%); whereas the oil-engine users have devoted about 60% and pumpsets owners only 46%. If we consider, Cereals as low value crops, then pumpset owners have adopted the right policy to divert major portion
of irrigated area to high value crops like sugarcane, banana, vegetables, etc. This should be considered as an important change in the cropping pattern adopted by the sample pumpset owners.

(ii) **Pulses:**

Pulses include gram and mung. Most users and oil engine owners have devoted about 12% of their total irrigated area for raising pulses like gram and mung. But in case of pumpset owners, the proportion of area devoted for the cultivation of pulses is only 6.6%. Pulses are generally taken, after growing hybrid jowar, as a second crop (gram).

(iii) **Others:**

In this category are included crops like sugarcane, potato. Among the two the sugarcane, potato crop is considered as a high value crop. Most users, oil engine owners and pump users have devoted 12%, 5.17% and 25.82% of their irrigated land for growing sugarcane. Among the 3 types of farmers the pump users have taken the greatest advantage of diversifying their cropping pattern in favour of high value crops like sugarcane. Both, oil engine users and pump users have devoted of their irrigated area for growing area potato crop.

(iv) **Condiments and Spices:**

Table No: 6.2 shows that most users have not been able to cultivate condiments and spices like garlic, chillies, ginger, haldi and onion etc. On the other hand, oil engine users have devoted about 3.69% of their irrigated land for this purpose. While electric pump users have devoted 3.81% of their total irrigated area for raising such crops, which are considered as high value crops. Due to increased facility of irrigation made available to pumpsets owners, have enabled them to diversify their cropping pattern in favour of high value crops.
(v) **Fruits and Vegetables:**

This category of crops are also considered as high value crops. They include fruits like Musambi, Banana, vegetables and miscellaneous. The mote-users have devoted only 8% of their irrigated land for raising grass used as fodder to the bullocks and cows. On the other hand, oil-engine users have devoted 13.29% and pump-sets users 13.26% of their irrigated area for fruit and vegetable crops; during the survey year 1982-83. Among the fruits, banana appears to be most important as 4.43% and 5.57% of irrigated land is devoted for banana crop by oil-engine users and pumpsets users respectively. Growing vegetables is also an important cash-crop raised by both oil-engine and pumpsets owners.

(vi) **Fibres:**

Cotton and Jute are two main fibre crops raised by the sample and control cultivators. It may be noted that, mote-users have not been able to raise fibre crops mainly because their average irrigated area is relatively very small (1.37 acres). Oil-engine users have devoted about 5.9% of their irrigated land for raising cotton crop, while electric pump users have cultivated cotton crop in about 2.51% of their irrigated land. The latter type of users have also cultivated jute crop to the extent of 0.1% of their irrigated land. In this way, of the total irrigated area, the oil-engine users have devoted larger area (5.7%) than that of electric pump users (i.e. 2.61%).
(vii) **Oil Seeds:**

Oil-seeds like ground nut and sunflower are considered as cash crops as well as high value crops. It is noteworthy that, neither mote users, nor oil-engine users have been able to devote a single acre of land for growing oil-seeds. On the other hand electric pump users have been able to devote about 1.94% of their irrigated land for raising oil-seed crops (i.e. groundnut, 1.91% and Sunflower 0.75%).

From the above analysis, we may draw some major conclusions:

Firstly, the mote-users, with small proportion of irrigation facility, have devoted a major part of their irrigated land for raising food crops. They could not diversify their cropping pattern in favour of cash crops or high value crops. Secondly, the pumpsets users, although with lower net irrigated area, compared to oil-engine users, have been able to raise numerous high value crops like sugar cane, banana, fruits, vegetables etc. Because the intensity of irrigation in case of pump-sets owners, was related very high than of oil-engine users. Hence the electric pump users were in a better position to diversify their cropping pattern in favour of high value crops, which could raise their gross level of income.

6.5 **Gross Farm Business income of Sample Cultivators:**

To calculate the total farm income per acre and per cultivator the output of each crops raised by the sample cultivators during the year 1982-83 has been recorded. Then to calculate the total farm income from each crop, the local average price of each crop was used. The prices of all crops were collected at the time of personal interview from each village. Table 6.3 shows the prices of agricultural
### TABLE NO: 6.3

**TABLE SHOWING PRICES OF AGRICULTURAL COMMODITIES IN SAMPLE VILLAGES.**

(Prices in Rs. per quintle) (1982-83)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of the crop</th>
<th>Fulambri</th>
<th>Malegoan</th>
<th>Tembhurni</th>
<th>Takli</th>
<th>Harangul</th>
<th>Khamas</th>
<th>Radi</th>
<th>Bapkal</th>
<th>Kone</th>
<th>Walki</th>
<th>K</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Wheat</td>
<td>265</td>
<td>260</td>
<td>210</td>
<td>265</td>
<td>270</td>
<td>260</td>
<td>250</td>
<td>200</td>
<td>225</td>
<td>200</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Jawar</td>
<td>160</td>
<td>NA</td>
<td>160</td>
<td>165</td>
<td>NA</td>
<td>180</td>
<td>175</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Jawar (Hybrid)</td>
<td>100</td>
<td>110</td>
<td>110</td>
<td>$00</td>
<td>100</td>
<td>105</td>
<td>100</td>
<td>NA</td>
<td>NA</td>
<td>100</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Bajra</td>
<td>125</td>
<td>NA</td>
<td>120</td>
<td>130</td>
<td>125</td>
<td>NA</td>
<td>125</td>
<td>115</td>
<td>125</td>
<td>NA</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Paddy</td>
<td>135</td>
<td>140</td>
<td>110</td>
<td>130</td>
<td>150</td>
<td>140</td>
<td>125</td>
<td>NA</td>
<td>NA</td>
<td>100</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Maize</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Gram</td>
<td>310</td>
<td>NA</td>
<td>300</td>
<td>280</td>
<td>260</td>
<td>230</td>
<td>275</td>
<td>300</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Tur</td>
<td>380</td>
<td>NA</td>
<td>300</td>
<td>320</td>
<td>400</td>
<td>350</td>
<td>400</td>
<td>300</td>
<td>250</td>
<td>NA</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Mung</td>
<td>250</td>
<td>260</td>
<td>250</td>
<td>250</td>
<td>300</td>
<td>240</td>
<td>275</td>
<td>250</td>
<td>250</td>
<td>250</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Urad</td>
<td>260</td>
<td>NA</td>
<td>280</td>
<td>NA</td>
<td>325</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>250</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Sugar-cane</td>
<td>*120</td>
<td>*150</td>
<td>*160</td>
<td>*160</td>
<td>*140</td>
<td>*180</td>
<td>*140</td>
<td>NA</td>
<td>+250</td>
<td>+250</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Ginger</td>
<td>750</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Cotton</td>
<td>475</td>
<td>475</td>
<td>480</td>
<td>475</td>
<td>460</td>
<td>450</td>
<td>490</td>
<td>490</td>
<td>490</td>
<td>490</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Groundnut</td>
<td>410</td>
<td>NA</td>
<td>350</td>
<td>400</td>
<td>500</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>300</td>
<td>NA</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Safflower</td>
<td>NA</td>
<td>NA</td>
<td>325</td>
<td>330</td>
<td>400</td>
<td>330</td>
<td>450</td>
<td>275</td>
<td>360</td>
<td>300</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Sunflower</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>550</td>
<td>450</td>
<td>400</td>
<td>400</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Hale (Turmeric)</td>
<td>NA</td>
<td>700</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Linseed</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>500</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

* Prices per Ton
+ Prices per quintle of Gur

NA: Not available; in some villages these crops are not raised.
commodities in each sample village. After multiplying the total output of each crop with average price of the same commodity in that village, the gross income of each crop was recorded.

6.6 **Total Income From Agricultural Output:**

To calculate the total income earned by moter users, oil engine user and electric motor users during the year 1982-83, the information relating to their output and total income earned has been shown in table No: 6.2.

Mot user cultivators have cultivated a net irrigated area of 11 acres or 1.37 acres per cultivator, and have earned a total gross income of Rs. 1937.5 per cultivators. They earned about 51.5 per cent of their total income from wheat, 12.9 per cent from sugar cane, 14.52 per cent from grass and hush. And the remaining 11.08% income has been earned from Jowar, gram crops etc. Out of total farm income, about two third income (Rs 10050) was from cereals. The remaining part of income has been constituted by gram, sugarcane, and grass (Rs 5450). The gross farm income of mot user cultivators was Rs. 1409.1 per acre during the survey year 1982-83.

The ten oil engine user cultivators have cultivated a net irrigated land, of 59 acres or 5.9 acres per cultivator and have earned the gross income of Rs. 8274 per cultivators. Due to use of oil engine there was a change in cropping pattern compared to mot users. Banana, Potato, Chillies and vegetables and cotton are the new crops raised by oil engine user cultivators. Because of availability of oil engine, the sample cultivators have tried to cultivate high value crops like
sugar cane, banana, vegetables. They have earned about 32.9% of income from sugar cane, banana and potato only and 30.03% from fruits and vegetable; thirdly, 24.38% income from cereals, 9.48% income has been earned from cotton and remaining 3% of income earned from pulses like gram and mung. The gross income per acre of this category of cultivators was found to be Rs. 1402.37. The per acre income of oil-engine user cultivators was little less than mot user cultivators. The reason behind this is that due to high operating cost of oil engine, cultivators could not supply adequate irrigation water to various crops, this has resulted into low productivity of various crops like Wheat, Jowar, gram, sugarcane etc.

The total 149 electric motor cultivators irrigated 1006.13 acres (gross) of land during 1982-83. The net area irrigated by them was 614.73 acres. Table No. 6.2 gives us information about the combined gross farm income of all the seven villages together. The total income received by pumpset owners amounted to Rs. 30,19,065, during the survey year 1982-83. The per cultivator gross income of this category of cultivators from the irrigated part of their land amounted to Rs. 20,255.47. The per acre gross income of this category of cultivators amounted to Rs. 4911.

6.7 Some Important points about Electric Motor User Cultivators:

(a) From Table No: 6.1 it is obvious that the average land irrigated by electric pumpsets was larger than the average area irrigated by the wells with traditional motor. For example, the average area irrigated by the farmer is 4.13 acres (net) or 6.70 acres (gross); while the average area irrigated by the
met user cultivators was only 1.37 acres (net) or 1.56 acres (gross). Therefore, the difference between the two is 2.76 acres (net) or 5.20 acres (gross). We may attribute this additional area irrigated by the electric motor user cultivator to energisation of electric pumpsets.

(b) A major part of the total farm income of sample electric motor user cultivators was derived from the cultivation of sugarcane (i.e. Rs. 13,513,300) or (44.76 per cent). The second important crop raised by this category of cultivators was irrigated Wheat, which accounted for about 25.36 per cent of total farm income (Rs. 7,65,735). The third principal crop Banana contributed about 12.74 per cent (or 384600) of the total farm income.

(c) The electric motor user cultivators have been able to obtain 3.03 per cent of their gross income from vegetable and 2.97 per cent of their gross income from Hybrid Jowar (HYV) crop. They have received Rs. 91419 (or 3.03%) from cultivation of vegetables and Rs. 89,760 from HYV crops like hybrid Jowar.

(d) Electric motor user cultivators compared to mot/oil engine/user cultivators have been able to cultivate different varieties of crops like gram, Mungs, Potato, Haldi, Chillies, Garlic, Onion, Ginger, Musambi, cotton. Oil-seeds etc. This indicates a greater diversification of the cropping pattern adopted by electric motor user cultivators. This diversification of cropping pattern was made possible by the energisation of electric pumpsets.
6.8 Cost of Cultivation of Sample Cultivators:

After calculating the total farm income from irrigated land per cultivator and per acre, we shall now calculate the cost of cultivation of the sample farms. To calculate the net income per acre and cultivator, this step is essential.

The cost of cultivation consists of all the paidout costs (A1 costs) of the cost of cultivation. These costs are divided into variable costs and fixed costs.

The comparative data of the cost of cultivation of sample cultivators is shown in table No: 6.4

The sample mot owner cultivators cultivated a net area of 11.25 acres per cultivators; while the net area cultivated by oil engine users and electric motors user was 25.15 acres and 13.89 acres per cultivators respectively; this includes irrigated as well as unirrigated part of their land.

As we are interested in net annual benefits due to electrification (i.e. energisation of pumpsets), we shall consider only the benefitting area while measuring the cost of cultivation of sample cultivation. As already noted, the average area irrigated by the mot users, oil engine owners and electric motor users was 1.37 acres (net) and 5.9 acres (net) and 4.13 acres (net) respectively. All the costs of cultivation are calculated in respect to this net irrigated area.

(a) **Variable Cost of cultivation:**

(1) **Expenditure on Seeds:**

The average expenditure per cultivator and per acre incurred by the mot user cultivators was Rs. 90.5 and Rs. 65.82 respectively. The average expenditure per cultivators and per
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Type of expenditure</th>
<th>Met users</th>
<th>Oil engine users</th>
<th>Electric pumpset users</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Per acre</td>
<td>Per cultivator</td>
<td>Per acre</td>
</tr>
<tr>
<td>1.</td>
<td>Seeds</td>
<td>65.82</td>
<td>90.50</td>
<td>132.56</td>
</tr>
<tr>
<td>2.</td>
<td>Fertilizers &amp; Manures</td>
<td>164.55</td>
<td>226.25</td>
<td>190.17</td>
</tr>
<tr>
<td>3.</td>
<td>Wages paid to casual labours</td>
<td>41.02</td>
<td>75.50</td>
<td>130.73</td>
</tr>
<tr>
<td>4.</td>
<td>Interest on crop loans</td>
<td>43.64</td>
<td>60.00</td>
<td>56.53</td>
</tr>
<tr>
<td>5.</td>
<td>Repairs &amp; Maintenance</td>
<td>57.73</td>
<td>79.37</td>
<td>100.00</td>
</tr>
<tr>
<td>6.</td>
<td>Operating cost.</td>
<td>13.64</td>
<td>18.75</td>
<td>161.27</td>
</tr>
<tr>
<td></td>
<td><strong>Total variable cost</strong></td>
<td><strong>387.18</strong></td>
<td><strong>532.38</strong></td>
<td><strong>779.45</strong></td>
</tr>
<tr>
<td>Sr. No.</td>
<td>Type of expenditure</td>
<td>Met users Per acre</td>
<td>Oil engine users Per acre</td>
<td>Electric pumpset users Per acre</td>
</tr>
<tr>
<td>---------</td>
<td>--------------------------</td>
<td>--------------------</td>
<td>---------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2.</td>
<td>3.</td>
<td>4.</td>
<td>5.</td>
</tr>
<tr>
<td></td>
<td>B) FIXED COST</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Land Revenue &amp; Cess</td>
<td>6.18</td>
<td>3.50</td>
<td>5.56</td>
</tr>
<tr>
<td>2</td>
<td>Cost of maintenance of</td>
<td>727.27</td>
<td>100.00</td>
<td>238.14</td>
</tr>
<tr>
<td></td>
<td>drought animals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Salary paid to annual</td>
<td>185.45</td>
<td>255.00</td>
<td>304.92</td>
</tr>
<tr>
<td></td>
<td>farm hand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Annual payments to</td>
<td>35.90</td>
<td>49.38</td>
<td>17.84</td>
</tr>
<tr>
<td></td>
<td>village artisans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total fixed cost</td>
<td>954.82</td>
<td>1312.87</td>
<td>556.45</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total cost of cultivation</td>
<td>1342.00</td>
<td>1845.45</td>
<td>1345.71</td>
</tr>
</tbody>
</table>
acre incurred by the oil engine user cultivators was Rs. 782.1 and Rs. 132.56 respectively. Similarly, the electric motors user cultivators have incurred expenditure on seeds, which was relatively higher at Rs. 947.63 per cultivators or Rs. 229.54 per acre. When we compare these figures with per acre expenditure incurred by control cultivators without electrification, the difference between the two was very high. The reason was that the mot user farmers utilized their major portion of land for low value crops like wheat, jowar and Bajra. Therefore, the value of seeds required by them was very meagre. Due to availability of electric motors (i.e. cheap irrigation facilities) electric motor user cultivators cultivated high value crops like sugarcane, Banana, Pulses, vegetables HYV, crops like Hybrid Jowar, etc, which requires larger amount of expenditure on seeds per acre.

(2) Expenditure on Fertilizers and Manures

The per acre expenditure incurred by mot user cultivators on fertilizers and manures was only 164.55. The per acre expenditure incurred by oil engine user cultivators on fertilizers was Rs. 190.17. On the other hand, the per acre expenditure incurred by electric motor user cultivators on fertilizers and manures was quite high Rs. 593.19, indicates that irrigated and high yielding variety crops require additional expenditure on fertilizers and manures.
(3) **Expenditure on Wages paid to Casual labours:**

The per acre expenditure incurred by mot user cultivators on wages paid to casual labours was only Rs. 41.82, on the other hand, the per acre expenditure incurred by oil-engine user cultivator and electric motor user cultivator was high compared to mot user cultivators; i.e. Rs. 138.73 and Rs. 126.07 respectively. The reason is that mot user cultivators need not employ casual labour due to their weak financial position. Second reason is that more irrigated land require more casual labour for farm operation. The expenditure of oil engine cultivators is little high than electric motor user cultivators, because of cropping pattern adopted by these type of farmers.

(4) **Expenditure on Repairs and Maintenance:**

The per acre expenditure incurred by mot user cultivators on repair and maintenance was Rs. 57.73. This include the repair and maintenance cost of mot as well as and other agricultural equipments. The per acre expenditure incurred by oil engine user cultivators and pumpset user cultivators was Rs. 100 and Rs. 93.90 respectively. This include the cost of repair and maintenance of oil-engine, electric motors, pipeline, other equipments, well etc. The repair and maintenance cost of oil engine user was high as compared to electric motor users; mainly because of high prices of diesel and lubricants.

(5) **Expenditure on Operating Cost of Materials:**

The per acre expenditure incurred by mot owner cultivators on operation of mot was Rs. 13.60. This expenditure is very small because not user cultivators need not employ any person for operating mot. The family members of owners
operated the mote. So the expenditure on operating is small.
The per acre expenditure incurred by oil engine user cultivator for operation of the oil engine amounted to Rs. 161.27 (for oil and lubricants). In this category also the family members operate the engine. The information collected from dealer of oil engine revealed that to run the engine it require one litre Kerosene per hour. The market price of kerosene in 1982-83 was Rs. 1.95 per litre. Therefore, the cost of operation of oil engine per hour was Rs. 1.95.

The per acre expenditure on operating cost incurred by electric motor user cultivators was Rs. 145.77. In the case of electric motor there was no need of any special farm hand to operate and supervise the electric pump. All the respondent cultivators operated and supervised the electric motors by their families members. Therefore, there was no paidout cost of the operation of the pump. The most important operating cost of the working of the electric pump sets was the cost of energy.

It was observed that at the time of field survey 45% of pump sets were of three Horse power each and 52% of pump sets were of five horse power each. The per hour consumption of electric energy of 3 H.P. motor was 2.53 units and that of 5 H.P. motor it was 4.22 units. This information was collected from the office of the Maharashtra State Electricity Board, Aurangabad. During the survey year (1982-83) Maharashtra state Electricity Board charged Rs. 0.20 per unit of electric energy. From this information per hour expenditure on operation of
3 H.P. electric motor was estimated to be \(2.5 \times 2.0 = 5.1\) only and 5 H.P. motor was \(4.22 \times 0.20 = 0.84\) only Rs. 0.84. Therefore, the expenditure incurred by oil engine users was higher than that of pump users (by \(1.95 - 0.51 = 1.44\)).

Nowadays Maharashtra State Electricity Board charging Rs. 123 per horse power per year. In our study majority of sample cultivators were paying electric energy bill by this system. The per acre expenditure on electric energy was Rs. 145.77 and per household expenditure on electric energy was Rs. 601.43; and per pumpset expenditure on energy was Rs. 503.44. The total number of electric pumps owned by sample 149 households giving an average of 4.21 horse power per cultivator.

(6) **Interest on Production Loan**;

The per acre expenditure incurred on production loan (i.e. crop loans) by mot user cultivators was Rs. 13.64; by oil engine user cultivators was Rs. 56.53, and by electric pumpset user cultivators was Rs. 34.33.

The per acre variable cost of mot user, engine user and electric pumpsets user cultivators was found to be Rs. 387.18, Rs. 779.25 and Rs. 1222.82, respectively.

(b) **Fixed Cost of Cultivation**;

(i) **Expenditure on Land Revenue and Cess**;

The per acre land revenue paid by mot user cultivators during 1982-83 was Rs. 6.18, oil-engine user cultivators have paid per acre land revenue of Rs. 5.56; and the
electric pumpsets user cultivators have paid per acre land revenue of Rs. 75.76. This revenue consists of an education cess imposed by State Government. The education cess was imposed on crops like sugarcane, banana etc.

(2) **Expenditure on Maintenance of Drought Animals:**

The per acre cost of maintenance of drought animal (i.e. bullocks) incurred by mot user cultivators during the year 1982-83 was Rs. 727.27. Oil engine user cultivators incurred maintenance of cost of drought animals per acre of Rs. 238.14; and electric motor user cultivators incurred an expenditure of Rs. 384.47 per acre. Mot user cultivators used bullock for operating mot, therefore, the expenditure on maintenance of drought animals of mot users was high. The energisation of pumpsets released the bullock power. Many of respondent sample cultivators had sold their bullock pair after installation of electric pump. This may be considered as cost reducing effect of a energisation of pumpsets.

(3) **Expenditure on Annual Farm Hand:**

The expenditure on the farm hads relates to the employed farm hands by the cultivators. A farm hand employed on the annual basis costs Rs. 2200. Only the large and well to do farmers could employ such farm hands and known as Saldars. The per acre expenditure incurred by mot user farmers on this account was Rs. 185.45, and per acre expenditure incurred by oil engine user cultivators was Rs. 304.92. On the other hand electric pumpset owner cultivators spent Rs. 293.48 per acre on this account. The expenditure of mot user farmers was small because
due to their weak financial position they could not employ an annual farm hand (Saldar).

(4) **Expenditure on Annual Payments to Village Artisans:**

This expenditure was actually made in kind and not in cash. These payments in kind was in the form of Jowar, Bajra, etc. These payments were made to village artisans like Carpenters, Cobbler, Blacksmiths, Barber etc in return of their services to farmers throughout the year. These payments in kind have been converted into money terms at current market prices. The per acre expenditure incurred by mot users, oil-engine users and electric pump user cultivators on this account, was Rs. 35.90, Rs. 17.84 and Rs. 17.10 respectively.

Per acre fixed cost of mot user, oil-engine user and electric pumpset user cultivators was Rs. 954.82, Rs. 566.45 and Rs. 700.81 respectively.

By adding per acre variable cost and per acre fixed cost we arrive at per acre average cost of cultivation. Table No: 6.5 shows per cultivator as well as per acre cost of cultivation incurred by the sample mot user, oil-engine user and pumpset owners of this study. It is obvious from this table that the per acre cost of cultivation of the pumpset owner is highest (Rs. 1936.33) than the note-users (Rs. 1342.00), and oil-engine users (Rs. 1345.71). This has happened mainly because the pumpset owners have spent relatively a large amount of money on fertilizers as well as seeds.
TABLE NO: 6.5

COST OF CULTIVATION OF SAMPLE CULTIVATORS.

<table>
<thead>
<tr>
<th></th>
<th>Mot User Cultivator</th>
<th>Oil engine user cultivator</th>
<th>Electric motor user cultivator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Per Cultivator</td>
<td>1845.25</td>
<td>7939.69</td>
<td>7936.33</td>
</tr>
<tr>
<td>2. Per Acre</td>
<td>1342.00</td>
<td>1345.71</td>
<td>1936.33</td>
</tr>
</tbody>
</table>

6.9 Net Farm Business Income:

After determining the gross farm business income per acre and average cost of cultivation per acre of sample cultivator, we are now in a position to calculate the net farm business income per acre of these three types of cultivators. The total farm business income per acre of mot user, oil engine user and electric motor user cultivators was Rs. 1409.1, Rs. 1402 and Rs. 4911 respectively. (Table No: 6.2). By deducting the cost of cultivation per acre from the per acre farm business income, we get the net farm business income per acre. The net farm business income was Rs. 67.1 for mot user, Rs. 56.66 for oil engine user and Rs. 2987 for electric pumpset user cultivators of this study. This information is shown in table No: 6.6. The electric pump users have earned the highest net income per acre (Rs. 2987.37) when compared to oil-engine users (Rs. 56.66) and mot users (Rs. 67.10).
### TABLE NO: 6.6

**TABLE SHOWING NET FARM BUSINESS INCOME.**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Type of No. cultivators</th>
<th>Gross farm business income (per acre)</th>
<th>Average cost of cultivation (per acre)</th>
<th>Net farm business income (per acre) (Col- 2-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1. Mot users</td>
<td>1409.1</td>
<td>1342.00</td>
<td>67.1</td>
</tr>
<tr>
<td>2.</td>
<td>2. Oil engine users.</td>
<td>1402.00</td>
<td>1385.71</td>
<td>56.66</td>
</tr>
<tr>
<td>3.</td>
<td>3. Electric pumpset users</td>
<td>4911.00</td>
<td>1923.63</td>
<td>2987.37</td>
</tr>
</tbody>
</table>

**Net Incremental Income per Pumpset owner as compared to Mot user Cultivator:**

For calculating the net incremental income of pumpset user sample cultivators, we have to use the mot user as control cultivator. As the net irrigated area per pumpset is 4.13 acres, and net farm income per acre of electric motor user being Rs. 2987.37, the total net income earned by the pumpset owner amounts to Rs. 12337.84 (or Rs. 2987.37 × 4.13 acres).

To determine the net incremental income per pumpset, we shall have to deduct the net income from the same area (i.e. 4.13 acre) where electric energy is not being used (in this case, mot user cultivator’s income). The net income per acre of mot user cultivator is estimated to be Rs. 67.1; hence the total income from 4.13 acres of mot users amounted to Rs. 277.12 (or Rs. 67.1 × 4.13). By substracting this amount from the total net income earned by
net income earned by pumpset user cultivators, we get Rs. 12060.72 as the net incremental income arising due to energisation of pumpsets (i.e. 12337.84 - 277.12 = 12060.72).

6.11 Net Incremental Income per Pump-set Owner as Compared to the Oil Engine user cultivators:

We have already calculated the average net income of electric pumpset owner cultivators i.e. Rs. 12337.84.

To calculate the net incremental income per pumpset owner cultivator, we shall have to deduct the net income from the area irrigated by the oil engine user cultivator. The net income per acre of oil engine user cultivator is estimated at Rs. 56.66. The total income from 5.9 acres of oil engine user amounted to Rs. 334.29 (or Rs. 56.66 x 5.9). By subtracting this amount from total net income earned by pumpset user cultivator, we get Rs. 12003.55 as net incremental income arising due to energisation of pumpset (i.e. 12337.84 - 334.29 = 12003.55)

Conclusion:

The net incremental income should be considered as the net impact of rural electrification on agricultural production. Rs. 12060.72 and Rs. 12003.55 which is quite sizeable.

Let us now estimate the financial feasibility of the mot, diesel engine and electric pumps, which are supposed to be the most popular methods of irrigation in Marathwada Region.
6.12 **Financial analysis and Economic analysis:**

There are some basic differences between financial analysis and economic analysis. Whenever an economic project affects the entire economy or the society, then under such conditions the application of the economic analysis becomes appropriate. For example, a big irrigation dam or steel factory etc. On the other hand, whenever a project affects an individual or a very small area under such conditions application of financial analysis is appropriate. Therefore, economic analysis is a wider concept that the financial analysis.

There is another important difference between the application of these two analysis. Whenever economic analysis of project is undertaken then for the valuation of output and services the method of shadow pricing is used (Little and Mirrlees called shadow prices as accounting prices or broader prices). On the other hand, in financial analysis not shadow prices but current market prices are applied.

As our study is related to the measurement of impact of electrification on individual cultivator or industry or consumer, we are required to apply only financial analysis.

6.13 **Financial analysis of Control Mot users/Oil engine users and Electric Pump users:**

(a) **Control Mot users:**

Let us first make the financial analysis of the control mot users. For estimating the financial feasibility of mot, the following conditions should be noted:
1) The life of the well is assumed to be 40 years.
2) The life of the mot (made of leather) is assumed to be five years.
3) The capital cost of well is assumed to be as Rs. 20,000/-
4) The cost of the mot = Rs. 368.25
5) The cost of bullock pair(1) = Rs. 4000/-
   (cost of bullock pair for irrigated part only =487.11)
6) The annual capital charge which includes the payments of principal + interest charges at 10% per annum (Land Development Bank in Maharashtra charges at 10% interest on their long term credit to the cultivator in 1982-83).
7) Annual capital charge of the well = Rs. 1525
   (at 10% interest rate).
8) The annual capital charge of the mot= Rs. 222.52
   (at 10% interest rate)

Now let us test the financial feasibility of sample mot users:

Financial feasibility of mot = Yn = (Q1 + Q2) = 1.

Where

Yn= net income per mot user cultivator
   (from irrigated part only)

Q1= annual capital charge of the long term loan for construction of well.

Q2: annual capital charge on the capital cost of mot and bullock pair user for irrigation purpose.

We have estimated the value of net business income (Yn) per mot user of as follows:

First of all we have calculated gross-income per acre of irrigated area, then by subtracting the average cost of cultivation per acre we get net income per acre. As the average irrigated area of the mot user was found to be 1.38 acres and
the net income per acre being (Rs. 1409.1 - 1342 = 67.1) Rs. 67.1, therefore, by multiplying net income per acre by average irrigated area per mot, we get what is known as net income per mot (Yn) = Rs. 67.10 x 1.38 = 91.93.

By subtracting our data in the equation \( Yn = (Q1 + Q2) \), we get the following result:

\[
\text{Financial feasibility of mot} = Yn - (Q1 + Q2) \\
= \text{Rs. 91.93 - (Rs. 1525 - Rs. 222.52)} \\
= \text{Rs. 91.93 - 1747.54} \\
= \text{Rs. -1655.59}
\]

As the results are negative,
therefore, the project (mot) is not financially feasible.

(b) **Financial feasibility of Oil engine:**

Let us now estimate the financial feasibility of oil engine which is considered to be another method of irrigating the land.

We have already mentioned the capital cost, life of the well and annual capital charge of the well, while discussing the financial feasibility of mot. Now while measuring the financial feasibility of oil engine, we have to note the following conditions:

1) The capital cost of the oil engine = Rs. 4800
2) Life of the oil engine = 10 years
3) Annual capital charge of the oil engine = Rs. 633.60 (at the 10% rate of interest).

We have estimated the net income per oil engine by following the same method which we have followed for estimating the net income of mot user. Therefore, net income per oil engine user is Rs. 334.29 (Rs. 56.66 x 5.9 = 334.29)
Subtracting these values in following equation, we get the following result:

Financial feasibility of oil engine user = \( Y_n - (Q_1 + Q_3) \)

where, \( Y_n \) = net income per oil engine (Rs. 334.29)

\( Q_1 \) = annual capital charge of well (Rs. 1525)

\( Q_3 \) = annual capital charge of capital cost of oil engine (Rs. 633.60)

Financial feasibility of oil engine users =

\[ \begin{align*}
&= \text{Rs. 334.29} - (\text{Rs. 1525} + \text{Rs. 633.60}) \\
&= \text{Rs. 334.29} - 2158.60 \\
&= - \text{Rs. 1824.31}
\end{align*} \]

as the result is negative, hence the project (oil engine) is not financially feasible.

(c) Financial Feasibility of Electric pumpset:

Let us now estimate the financial feasibility of investment in electric pumpset under taken by cultivators.

The gross income per acre in case of pumpset owners was observed to be Rs. 4911, while the cost of cultivation per acre was observed to be Rs. 1923.63, hence the net income per acre would be Rs. 2987.37. Now as the average area irrigated per pump was found to be 4.13 acres, hence the net income per pumpset would be \((\text{Rs. 2987.37 \times 4.13 = 12337.84})\) = Rs. 12337.84. Before measuring the financial feasibility test following conditions should be noted:

1) The capital cost of the electric pumpset is Rs.5614.63
2) The life of the electric motor pumpset is 15 years.
3) Annual capital charge of the pumpset is Rs.673.73

(at the 10% rate of interest).
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Type of Investment</th>
<th>Net Income (Yn) Rs.</th>
<th>Capital Charge of Well (Q1) Rs.</th>
<th>Annual Capital Charge (Q1) Rs.</th>
<th>Whether Investment is Feasible/Unfeasible</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Motor</td>
<td>91.93</td>
<td>- (1525 + 222.50) = -1655.59</td>
<td></td>
<td>Net Feasible</td>
</tr>
<tr>
<td>2.</td>
<td>Oil engine</td>
<td>334.29</td>
<td>- (1525 + 633.60) = -1824.31</td>
<td></td>
<td>Net Feasible</td>
</tr>
<tr>
<td>3.</td>
<td>Electric pumps</td>
<td>12337.84</td>
<td>- (1525 + 673.73) = +10139.11</td>
<td></td>
<td>Feasible</td>
</tr>
</tbody>
</table>
Now let us test the financial feasibility of electric pumps by subtracting our survey data in following equation:

Financial feasibility of electric pumpset = \( Y_n \) - (Q1 + Q4)

where:

\( Y_n \) = net income per pumpset (Rs. 12337.84)

Q1 = capital charge of investment on pumpset (Rs. 1525) (at 10% interest)

Q4 = Capital charge on capital cost of electric pump set (at 10% interest) (Rs. 673.72)

Financial feasibility = Rs. 12337.84 - (Rs. 1525 + 673.73)

= Rs. 12337.84 - 2198.73

= Rs. 10139.11

As the result is positive, hence the investment in pumpset satisfies the test of feasibility. Hence the project (electric pumpset) is feasible.

6.14 Benefit-Cost Ratio, Net Present Worth and Internal Rate of Return:

In the earlier section we have estimated the financial feasibility of the mot, oil engine and electric pumps by using net income per cultivator at a point of time. Now in this section we are going to adopt various discounted cashflow method for measuring the financial feasibility of various investments:

(A) Benefit-Cost-Ratio:

In the benefit-cost ratio method we have to identify various benefits flowing from the project, as well as identify the various costs which have to be incurred while implementing such projects. After identifying benefits, all these benefits are valued at current market prices. While estimating the cost of the project we have to make a distinction between:
(i) capital cost and (ii) current cost (production, operation and maintenance etc.) For example, in our study the cost incurred for digging a well or purchase of mot, oil engine or electric pumpset should be considered as capital cost, because they have a longer life and can be used for number of years. It should also be noted that while incurring the capital cost, we have to make an allowance for gestation period in which the project is being undertaken without any benefit. For example, a project of a well and mot may require one year for completion; hence in the first year there are only capital costs and no benefits. Naturally during the period as the project is not complete, there are neither operation and maintenance cost nor additional production costs, i.e. seeds, fertilizers, expenditure on labour etc. Now once the project is complete both benefits as well as costs being to flow from the project. Benefits are mostly in the form of additional output received by the cultivator over the life time of the capital asset. For example, if the life of the mot is five years, then the benefit of mot will be received by the cultivator till the end of the fifth year. Similar benefits will be received by oil engine users as well as pumpset owners over a period of 10 years and 15 years respectively. At the end of the life of the capital asset, its functional value becomes zero, that means the project is not in a position of functioning or in other words cease to function at all. In our study the investment on mot, oil engine, and pumpset will cease to give any flow of benefit at the end of their life, even then each of these asset has a scrap value at the end of their life. This is also known as the salvage value of the project capital
asset. Salvage value is considered as the benefit of the project. Discounting gross cost and gross benefits:

After identifying the gross and gross costs of the projects, we have to discount them at an appropriate rate of discount. As the lean term rate of interest charged by the Land Development Banks (LDB) in India, for financing agricultural investment like wells, tractors, oil engines, electric pumpsets, bullock pairs etc. was 10% per annum. We have also chosen the rate of discount for estimating the benefit-cost ratio of the i) mot, ii) oil engine and iii) electric pumpsets.

1) **Mot**:

Table No: 6.3 shows the estimation regarding benefit-cost ratio of investment in mot. For example, in column No. 2 we have shown the capital cost of the project, which includes cost of well (Rs. 20,000) plus the cost of bullock pair and mot (Rs. 855.56) or the total capital cost of Rs. 20855.56. As the first year is taken as gestation period, there are no benefits from the project, we well as there are no current cost, also hence the gross cost is equal to total cost. But from second year and onwards, there are zero capital cost till the end of the project (5 years in case of mot). But there are operation and maintenance costs of the project on the one hand, and secondly, there are additional production costs, due to irrigation of land. For example, column No. 3 of the table shows Rs. 98.12 as operation and maintenance cost and column No. 4 shows the additional production costs per cultivator. Hence in the second year, the gross cost shall be addition of operation and maintenance cost plus production cost (Rs. 98.12 + 1747.13 = 1845.25). These costs continue till the
### TABLE NO: 6.8

**COMPUTATION OF BENEFIT-COST RATIO OF MOT PROJECT**

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital cost of Net users (per cultivator) Rs.</th>
<th>Operation &amp; maintenance costs (per cultivator) Rs.</th>
<th>Production costs (Per cultivator) Rs.</th>
<th>Gross costs (Per cultivator) Rs.</th>
<th>Discount factor (10%)</th>
<th>Present worth of costs (10%)</th>
<th>Present worth of benefits (col 5x6)</th>
<th>Total value of production (= gross benefits) (col 8x6) Rs.</th>
<th>Net present worth benefits (10%) Rs.</th>
</tr>
</thead>
<tbody>
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<td>0</td>
<td>20,855.86</td>
<td>0.909</td>
<td>18,957.98</td>
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<td>1,845.25</td>
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<td>1,524.18</td>
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<td>1,845.25</td>
<td>0.751</td>
<td>1,385.79</td>
<td>1944.55</td>
<td>1460.36</td>
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<td>1747.13</td>
<td>1,845.25</td>
<td>0.683</td>
<td>1,260.31</td>
<td>1944.55</td>
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<td>5</td>
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<td>1747.13</td>
<td>1,845.25</td>
<td>0.621</td>
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</tr>
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<td></td>
<td></td>
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<td>28,236.9</td>
<td>3.750</td>
<td>24,274.17</td>
<td>7815.08</td>
<td>5625.16</td>
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</tr>
</tbody>
</table>

*Salvage value 10% to capital investment in moto only.

**Benefit-cost ratio** = \[
\frac{\text{Present worth of gross benefits}}{\text{Present worth of gross costs}}
\]

\[
\frac{5625.16}{24274.17} = 0.232
\]

**Net Present Worth (NPW)** = Present worth of benefit - Present worth of costs

\[
5625.16 - 24274.17 = -18649
\]
Rs. 20055.80 (mot) by the discount factor 0.909 which gives us the present worth of the cost of Rs. 18957.98. Similarly, we have calculated present worth of cost each year by discounting the gross cost of that year. In this way, we have discounted the gross cost of the mot for five years. Then finally we have added the present worth of cost \( \sum_{t=1}^{5} \frac{C_t}{(1+i)^t} \) five years which is equal to Rs. 24274.17. Similarly, we have also discounted the gross benefits each year by the same discount factor to arrive at the present worth of the benefit. For example, in the second year, the gross benefit from the mot is Rs. 1944.55 by multiplying this benefit by the discount factor of second year, we get present worth of benefit of Rs. 1606.20. By using similar method, we have discounted benefits for the next three years (and also the salvage value) by using the appropriate discount factor. Finally we have added all the values of the present worth of the benefits flowing from the mot for a period of four years which is equal to Rs. 5625.16.

Now we are in a position to measure the benefit-cost ratio of the project (mot). As along as the benefit-cost ratio is at-least one or more than one the project is considered to be feasible. But when benefit-cost ratio falls below one, it is considered as not feasible. In the light of these criterion, let us examine benefit ratio of the mot.

\[
\text{Benefit-Cost ratio} = \frac{\text{Present Worth of Gross Benefit}}{\text{Present Worth of Gross cost}}
\]

Or symbolically Benefit-cost ratio = \( \sum_{t=1}^{n} \frac{B_t}{(1+i)^t} \) \( \sum_{t=1}^{n} \frac{C_t}{(1+i)^t} \)
Where

\[ B_t = \text{benefits in each year} \]
\[ C_t = \text{costs in each year} \]
\[ t = 1, 2 \ldots n \]
\[ n = \text{number of years} \]
\[ i = \text{interest (discount) rate}. \]

Substituting the values of Present Worth of gross costs and Present Worth of gross benefits, we get

\[
\text{Benefit-Cost ratio} = \frac{5627.17}{24274.1} = 0.231.
\]

Since the benefit cost ratio is below one the project is not feasible or unremunerative.

\( \text{(B) Net Present Worth of the Project (NPW)} \)

Estimation of Net Present Worth is yet another method of measuring financial feasibility of project by using discounted cost flow measure over a period of time.

In this method, the gross costs and gross benefits of each year are discounted by the 10% discount factor. By adding the total discounted benefits we get Present Worth of gross benefits (Rs. 5625.16). Similarly, by adding the discounted gross costs of the five years, we get present worth of gross cost (Rs. 24274.17). By using the following formula we can calculate the Net Present Worth (NPW) of the project.

\[
\text{Symbolically Net Present Worth} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1 + i)^t}
\]

Or Net Present Worth = Present Worth of gross benefits - Present worth of gross costs.
Where,

\[ B_t = \text{Benefit in each year} \]
\[ C_t = \text{Costs in each year} \]
\[ t = 1, 2, \ldots, n \]
\[ n = \text{number of years} \]
\[ i = \text{interest (discount) rate} \]

Substituting our survey data in the above mentioned formula, we get the following result:

Net Present Worth: Rs. 5625.16 - 24274.17 = - 1849.

As long as the value of the net present worth is positive (+) or at least zero, the project is feasible. If the value is negative the project is considered to be not feasible. In our study, the net present worth of investment in met gives negative Net Present Worth (NPW) the project should be considered as not feasible.

(c) **Internal Rate of Return (IRR):**

The internal Rate of Return (IRR) is an important measure which indicates the earning power of every rupee invested in the project. This method is also useful for the ranking of various alternative projects on the basis of their profitability; hence the method of IRR is very popular and useful while selecting the various irrigation projects on the basis of their IRR, as the total resources are limited. The term internal rate of return is defined as that discount rate which just makes the net present worth of the cash flow equal to zero; or benefit-cost ratio equal to one\(^2\).

---

2. Ibid p. 71.
Symbolically the IRR is that discount rate 'i' such that:
\[ \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} = 0 \]

where,
- \( B_t \) = Benefit in each year
- \( C_t \) = Costs in each year
- \( t \) = 1, 2, 3, ..., \( n \)
- \( n \) = Number of years
- \( i \) = Interest (discount) rate

For the calculation of IRR, we have to follow the following procedure which is shown in the table No. 6.9. In the first place, we have to deduct gross cost of each year from the gross benefit of that year (without applying discount factor) to obtain the value of net benefit (incremental benefits) of that year. In the initial year as the capital cost is very high, the incremental benefits are negative, but during the feature years, as benefits begin to flow the incremental benefits become positive. This is shown in the column No. 7. After obtaining the values of incremental benefits for each year, we are required to apply the such a discount rate, which makes the net present worth (NPW) of cash flow equal to zero.

We have made an attempt to find out such a discount rate by using our survey data in table No. 6.9. We account that the discount rate become negative indicating that project is not feasible and non-remunerative. Hence IRR in case of net is negative. As long as the IRR of a given project is positive
### Table No: 6.9

**Computation of Internal Rate of Return of HOT Project.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Capital cost Rs.</th>
<th>O &amp; M costs Rs.</th>
<th>Production costs Rs.</th>
<th>Gross costs Rs.</th>
<th>Total value of production benefits Rs. (= gross benefits)</th>
<th>Incremental benefits Rs. (5%)</th>
<th>Present worth factor (5%)</th>
<th>Present worth (0%)</th>
<th>Discounted present worth (0%)</th>
<th>Present worth (col. 7x10)</th>
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</thead>
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<td>0</td>
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<td>0.952</td>
<td>-19854.78</td>
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<td>-20855.86</td>
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<td>1855.25</td>
<td>1944.55</td>
<td>89.3</td>
<td>0.907</td>
<td>80.99</td>
<td>1</td>
<td>89.3</td>
</tr>
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<td>98.12</td>
<td>1747.13</td>
<td>1855.25</td>
<td>1944.55</td>
<td>89.3</td>
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<td>77.16</td>
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<td>89.3</td>
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<td>1747.13</td>
<td>1855.25</td>
<td>1944.55</td>
<td>89.3</td>
<td>0.823</td>
<td>73.49</td>
<td>1</td>
<td>89.3</td>
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<td>0</td>
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<td>1747.13</td>
<td>1855.25</td>
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<td>0.784</td>
<td>70.01</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
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<td>Total</td>
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<td>6988.52</td>
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<td>7815.08</td>
<td>-20421.82</td>
<td>-19434.92</td>
<td>5</td>
<td>-20434.82</td>
</tr>
</tbody>
</table>

* Salvage value at 10% to capital investment in hot only.
** Omitted from total to avoid double counting

**Note:** Since even at zero percent rate of discount, the net present worth is negative the project is clearly not feasible and hence the IRR is negative.
the project is considered to be financially feasible, but if the IRR shows a negative sign the project is considered non-remunerative or not feasible.

11) Benefit-Cost-ratio, Net Present Worth and Internal Rate of Return of Oil-Engine and Electric Pumpset Owner:

Let us now analyse the financial feasibility of oil engine users and electric pumpset: user cultivators using the above mentioned three methods, i.e. ratio, NPW and IRR.

Following the same methodology which we have adopted for measuring financial feasibility of the mot project, we now discuss the present worth of gross benefits and present worth of gross costs of these two projects (oil engine and electric pumpsets). Table No. 6.10 and 6.12 show the calculations of the Present worth of cost and present of benefits at appropriate rate of discount. Present worth of gross benefits and present worth of gross costs of oil engine project are Rs. 43499.7 and Rs. 64107.49 respectively. Similarly the present worth of gross benefits and present worth of gross costs of the electric pumpset project are Rs. 1,35,945.33 and Rs. 76475.18 respectively. Substituting these values in the following formula of benefit-cost ratio and Net Present Worth (NPW), we get

\[
\text{Benefit-cost-ratio} = \frac{\text{Present Worth of gross benefits}}{\text{Present worth of gross costs}}
\]

and Net Present Worth (NPW) = Present worth of gross cost - Present worth of gross costs.

Benefit-cost ratio of oil engine project =

\[
\frac{43499.7}{64107.49} = 0.67
\]
<table>
<thead>
<tr>
<th>Year</th>
<th>Capital O &amp; M costs (Rs.)</th>
<th>Production costs (Rs.)</th>
<th>Gross Production costs (Rs.)</th>
<th>Total Incremental value of production (Rs.)</th>
<th>Discount factor (-25%)</th>
<th>Present worth factor (-25%)</th>
<th>Present worth factor (-30%)</th>
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<td>6398.19</td>
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<td>334.31</td>
<td>594.40</td>
<td>2.041</td>
<td>682.32</td>
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<td>6398.19</td>
<td>8274.64</td>
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<td>6398.19</td>
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<td>334.31</td>
<td>1408.78</td>
<td>5.950</td>
<td>1989.14</td>
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<td>8274.64</td>
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<td>8.499</td>
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<td>6398.19</td>
<td>8274.64</td>
<td>334.31</td>
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<td>480.00(17.757)**</td>
<td>8523.36 (35.401)**</td>
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<td>-2571.89</td>
<td>114.669</td>
<td>19458.67</td>
</tr>
</tbody>
</table>

Internal Rate of Return (IRR) = \(-30 + \frac{19458.67}{22030.56}\) = \(-30 + 5 \cdot 0.883\) = \(-30 + 4.415\) = \(-25.58\) = \(-26\%

* Salvage value 10% to capital cost in oil engine only.
** Omitted from total to avoid double counting.
and Benefit cost ratio of electric project =

\[
\frac{1,35,945.33}{76,475.18} = 1.78
\]

Similarly net present worth of oil engine

\[= \text{Rs. } 43499.7 - 64107.49 = -20607.79\]

and net present worth of electric pumpset

\[= \text{Rs. } 1,35,945.33 - 76,475.18 = + 59470.15\]

Since the Benefit-cost ratio of oil engine user is below one and Net present Worth (NPW) of oil engine is also negative, the project is not financially feasible.

The electric pumpsets projects is financially feasible because Benefit-cost ratio is above one (1.78) and NPW is also positive (+ Rs. 59470.15).

Hence the investment in electric pumpsets project is financially feasible and remunerative.

**Internal Rate of Return (Oil engine and electric pumps):**

We have observed in the earlier section that the IRR in case of investment in oil engine shows a negative sign indicating non-feasibility of the project. Let us now estimate the IRR in case of investment in oil engine and electric pumps. Procedure of estimation of IRR in case of oil engine is presented in table No. 6.11 and that of electric pumps shown in table No. 6.13. As regards the IRR of oil engine, we have again observed that the IRR is negative (-26%) indicating that the investment in oil engines made by the cultivators is also non remunerative and not feasible.
Let us now estimate IRR of investment in electric pumps. Table No. 6.13 shows the procedure of estimation of IRR relating to the sample electric pumps. For finding out appropriate IRR we have to follow what is known as trial and error method. We have found that in case of electric pumps the correct IRR (internal rate of return) comes to 48%. For finding out this appropriate IRR the following formula is adopted:

\[
\text{IRR} = \text{Lower discount rate} + \frac{\text{Difference between the discount rates}}{\text{Present worth of cash flow at lowest discount rate}}
\]

This procedure has been applied by using data in table No. 6.13. The lower discount rate is 45%. The difference between the two discount rates is the difference between 45% and 50%, which is 5%. The present worth of cash flow stream at the lower discount rate of 45% is Rs. 1155.7. The absolute difference between the present worth of cash flow at the two discount rates is:

\[
\text{Rs. } 1155.7 + 675.83 = \text{Rs. } 1831.53
\]

(Recall that the absolute difference is simply the sum of the two values ignoring the sign which is attached to them) Hence,

\[
\text{IRR} = 45 + \frac{1155.2}{1831.53} = 45 + 5 \times 0.631 = 45 + 3.155 = 48%.
\]
In practice, it is better not to try to interpolate between a spread wider than about five percentage points. The IRR should always be rounded to the nearest whole percentage point since the underlying projections never can justify the implication of greater precision.

Hence we may conclude from the above analysis that the IRR of investment in electric pump is high (48%), indicating that the project is highly remunerative and feasible.

6.15 Major Conclusions:

We are now in a position to draw a few major conclusions, which are based on our survey data.

1) Investments in the traditional met as a method of irrigation is nonremunerative, because it does not satisfy all the three criteria or the feasibility test. Its benefit-cost ratio is less than one, its net present worth is negative and the internal rate of return is also negative.

2) Considering investment in oil engines also are not feasible in Marathwada Region. Because the benefit-cost-ratio of investment in oil engine is found to be less than one, similarly its net present worth (NPW) and IRR both shows negative signs.

3) According to our study investments in electric pumps are found to be highly remunerative to the cultivators, because its benefit-cost-ratio is 1.78, its net present worth (NPW) is also positive (Rs. 59470.15), and its internal rate of return (IRR) is also high (48%).

Let us now examine the impact of rural electrification on rural industries in the Marathwada Region in the next chapter.