ABSTRACT

Present planned interrogative study was carried out by applying a test of Goodness of Fit (Chi-square) for making comparison between adoptability of tubewell irrigation and types of land. Additionally, Paired Sample t-test has been employed for cash crops (Sugarcane, Berseem, Vegetable and Wheat) growth before and after the introduction of tubewell irrigation of marginal, small, medium and large size class farmers for nine selected villages in D.I.Khan, Kulachi and Paharpur Tehsils of KP during 2008. The findings of the study revealed two aspects: one is the economic impact on number of cash crops cultivated (after the advent of tubewell irrigation, the total output of Sugarcane, Berseem, Vegetable and Wheat crops rose from Rs. 22203 to 41473 /season/acre) and the other is the change in the proportion of the area taken of each crop (from cereals mainly to cash crops) to the total holdings of the farmers.

Key words: Tubewell, irrigation, D.I.Khan, Villages, Farmers, Economics of barani and irrigated land.

INTRODUCTION

The underlying rationale for tubewell irrigation in selected nine villages of D.I.Khan, Kulachi and Paharpur Tehsils of KP manifests from important and concrete factors obtaining there. In such tehsils with extensive irrigation networks, the water supply was insufficient to enable cultivators to achieve the maximum intensity of land use (Datta, et al. 2000). Irrigation land, already developed, lied fallow because of water shortage. It is important for policy makers to keep into close watch the objective conditions in Dera Ismail Khan, Kulachi and Paharpur Tehsils that a sound case for preferring tubewells, over remodeling canals mainly from two reasons. Firstly, tubewells can be constructed without distributing the existing canal flows, whereas canal remodeling will inevitably result in some distribution to the existing system. Secondly, tubewell will give some measure of drainage, in addition to irrigation water, whereas additional canal water will in fact exacerbate drainage problems (Gangwar, et al. 1987). Consistent with the spirit of the grow-more food campaign, which was launched in 1943, large amounts were allocated as grants-in-aid and taccavi loans to the extent of one-fifth of the cost of work. Again following the recommendations of the grow-more-food Enquiry Committee (1952), priority was accorded to minor irrigation works during the first three plans, which gave a new direction to the progress of tubewell irrigation was further accelerated. Shifts in the costs of new schemes and recent advances in agricultural production possibilities (for example, short-season varieties of cereals) have made it possible and desirable to increase the cropping intensity on existing schemes. Tubewell irrigation and drainage has claimed an important component of any intensification programme. If ground water is pumped and reused for irrigation, efficient use of water will rise from about 50% to 80%. In all areas of resource use it is to be expected that economic efficiency will be highest where the consumers pays the real costs of supplying the various inputs or services demanded (O'Connell, et al. 1999). On public irrigation schemes, it was rare for these circumstances to hold serious biological contamination of groundwater. Therefore, groundwater was an important source of public drinking water in almost all areas of District D.I.Khan. Generally, no further treatment beyond the safeguard of chlorination was necessary. Drinking water needs are limited. Rural Communities in poor countries seldom consume more than 15 litres per head per day if they carry water to the house, or 80 litres per head per day if water was piped to the house. Usually, there are four main components to the tubewell system: the power supply, the pump, the type of screen, and the disposal network. The system was operated by public and private authorities. The type of pump was not selected without references to the power source.
Land Holdings

The land holdings are classified into four groups i) below 2.5 acres ii) 2.5 to 5.00 acres iii) 5.0 to 10.0 acres and iv) above 10.0 acres and are called as marginal, small, medium and large size holdings throughout the following statements and analysis. Less obvious point but important from point of view of ours is the pattern of land utilization among farmers having holding of different sizes. Our emphasis is that the large farmers must keep some plots of land uncultivated because they do not use common sense to clear them for cultivation in view of their low fertility. On the other side for the small farmers, land is a scarce factor of production. Therefore, they like to make the best use of it. More or less similar trends have to be observed in respect of the current fallow land. The marginal and small farmers particularly kept nothing of their operational holdings as current fallow, but a little over 5% in the case of medium farmers and 10% of the land in the case of large farmers lied as current fallow. Further, the human labour was scarce to carry on certain agricultural operations and the inability of the farmer to devote his proper attention to all the field areas may compel him to restrict the area of cultivated land within manageable proportions.

Pattern of Land Distribution

Among the farmers the pattern of land distribution having different sizes of land holdings, were a key to the extent of economic inequalities that prevailed among them. It was clearly observed that the marginal and small farmers, who contributed 50% of the sample, owned about 20% of the land; on the other side, the medium and large farmers, who accounted for the same proportion of the households owned 80% of the land. These data clearly indicate the extent of economic inequalities which prevailed among the farmers in rural areas.

Cropping Pattern

It was clearly seen that, under tubewell irrigation, many crops are raised extensively. Inspite of cereals only, the farmers now raise cash crops like Sugarcane, berseem, vegetable, wheat and so on. Their cropping patterns have been considerable changed from wheat-maize to wheat-sugarcane etc. Further, both medium and large farmers have a large proportion of area under cereals than marginal and small farmers. Majority of farmers devoted a larger proportion of their holdings to inferior cereals; a smaller proportion was earmarked for superior cereals. But what was most surprising that, contrary to expectations, medium and large farmers devoted a larger proportion of their holdings to the cultivation of inferior cereals than marginal and small farmers do. Coming to cash crops including fodder, all sizes of farmers devoted to the larger proportion of gross area under cash crops than medium and large farmers here. It is believed that large areas of land in arid regions are so situated that available water cannot be brought economically to them by gravity flows in pipes and canals. That is why, in most of the situations, underground or surface water is pumped to the land to be irrigated. Pumping and drainage waters were lifted to a higher elevation for the irrigation purposes (Johnson and Reiss 1993). In some parts of the areas, pumps were required to lift drainage water into a higher channel where it can flow out of the area by gravity.

MATERIALS AND METHODS

Sample Size

A sample size of total number of 90 households (depending on the homogeneity of variance, magnitude of acceptable error and confidence interval), having an average of 6.9 acres household land holdings, had been enquired into for in-depth study. 10 random sample each taken from nine selected villages of D.I.Khan, Kulachi and Paharpur Tehsils of KP with the help of well structured and pre-tested questionnaire.

Area of Investigation

D.I.Khan, Kulachi and Paharpur Tehsils in N.W.F.P, were selected as study area, because of its vast potentials for agricultural growth, with extensive and effective network, of tube-well irrigation. In selecting the area of investigation for the widespread of tubewell irrigation, the intensity of tubewell irrigation, worked out by a composite index arrived at by multiple indicators. These indicators are:

i. Proportion of Sugarcane, Berseem, Vegetable and Wheat crops area irrigated by tubewells to the net irrigated area in these tehsils.

ii. Proportion of area irrigated by tubewells in the targeted nine villages to the area irrigated by tubewells in the respective tehsil and;

iii. Area irrigated by tubewells as a proportion of the net area sown in the respective tehsil.
The present study was carried out by an empirical investigation conducted by canvassing a proposed and structured questionnaire. By providing resources, man-power and precious time, a sampling design was used for study purposes as given below;

**Sampling Design**

Due to the close proximity of the river, the water table is high and water is drawn to the surface by tubewells. In 1960-61, there were only two tubewells in working conditions which discharged 6,912,000 cusecs of water. With the passage of time, there emerged high feet demand for installing increasing numbers of tubewells, since the growing needs of the population for food and other agriculture commodities made such a demand. Although the number of tubewells increased manifold up to year 2008, but their utilizations remained much below the optimum level and these were not fully utilized, due to frequent breakdowns and closing of number of tubewells because of saline water.

Stratified Sampling Design was adopted as given below;

Stage I. Tehsil wise villages were stratified into:

i. Inhabited

ii. Uninhabited

Stage II. The stratum i of the inhabited villages was further stratified (as given in Table 1) into:

a) Villages with tubewell irrigation

b) Villages with canal irrigation

Stage III. With a given time and man-power, it was decided to take 10% sample of the irrigated tubewells for the purpose of authentic study. There were 810 tubewells in the nine selected villages of D.I.Khan, Kulachi and Paharpur Tehsils at the time of investigation; 10% of the total tubewells therefore worked out to 81 as mentioned in Table II, which were later distributed among nine selected villages according to weightages in terms of irrigated tubewells within tehsils (Abhayaratna, *et al.* 1994).

Stage IV. Three villages each from strata (a) and (b) together was selected randomly from each tehsil. Among three selected tehsils, Table 1 indicates data pertaining to number of inhabited villages, number of uninhabited villages, sources of canal irrigation in comparison with sources of tubewell irrigation.

**Stage V** In order to observe the economic impact of tubewell irrigation on farms and farm families information regarding farming and farm families before and after the sinking of tubewells was gathered randomly, from Chowdwan, Daraban and Mussa Zai Sharif villages in Kulachi Tehsil. The sample size of which was 30.

Stage VI. Furthermore, to measure the overlook of comprehensive study of tubewell irrigation, it was also decided that a sample of respondents under other sources of irrigation, who formed about 33% of the sample tubewell irrigation farmers, chosen for further study namely Kathgarh, Kirri Khaisore and Kot Jai randomly, the sample size of which was 30. In the past similar aspects of drainage systems have been investigated by Azhar, *et al.* 2004.

**Table I: Number of inhabited and uninhabited villages with different sources of irrigation in D.I.Khan District**

<table>
<thead>
<tr>
<th>Name of Tehsil</th>
<th>No. of inhabited villages</th>
<th>No. of uninhabited villages</th>
<th>Source of canal irrigation No.</th>
<th>Source of tubewell irrigation No.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.I.Khan</td>
<td>25</td>
<td>3</td>
<td>15</td>
<td>65</td>
<td>108</td>
</tr>
<tr>
<td>Kulachi</td>
<td>19</td>
<td>2</td>
<td>10</td>
<td>35</td>
<td>66</td>
</tr>
<tr>
<td>Paharpur</td>
<td>6</td>
<td>2</td>
<td>5</td>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
<td><strong>7</strong></td>
<td><strong>30</strong></td>
<td><strong>107</strong></td>
<td><strong>194</strong></td>
</tr>
</tbody>
</table>

Source: Survey data
RESULTS AND DISCUSSION

The statistics used for this study is Chi-Square ($X^2$) (found in 1876 by Halmart and in 1900 by Karl Pearson and R.A; Fisher). Chi-Square ($X^2$) is a technique of goodness of fit by means of which we test the hypothesis whether the sample distribution is in agreement with the hypothetical (theoretical) distribution as;

$$X^2 = \sum \frac{(O_i - e_i)^2}{e_i}$$

Where $O_i =$ Observed values, $e_i =$ Expected value

$X^2 =$ Chi-square distribution

Statistics also applied for this analysis is Paired Sample t-test in order to compare the income of cash crops of marginal, small, medium and large farmers before and after the advent of tubewell irrigation, which is given as follows;

$$t = \frac{(X_1 - X_2) - d_0}{\sqrt{(S_1^2/n_1 - S_2^2/n_2)}}$$

Where

$X_1 =$ Mean value after tubewell irrigation

$X_2 =$ Mean value before tubewell irrigation

d$_0 =$ Mean of difference between paired observations

$S_1^2 =$ Sub sample variance after tubewell irrigation

$S_2^2 =$ Sub-sample variance before tubewell irrigation

$n_i =$ Sub-sample size

<table>
<thead>
<tr>
<th>Table II</th>
<th>Comparison between adoptability of tubewell irrigation and type of land irrigated and barani villages of Tehsils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of land</td>
<td>Adoptability of tubewell irrigation</td>
</tr>
<tr>
<td>Head area (%)</td>
<td>Middle area (%)</td>
</tr>
<tr>
<td>Irrigated</td>
<td>17</td>
</tr>
<tr>
<td>Barani</td>
<td>07</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
</tr>
</tbody>
</table>

Source: Survey data

This study tests the following hypotheses:

H0: There is no significance relationship between adoptability of tubewell irrigation and types of land

H1: There is significance relationship between adoptability of tubewell irrigation and types of land

$X^2 0.05 (2) = 5.991$, while $X^2 = 16.19$

Since $X^2 C > X^2 0.05 (2)$, hence we reject out Ho and accept H1, which proves that there is significant relationship between adoptability of tubewell irrigation and type of land.

Table II shows that 31% of the total cultivable area under all the holdings in all selected villages is irrigated and 50% is barani. This implies that quite a large proportion of potential land capacity, that could otherwise have been
brought under irrigation through tubewells, depends on the rainfall or monsoon. Economics of land use for tubewell irrigation in view of inter-holding comparison of irrigated and barani area in the context of all nine selected villages yields the following results:

a) The larger the holding size, the greater the extent of dry land (i.e. barani land).
b) The smaller the size of the holding, the greater the area irrigated.

The variations in the extent of irrigated area across and within the villages may be accounted for by the following:

c) The land with a patchy and undulating character are more underdeveloped in dry villages than in wet villages.
d) Most of the dry lands are concentrated in the large farm sectors. The small holdings in the irrigated villages are an exception as they, too, have some dry land, but quite significant. The medium holdings have some amount of cultivable dry land.

Table III  Comparison between applications of tubewell irrigation and total income of cash crops

<table>
<thead>
<tr>
<th>Cash Crops</th>
<th>Application of tubewell irrigation results in total income of cash crops (Rupees/ season/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>8239</td>
</tr>
<tr>
<td>Berseem</td>
<td>4051</td>
</tr>
<tr>
<td>Vegetable</td>
<td>3456</td>
</tr>
<tr>
<td>Wheat</td>
<td>6457</td>
</tr>
<tr>
<td>Total</td>
<td>22203</td>
</tr>
</tbody>
</table>

Source: Survey data

Table IV  Result of Paired Sample t test through SPSS (Statistical package for social sciences)

<table>
<thead>
<tr>
<th>Paired Differences</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>P- value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash crops - Income in Rupees/ Season/Acre before Tubewell Irrigation</td>
<td>-5548.3</td>
<td>2212.9</td>
<td>1106.5</td>
<td>-9069.5 to -2026.9</td>
<td>-5.0</td>
<td>3</td>
<td>0.015***</td>
</tr>
<tr>
<td>Cash crops - Income in Rupees/ Season/Acre after Tubewell Irrigation</td>
<td>-10365.8</td>
<td>3414.6</td>
<td>1707.3</td>
<td>-15799.1 to -4932.4</td>
<td>-6.0</td>
<td>3</td>
<td>0.009***</td>
</tr>
</tbody>
</table>

Note: Sign *** indicates 1% level of significance.

The Table III indicates that the cropping pattern of land that has emerged from wheat-maize to wheat-sugarcane and so on and the income of their farmers per season per acre significantly affected under the system of tubewell irrigation (Waheed, 2000). It may be seen that under tubewells irrigation, income of four cash crops have been increased significantly. As far as the economic impact of tubewell irrigation on cropping pattern in respect of four sizes of landholders is concerned, the results are very interesting (Fuss, et al. 1978). In the first place, there was a uniform fall in the production of area devoted to cereal production by all sizes of landholders (marginal, small, medium and large) after the introduction of tubewell irrigation. The land so released has been used to raise cash crops like sugarcane, berseem, and vegetables too along with wheat, which appeared to have become more attractive. From the forgoing it is evident that irrigation has altered the cropping pattern and output of cash crops. It is obvious from the Table III that before the introduction of irrigation, farmers raised cash crops including cereals in relatively smaller income proportion, the output of which was Rs. 22203 / season/ acre. After the advent of tubewell irrigation, cash crops output rose to Rs. 41473 / season/ acre (Shah, 2000) subjected to constant increase in cost of production. After the use of tubewell irrigation, the total income/ output was worked out Rs. 63676/ season/ acre, which clearly reveals the considerable and positive returns in case of sugarcane, berseem, vegetables and wheat crops in three villages of KP. Moreover, The Table IV provides that the significant value (P-value = 0.015****) of cash crops - income in rupees/ season/acre before Tubewell Irrigation has been considerably enhanced (P-value =0.009****) due to cash crops - income in rupees/ season/acre after application of tubewell irrigation. Here in this
case two points may be prominent; first one is that income has increased after the advent of tubewell irrigation, though the proportion of the area devoted to cereal crops has declined. Secondly after tubewell irrigation was introduced, the yield per acre, too, enhanced. The findings of Sivasubramaniyan, 2000 have also justified the role of irrigation in enhancing agricultural productivity.

CONCLUSION AND RECOMMENDATIONS

In D.I.Khan, Kulachi and Paharpur Tehsils, Irrigation water supplies have been increased due to advent of Tubewell source of irrigation. It has been observed at the time of investigation that the water table has been lowered over large area of agricultural land. In this study an attempt has been made to find out to what extent the proportionate change in the adoptability of tubewell irrigation (head, middle and tail area) in barani and irrigated land of nine selected villages of D.I.Khan, Kulachi and Paharpur Tehsils. Such study also shows that income of cash crops per season per acre has undergone a significance change of improvement (From Rs. 22203 / season/ acre to Rs. 41473 / season/ acre) with total income /output increase of Rs. 63676/ season/ acre after the advent of tubewell irrigation. It has been observed at the time of interrogation that cropping pattern of land that has emerged from wheat-maize to wheat-sugarcane and so on due to substantial increase in output after application of tubewell irrigation in such areas. In the rain fed areas of D.I.Khan, Kulachi and Paharpur Tehsils of KP, irrigation water is the major constraining factor in the land development. Due to which farmers are compelled to grow drought resistance cereals crops in relatively greater proportion in comparison with cash crops, through which they get less income and hence remained below poverty line. Hence it is imperative that farmers must be encouraged to supplement the tubewell irrigation at subsidized rates as rest of other alternate irrigation sources are still uncertain, insufficient and scarce in meeting their irrigation requirements in such regions of KP.

REFERENCES


