RESEARCH REPORT SERIES

No. 23

The Economics of Irrigation in East Pakistan

By

Abdul Ghafur

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS
OLD SIND ASSEMBLY BUILDING
BUNDER ROAD, KARACHI
PAKISTAN

No. 23

The Economics of Irrigation in East Pakistan

By

Abdul Ghafur

November 1964

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS
OLD SIND ASSEMBLY BUILDING
BUNDER ROAD, KARACHI-1
(PAKISTAN)

THE ECONOMICS OF IRRIGATION IN EAST PAKISTAN:

A CASE STUDY

Abdul Ghafur*

INTRODUCTION

A concerted effort based on well defined strategy for agricultural development in East Pakistan is still lacking primarily due to the absense of adequate information on technical problems of agriculture and farmers reaction to innovation in that province. The Comilla Rural Cooperative Pilot Experiment [8], though not a strategy by itself, may be considered a major step towards overcoming this limited information problem. The Comilla Experiment emphasises the crucial position of the institutional factors in the development of the agrarian economy in East Pakistan. It aims at transforming the economic and social structure of the Project area through village cooperatives temporarily nourished by a number of supporting institutions, mainly the Kotwali Thana Central Cooperative Association (KTCCA) which is the nucleus of the cooperatives. The Experiment comprises a wide range of socio-economic programmes including improvement in agricultural productivity through introduction of a broad range of agricultural inputs and improved practices to be channeled through the cooperatives. The Comilla Pilot Project in Irrigation-Electrification [10] is a major experimental programme sponsored by the KTCCA and the East Pakistan Water and Power Development Authority to examine all the important facets of costs and benefits of such a project. Together with other agricultural development programmes the

---

* The author is a Staff Economist at the Institute of Development Economics. He is deeply indebted to Dr. Stephen R. Lewis Jr., Research Adviser at the Institute, for his guidance at all stages of the work. He is also indebted to Mr. S.A. Rahim and Mr. Aziz Khan, Research Specialist and Research Associate respectively at the Pakistan Academy for Rural Development, Comilla, for their active cooperation in course of the study. This paper is based on an investigation carried on in Comilla Project area from May, 1964 to October, 1964. Responsibility for the views expressed and for any errors is that of the author alone.

Irrigation-Electrification Project is expected to generate valuable information on farmers' reaction to and adoption of different varieties of agricultural improvement programmes and also the cost and benefit implications of these programmes. Moreover, the irrigation experiences in the project area will also be available for comparison with other projects undertaken by the East Pakistan Water and Power Development Authority (WAPDA) and East Pakistan Agricultural Development Corporation (ADC). The Comilla experience may provide a firmer basis than is warranted by theoratical feasibility studies upon which an optimum intra-agricultural resource allocation policy can be formulated and incorporated into national planning.

I

THE PROJECT AREA

The Comilla Pilot Project area is the Kotwali Thana of the district of Comilla, East Pakistan. The area of the Thana is approximately 107 square miles and the population, as shown by the 1961 census, was 2,17,297. It lies in the middle eastern corner of the district. The main river in the Thana is the river Gumti which flows from east to west. In the past the river has caused tremendous damage by flooding during the monsoon season and an embankment has been constructed along both sides of the river. The geological formation of Thana is alluvial; soil texture varies from sandy loam to clay and clay loam.

THE PROJECT

The Pilot Project consists of three different irrigation projects and Rural Electrification Project (REP) each of which is seperately evaluated in the Project Report. The first irrigation project, which is known as Sonaichuri Project, will take water from the Gumti River by gravity flow through pipe sluices into a network of canals. The Sonaichuri Project will be financed from the works programme funds of the Kotwali Thana

Council. The second irrigation project consists of floating pumps on rafts on the river Gumti and will irrigate adjacent lands. The project is expected to irrigate 980 acres, compared to 6000 acres for the Sonaichuri Project. In the third irrigation project, tubewells will be installed to irrigate an area of 12,000 acres not easily reached from the Gumti or from Sonaichrui. The first project is at the initial phase of construction and has not been used for irrigation so far. The second and the third projects will be financed by the KTCCA and it is only these two projects that are the basis of our discussion.

THE TUBEWELL PROJECT

Considering the topographical and other limitations, irrigation by tubewells has been recommended in the pilot project for the areas not in proximity of the Gumti or Sonaichuri. The seasonal distribution of rainfall in Comilla area [Appendix - 1] demands control of water supply particularly for winter irrigation. The high cost of surface storage sites, problems of evaporation and infiltration contributes to more extensive and intensive development of underground water as an alternative. The usual problems like serious lowering of water table[1/] by developing sub - surface water is not acute in case of the Project area due to favourable geological formation and abundant rainfall facilitating natural recharge of the water bearing strata. Experiences already gained regarding draw-down suggests that the level (or pressure) of water in the aquifer will not be disturbed much if water is pumped at the proposed rate. The concept of mining of water may, however, be applicable to the south eastern part of the Thana where recharging possibilities are limited. In the test boring conducted at various locations throughout the Thana, the natural characteristics of

---

1/ Lowering of the ground water level increases the pumping lift and makes water increasingly expensive. There are other problems as well.

the water bearing sand and the extent and thickness of the aquifer were found favourable to developing underground water at reasonably low costs.

The tubewell project consists of sinking 200 tubewells of 6 inch diameter with centrifugal pumps over a period of four years. Each tubewell yielding 1.5 cfs of water is expected to irrigate about 60 acres of land. Thus 200 tubewells will irrigate 12,000 acres although approximately 30,000 acres of cultivable land could presumably be irrigated from tubewells, if sufficient numbers were installed. The average depth of the tubewells is expected to be 300 ft. The average cost of tubewells using electric engine and diesel motor is estimated to be Rs. 20,632 and Rs. 21,425 respectively. The sponsors of the project favour tubewells using electric engines over diesel engines on the ground of lower annual costs of the former. About forty tubewells have so far been installed in different cooperative villages out of which eleven tubewells irrigated during last winter. The financial procedure followed is that the KTCCA installs the tubewells and the entire cost of installation is extended as a long term loan to the cooperative societies. So far the procedure of payment has not been decided. It is expected in the Project Report that such purchase on instalment by the primary cooperatives will force more efficient utilization of water since the overhead charges will fall on the villagers themselves.

THE GUMTI LOW LIFT PUMPING PROJECT

It is proposed that by 1964-65 six rafts are to be floated on the Gumti River each with pumps capable of delivering 4 cfs of water. The sponsors think that the most economical pump to use is the 4 cfs electric powered pumps but it is suggested that other types of pumps already acquired will also continue in use. The Project suggests that the cost of pumps and their installation should be handled as loan from the KTCCA to the village cooperatives. Three low lift pumps were used for the last winter irrigation.

The estimated costs of tubewells and power pumps are shown in Appendix II.

THE RURAL ELECTRIFICATION PROJECT

In addition to the irrigation Projects, a pilot project for rural electrification is undertaken by East Pakistan WAPDA to make electric power available throughout the Thana. It is projected that net power use by the irrigation projects will be 3,346,776 KWH, the domestic consumption will be 1.5 million KWH, and commercial and industrial usage will add another 150 thousand KWH. It is estimated that the annual cost of the REP will be Rs. 552,000 and the annual deficit in the system will be Rs. 167,903.

II

SOME EXPERIENCES ON FIXED COSTS

The particularly favourable results of the test boring in the Comilla area facilitate low cost of installation of tubewells. It is very difficult to assert that the Comilla experience on costs of tubewells may be considered a representative picture of the whole of East Pakistan. Nevertheless, these sets of disaggregated cost data may contribute to any comparative study on the cost aspect of irrigation in East Pakistan.

It is interesting to note that for tubewells using diesel engines there is a little divergence between the estimated and the actual total cost, though on an item by item basis there is much difference (Appendix - III). The cost of a 15 H.P. diesel engine with pumps turned out to be more than Rs 9,300 as against an estimate of Rs 7,500. The cost of pump house which has not been mentioned in the estimate comes to about Rs 2,000. On the other hand, labour charges (testing, boring and transportation) turn out to be about

Rs 500 as against estimated R_s 2,000; overhead charges are fixed around Rs 1,000 as against estimated Rs 2,500. The estimated reserve for dry holes of Rs 2,000 is so far a "possibility".

To minimize the cost, a simple labour intensive method of drilling is followed by the KTCCA. The scaricity of skilled drillers is still a problem but the attempt to train local people for this purpose appears to be quite successful and has not so far retarded the tempo of installation of tubewells. We are, however, in doubt, when we come to overheads. It is not quite obvious how the combined costs of casing pipes, boring and other drilling equipments, the engineering section; transport (jeep, driver, fuel) and all others can contribute as little as Rs 1,000 per tubewells. In case of deep tubewells using electric engines the divergence between the estimated cost in the Pilot Project and the actual cost for pump-house, labour charges, overhead and reserve for dry holes are similar to that of tubewells using diesel engines.

In the original estimate [11] the cost of 1/2 mile of 400 volt line (Rs 11,485) was included as a part of the cost of each tubewell and low lift pump using electric engines and the practice is continued in the revised project in the case of low lift pumps only. In the original estimation the cost of tubewells with electric engines and diesel motors were Rs. 29,350 and Rs 21,425 respectively. In the revised estimate the costs of tubewells with electric engines have been "cut down" to Rs 20,632, making the tubewells using electric motor "cheaper" than tubewells using diesel motor. In the revised project provision has been made to charge, "where necessary" [10, p.26] the cost of 400 volt line with an average of 750 ft against each tubewell. The implication of such cost accounting will be discussed in detail in Section V.

The method commonly used in distributing water over the area to be irrigated in open ditch. These ditches may be permanent or temporary, lined or unlined. It is generally accepted in Comilla area that the temporary ditches, though they have to be re-excavated each year, are economically more efficient than other methods. No attempt has yet been made to measure the extent of seepage losses in the distribution channels but the nature of the soil (both texture and structure)
that excessive so that bricklined canals may be
suggests that seepage losses may not be/economically justified in this area. The choice between earth ditches and brick lined canals, however, is not so obvious as it appears to be. In the Pilot Project a seepage loss of 20 per cent in the distribution canals has been estimated /_ 10, p.60 _7. If the water lost in the ditches could be fully utilized then each tubewell could irrigate another 15 acres of land. Assuming a net additional benefit of Rs 50 per acre and a 100 per cent replacement requirement in 25 years, and additional investment of as much as Rs 10,700 for bricklined ditches would have been justified at 5 per cent interest rate.

No diaggregated cost data for the low lift pumps are available. A rough breakdown of the cost of construction of rafts indicates that the actual cost of rafts is higher than the planned cost. The cost of fittings is also slightly higher. However, the disparity between the estimated cost and the actual cost is not likely to be large. Most of the discussions in the report are based on tubewells. Still a large number of conclusions arrived at would also be true in cases of low lift pumps particularly with regard to utilization and benefits.

In estimating the costs of different materials used in tubewells and power pumps the market prices of these materials at Dacca and not the actual cost of aquisition has been used by the KTCCA. In calculating the cost of materials for the Ground Water Development and Pump Irrigation 2/ [14], the International Engineering Company Inc., (IECO), general consultant to the East Pakistan WAPDA, has used the cost of aquisition of the materials a substantial part of which is to be imported. Particularly due to the undervaluation of foreign exchange in Pakistan [16] the rupee cost of aquisition of an imported good is much lower than the domestic free market price which is a better index of the (social) cost of material. In this respect the costing policy of the KTCCA is more in conformity with the proper economics of project avaluation. The divergence between the social cost and the private cost will be discussed more elaborately in section V.

III

VARIABLE COST

It has been assumed in the Pilot Project that the annual cost of maintenance of tubewells (including inspection, operators wages, repair) will be reoughly 2 per cent of total costs [10,P. 56-60] or slightly more than Rs 400 per year per tubewell. On the basis of the estimated annual costs of tubewells in the Pilot Project this implies that on a per acre basis maintenance cost will be Rs 7 or ~~rou~~ roughly 10 per cent of the annual cost. It may be noted in this connection that in the Scheme on Power Pump Irrigation 3/ by the East Pakistan Agricultural Development Corporation (ADC) [13] the annual cost per acre on the said item is Rs 14.40 or 34 per cent of

---

2 / The East Pakistan WAPDA has taken up a vast irrigation project comprising irrigation by tubewells and lift pumps to be driven by electricity or diesel engines titled 'Ground Water Development and Pump Irrigation in the Northern Districts of East Pakistan'. The estimated total cost of the Project is Rs. 134 million. The Project will be located in the districts of Dinajpur, Rangpur, Bogra and Rajshahi and is likely to irrigate an area of 180,800 acres.

3/ An extensive Power Pump Irrigation programme to be located all over East Pakistan has been undertaken by East Pakistan ADC at an estimated cost of Rs. 52.98 million rupees. It is expected that in 1964-65 a capacity of 9081 cfs will be available for the irrigation of 381,402 acres. Per acre cost of irrigation based on boro paddy is estimated to be Rs 42.95

total annual cost. Even so, the ADC experience tends to show that the maintenance cost has been underestimated. Experiences gained by the KTCCA in the first five months of 1964 indicate that the annual cost of maintenance will be much greater than expected and a much larger increase is to be feared for the future. In the case of the tubewells which irrigated more than 50 acres for the 1964 boro[4/] crop, the total bill for drivers wages exceeded Rs 400. In calculating the actual cost of operation, the cost of inspection is not taken into account at present, though this is a very important item of real cost. On the one hand the cost of inspection is a current cost item; on the other hand the frequency of inspection largely affects the economic life of engines and reduces replacement cost. The cost of repair (spare parts' and labour) has in some cases exceeded Rs 100 though the engines are not old. It seems, therefore, that there has been a major underestimation in the cost of maintenance - the actual cost may be within 30 to 40 per cent of total annual costs.

No serious bottleneck in operation and maintenance of tubewells is anticipated in the near future if the current rate of output of trained engine drivers which exceeds the rate of expansion of tubewells, is continued. With further increase in tubewells in operation the demand for machanics and assistant mechanics will also increase to keep a reasonable frequency of inspection and a prompt repair service. Both the qualitative and quantitative aspects of training is important because only with the availability of semi-skilled drivers at a low wage rate will the cooperatives find the tubewells attractive and also have confidence in their own capability of running tubewells economically, A series of short training courses will improve the efficiency in maintenance of engines and may lay the foundation of satisfying the demand for mechanised cultivation and other mechanical developments.

4/ Boro is sown in seed bed in October- November, transplanted in December, - January, and harvested in March - April.

All these problems of operation and maintenance are now exogenous to the primary cooperatives. As long as the ownership of tubewells is not transferred to the cooperatives, lack of proper protection and cleaning of engines, carelessness in timely reporting of trouble with the tubewells, etc, by the drivers will continue, due to the absense of any interest group.

IV

ASSUMPTIONS IN THE CALCULATION OF ANNUAL COSTS

In computing the annual costs of tubewells using either electric engines or diesel engines an economic life of 15 years for engines and 30 year for wells have been assumed. The International Engineering Company, Inc., (IECO), expects [14, P. 14] a life of 20 years for both engines and wells for the tubewell segments of the Ground Water Development and Power Pump Irrigation Project. In both cases the cost of well is much more than the cost of engines. Since the conditions of operation and climatic conditions are not very different between the two project areas it follows that there has been downward bias in the calculation of replacement reserve in the Comilla Project or an upward bias in the WAPDA project. Such a downward bias in calculation by the KTCCA is reinforced by the fact that the imported materials which will be used in East Pakistan WAPDA Project are expected to outlast the local varieties used by the KTCCA. In case of diesel driven low lift pumps, provision has been made in the WAPDA Project Report to replace the engine and raft in 5 year [14, p.17] whereas in estimating the annual cost of low lift pumps in Comilla it is assumed that the economic life of the diesel engines will be 15 years. The East Pakistan ADC has calculated the annual depreciation at 10 per cent of capital expenditure [13, Appendix VIII] in a straight line method. If converted by sinking fund method this means a provision for replacement in 8 years (at 5 per cent interest). This is not to say that the Comilla Pilot Project necessarily, will be proved very optinistic in this respect, but the element of uncertainty could have been better avoided by a slightly conservative esti-

The rate of interest (5 per cent) used in the Pilot Project is an example of divergence between the social and private cost. Even though the KTCCA can borrow money at a lower rate of interest, the marginal productivity of capital in Pakistan is much higher- about 10 per cent according to some estimation [6]. In addition, there is always an element of risk attached to a specific project particularly where the output is a local product because such output cannot be transferred to other parts of the economy where an excess demand at the current water rate may exist. It has been generally accepted that "a premium in the interest rate appears to be the most useful adjustment for risk in a project evaluation" [4]. It seems that a rate of interest between 8 and 10 per cent would have been more appropriate in calculating the cost aspect of the project. The practice of using a low rate of interest in project evaluation is also followed by the East Pakistan WAPDA and the East Pakistan ADC.

V

A RE-ESTIMATION OF THE PROJECT COST

All the components of the Comilla Pilot Project can be broadly divided into two parts - Rural Electrification Project and Irrigation Projects. All the Irrigation Projects will use electric power from the REP.[5] It is interesting to note that in evaluating all the projects seperately, the implication of such inter-relationship on the benefit-cost calculation of different project has been overlooked. If there is an increase in the rate changed for electricity, the benefit of the REP and the cost of the Irrigation Projects will be inflated. A problem of the same genus is encountered in the process of allocation of the costs of transmission lines for supplying electricity between REP and Irrigation Projects. If only a very insignificant part of the total cost of the transmission structure is charged on the

5/ The pumps to be used on the Sonaichuri would use approximately 62 thousand KWH and the Gumti Low Lift [illegible] will use approximately 126 thousand KWH per annum. The 200 pumps in the Tubewell Project will consume approximately 3,158 thousand KWH per annum.

Irrigation Projects they will be facourably treated in evaluation at the cost of the REP and vice versa. It follows that by manipulating both the electricity rates and the allocation of costs of transmission lines a systematic bias can be introduced in favour of either REP or Irrigation Projects at the expense of the other. In the Pilot Project it has been estimated that there will be an annual deficit to the amount of Rs 1,67,903 in the REP. In such a form the REP is not feasible and should not be undertaken at all. The Project becomes feasible if the annual deficit is shifted to the Irrigation Projects through either higher rates of electricity or shifting a larger burden of transmission lines to the Irrigation Projects or both. Otherwise 'toleration' of deficit in the REP will subsidize the Irrigation Projects and conceal the weakness of the Irrigation Projects as independent Projects.

The rules of game followed by the EPWAPDA are altogether different. In the Groundwater Development Project the costs of transmission lines (Rs 31.7 million) and power plant (Rs 18 million) have been included in the total project costs (Rs 134.6 million)- the total costs of electrical structure comes to 27 per cent of the total costs. The power plant at Thakurgaon will generate surplus power which will be absorbed by domestic, light industry and commercial users as in the case with Comilla REP. In case of the Comilla Project a very negligible part of the cost of electrical structure has been imputed to the irrigation projects and an important cost item (power plant) has been omitted - "the economic analysis shown for these projects is dependent on the continued ability of EPWAPDA to make available a wholesale night power rate of Rs 0.06 per KWH "[10, P. 60]. The experimental nature of the pilot project does not justify the arbitrary procedure followed in seperating the REP and Irrigation Projects. Although we may subsidize experimental projects for a variety of reasons we must also recognize the extent of subsidy in evaluating the projects. If the two aspects of the Pilot Project are to be seperated at all, it should be based on correct economic principles because otherwise wrong assessment may be made about any individual project. For our present purposes we are more interested in the total cost implication of the Irrigation Projects than the borderline drawn for allocating financial burdens to different organisations.

The estimation of total power utilization in the Pilot Project corroborates our point. The net power use by the Sonaichuri pumps, tubewells and low lift pumps will be 3.3 million KWH. Commercial and Industrial uses will be 150 thousand KWH and "it is not inconceivable" that by 1967 residential consumption will be 1.5 million KWH [10, p. 72]. The abysmally low standard of living in the rural areas in East Pakistan, experiences on rural residential consumption in West Pakistan and low per capita electricity consumption in urban households in East Pakistan strongly indicate that such a projection of rural residential consumption of electricity has very little, if any, element of realism in it. It appears that for all practical purposes almost the entire REP may be considered an appendage to the Irrigation Projects.

In evaluating the costs of tubewells and power pumps we therefore propose that a fresh set of estimates be made by including all the social costs (or costs to the economy) that should be apportioned to the two projects. All the investments ancillary to the tubewell or power pump projects should be considered cost of the projects. There is very little doubt about the fact that from the KTCCA point of view such a re-evaluation would look less sensible. But the divergence between the social costs (to the economy) and private costs (to the KTCCA) cannot be overlooked in the context of macro economic planning. As analysed in this section, an omission of relevant social costs leads to the choice of tubewells using electric engines whereas efficiency conditions in macro planning are better fulfilled if tubewells using diesel motors are used.

According to the revised estimate 200 tubewells will use 3.1 million KWH which means, excluding residential consumption use of power, more than 90 per cent of total power supply will be consumed by the tubewells. It is, therefore, quite safe to suggest that 75 per cent of the total costs of REP should be included in in the Tubewell Project. Again 75 per cent of the deficit, which is likely to be greater than the estimated Rs 1, 67, 903 due to shortfall in residential consumption in REP should also be included in the tubewell project.

In an attempt at recalculating the annual cost per tubewell using electric engine by including the cost of 1/2 mile 400 volt line for each tubewell, 75 per cent of the total capital expenditure on REP (the cost of power plant is excluded) and 75 per cent of the annual deficit on the REP it is found that the annual cost of tubewells using electric engines increases by roughly 66 per cent. Even if we cut down the extent of increase by, say, 25 per cent the use of electric engines becomes more costly than the use of diesel engines. Although the KTCCA will find it profitable to use electric engines the choice is not optimal from a macro economic viewpoint.

On the basis of re-calculation the cost of irrigation per acre by tubewells using electric engines and diesel engines becomes roughly Rs 82 and Rs 70 respectively assuming that 60 acres are irrigated by each pump. However, the actual social cost of irrigation will be much higher when underestimation regarding maintenance cost is taken into account, the average life expectancy of wells and engines is adjusted to conform with the East Pakistan WAPDA and ADC assumptions, a rate of interest is chosen which reflects the opportunity cost of capital and includes the risk allowances. Moreover, like the EPWAPDA practice, all the costs of preliminary investigation, from test drilling through the feasibility report, should be included in Comilla Pilot Project.

The annual cost of the entire Low Lift Pumping Project has been estimated at Rs 30, 116 or about Rs. 31 per acre. Unlike the tubewell project, full cost of 1/2 mile 400 volt line has been included in the computation. It is interesting to note that an estimation of the annual costs of 4 cusec pumps using electric or diesel engines (without changing any assumptions made in the Pilot Project) establishes relative profitability using diesel engine. The apparent lower cost of electric engines with pumps becomes inverted when the appartioned cost of transmission structure and deficit in REP is included. As has been discussed above the actual cost of irrigation on a per acre basis will be much greater than the estimates in the Pilot Project, but it cannot blunt the truth that the low lift Pumping Project is on a better footing than the Tubewell Project. In the Pilot Project it has been asserted [10, P. 58] that nearly 2,500 acres can be covered by low lift pumps from River Gumti. Considering the low annual cost of irrigation per acre by the low lift pumps we are inclined to suggest that priority should be given to full exploitation of this potential over expansion of tubewells.

VI

PROJECT BENEFITS

Given the extent of utilization, estimation of the cost of irrigation helps us to weed out all non-optimal methods and size of irrigation projects. However, in comparing two projects in two different areas there is no reason to select that one which produces cheaper irrigation water. Irrigation water is demanded as an input to agricultural production and the advantages of cheaper irrigation water may be more than offest by a low benefit generated by it.

Irrigation water supplements the existing water available for agricultural production and so the scope of irrigation is mainly governed by both the physical quantity and the time distribution of available water. Secondly, in general terms, the benefits from irrigation is the difference in net benefits, i.e., value of gross output minus cost of productions, accrued from the present cropping pattern and the cropping pattern possible with the introduction of irrigation facilities. These two aspects are, therefore, briefly discussed as an introduction. In analysing the benefits from irrigation some external alternatives like agricultural extension services are also taken into account in so far as they are related to the economics of irrigation. Finally the comparative advantages of irrigation projects and agricultural extension services are compared in an attempt to formulate an outline of agricultural development strategy for Comilla Thana and similar areas.

Importance of Irrrigation

Even though the project area is blessed with copious rainfall there is an overabundance of rainfall during the months of June through September and a general deficiency of moisture during the remainder of the year [Appendix 1]. The purpose of irrigation is to provide soil moisture so that crops may maintain productive growth. Supplemental irrigation is essentially a method of providing water for plant use when the natural rainfall is inadequate. In fact the inadequate soil moisture in the winter season is the most, though not the only, important limiting factor in raising the intensity of cropping in East Pakistan. Experience has shown that irrigation water, if controlled and applied wisely in the required amount and at proper stages of plant growth, has numerous advantages.

Proper time of sowing is an important limiting factor for the production of aus paddy.[5/] In the project area, land is ploughed and sowing is done just after the first rain. The date of sowing is not the only factor determined by rainfall - the ratio of germination is adversely affected by a shortage and the growth of weeds is facilitated by an excess of rainfall. The hazards of late rainfall can be easily overcome with the introduction of irrigation facilities. Moreover, facilities for irrigation are needed before any general change from the broadcasting method now widely used for aus paddy to the improved transplanting method can be expected. Under the broadcasting method, seeds are sown and covered and left to germinate as determined by available moisture. But if transplanted seedlings were left without water supply, they would die. This largely explains why the farmers continue their traditional practice of sowing directly into the field. In case of aman paddy,[6/] the much needed abundant supply of water at the flowering stage (October-November) is not always met with rainfall causing a serious loss in production.

Cropping Pattern

According to their life cycles the crops in and around the Project area may be roughly divided into three groups: (a) wet season crops or Kharif crops e.g., aus, aman, jute,

---

5/ Aus paddy is sown in March-April and harvested in July-August. Aus is a period bound crop and the naturation period is roughly 3 months.

6/ Aman paddy is sown in seed bed in May-June, transplanted in July-August and harvested in November through January. Aman is a time bound crop and the time of harvesting depends more upon the variety than on time of sowing.

(b) dry season crops or Rabi crops e.g., boro, mustard, pulses, potato and (:) perennial crop e.g., sugarcane. In the project area, the present pattern of cropping gives an overall cropping intensity of 159 per cent [10, p. 46]. An economic survey of the areas around and including the project area conducted by the Associated Consulting Engineers Ltd. (ACE) on behalf of the East Pakistan WAPDA[7/] shows an intensity of 167 per cent [15, p.88]. One of the most interesting findings of the ACE is that the intensity of cropping in the wet season is 156 per cent against only 10.8 per cent in the dry seasons. With the inauguration of the irrigation project it may be possible to raise the cropping intensity in the dry season near 100 per cent and thus raise the overall intensity to approximately 250 per cent which exactly corresponds to the cropping projection in the Pilot Project [10, p.46].

Benefit Estimation

It is estimated in the Project Report that at the end of the maturation period net income for the project area of 18,960 acres will increase from about Rs. 3.4 million to Rs. 8.4 million or an increase of 147 per cent. It is expected in the Report that yield per acre for aus paddy will increase from 14 mds. 24 srs. to 21 mds. (45 per cent), aman paddy from 18 mds. 10 srs. to 28 mds. (50 per cent), and boro paddy from 15 mds 10 srs to 24 mds (57 per cent). How this increase in yield will be brought about? It has been argued that "increase in yield is due partly to irrigation and partly to application of fertilizers and intensive cultivation" [10, p. 48]. This seems to be application of the fallacious basis of comparison, "before and after", which does not prevent attributing to a project effects which are not caused by it but which occur because of the passage of time or for other

---

7/ The survey on agricultural conditions was conducted from November, 1962 to May 1963 in connection with the feasibility study on Gumti Flood Control and Irrigation Project. Agricultural conditions including crop pattern, rotations, practices, seed ratio, economic returns were enquired in 40 villages.

reasons. An exogenous increase in yield due to increased use of fertilizers, intensive cultivations, line sowing or pest control has nothing to do with the agricultural benefits from irrigation. The gem of the problem asserts itself when increased yield due to the use of fertilizers etc of those crops which" is not proposed to irrigate" /10, p. 48/ is also included in the agricultural benefit from irrigation. From experiences gained in the first two years in Comilla area it can be asserted that the use of irrigation water for aus and aman paddy still remains hypothetical. Both aus and aman should be dropped from the benefit schedule for this simple reason.

The weakness of the estimation of agricultural benefits in the Project Report lies not only in including crops which are not proposed to be irrigated or which are not actually irrigated at present but also in not setting any time limit for the maturation period.[8/] The method of inducing the farmers to accept the proposed acrage pattern is not formulated. Moreover, what is expected to happen to the utilization irrigation water, net benefits and costs in the development period?

Utilization of Water

In the Comilla Project the response of the farmers in respect of utilization of water has been encouraging, a part of which has originated in the changing environment created by a massive socio-economic programme by the KTCCA. The present practice is to charge a water rate of Rs. 35.00 per acre per crop but due to difficulty in realisation the amount has been extended as a loan to the users of water. In a number of cases delay in irrigation water availability due to late installation of tubewells restricted the acreage under irrigation. Water conveyance structures did not create any bottleneck. To what extent will the farmers continue using irrigation water if the planned water

8/ It is generally accepted that the benefit rate depends very much on the project age. Most irrigation projects go through a maturation period in which economic activities expand to take advantage of the project services; during this period the project yields few benefits in comparison with its future potentials.

charges necessary to pay long term tubewell loans are levied? The question is difficult to answer at this stage but it can be reasonably asserted that the extent of utilization can be made satisfactory if and only if the production of irrigated crops is profitable enough. As could be expected, the rate of utilization of irrigation water by the village cooperative members was much higher than that of the non-members though there is no water rate discrimination. It seems, however, that there is insignificant difference in incentives between members and non-members in respect of utilization of water.

Estimating Net Benefits

The experience and knowledge of the farmers on sound production planning will have to reach a reasonably high level before they are expected to use irrigation water for aus and aman crop unless the seasonal distribution of rainfall is seriously hazardous. A financial analysis of the fixation of water rates and the (immediate) possibility of transfer of ownership to the primary cooperatives should, therefore, be based on dry season or rabi crops. The limited evidence of a major trend showing farmers responsiveness to production of rabi crops other than boro paddy with irrigation water availability suggests that for all practical purposes boro crop should be used as the basis for calculating the net benefits of the irrigation project in Comilla area, at least for the early years.

The prospect of a major substitution of boro paddy by other rabi crops depends to a great extent on relative profitability. Since we are to depend on market mechanism for bringing about such changes, we will have to depend on farmers own initiative or induce the farmers through agricultural extension services. Anyway, it is important to determine the relative profitability of different types of rabi crops at different levels of adoption of improved practices before farmers are suggested anthing about substitution. It is expected that studies on costs and gross output of different types of rabi crops will be initiated by the sponsors of the Comilla Project as early as possible. The relative profitability moreover depends on better marketing and storage facilities, improved transport facilities etc., and further information on the benefits and costs of all these programmes may be very important in suggesting the direction of changes in cropping pattern. For example, the production of potatoes may be relatively profitable to other alternative crops if there is a storage facility. If the additional (over and above the next highest profitable alternative crop) profit from growing potatoes is high enough to justify investment in storage facilities, then in calculating relative profitability of different crops such a programme should not be excluded.

Experience on boro paddy

The crop cutting experiment carried out in 1964 to determine the yield of boro paddy in Comilla Kotwali Thana by the Pakistan Institute of Development Economics, and the Pakistan Academy for Rural Development shows [12] that the yield of boro paddy on the plots which received no irrigation was significantly[9/] higher than that on the plots irrigated by tubewells or power pumps. The average yield under each category is given below:

TABLE - A

Yield of boro paddy in Comilla Kotwali Thana area in 1964.

	No. of plots	Average yield per acre
Tubewell or power pump irrigation	96	13.2 mds
Hand irrigation	52	14.2 mds
No irrigation	48	21.0 mds

Adverse soil conditions and far from satisfactory adoption of improved practices are believed to be the most important factors

9/ statistically significant at 95 per cent level of confidence.

gravitating against the villages using irrigation water from tubewells or power pumps.

A widely used cost figure collected on the basis of an extensive survey gives the cost of production of boro crop as Rs. 213.00 per acre [3] the Pilot Project uses a figure of Rs. 189.71. According to the Agricultural Marketing Department, average harvest prices at important markets (and not at the farmers level) for the last 3 years was Rs 13.85 per mds [10, p.47]. The gross revenue per acre from boro paddy raised on plots using water from tubewells or powerpumps comes to (13.2 mds times Rs 13.85) Rs 182.56 which falls short of the cost of production even without irrigation cost.

It may be argued that the labour cost, which constitutes roughly one quarter of the total cost, in the cost of production should be deflated to bring it in conformity with shadow price of labourer. In the absense of adequate information such a deflation factor is just a matter of guess. An important point to note is that to make the project operational it is necessary that gross output must also cover the money wages whether actual or imputted, because the formers are likely to prefer leisure to work if only shadow wages are paid to or earned by them. What is more, inclusion of money wages in the cost of production is necessary to calculate a rough magnitude of the minimum amount that the farmers would be ready to pay for irrigation water. It should also be noted that reduction of boro prices at important markets to prices at farmers level and deflation of wage cost by 50 per cent tends to cancel each other.

Intensification of the agricultural extension activity can bring about changes in the desired direction. The yield of boro paddy can be greately increased with proper adoption of improved methods. In Comilla Thana a number of model farmers, supervised by a Japanese team, produced an average of 25 mds 30 seers of boro paddy per acre [9, p.3]. The results obtained in the experiments on Japanese method and indigenous method with manure at the Agricultural Experimental Station, Tajgaon, Dacca, were an average of 31.0 mds for Japanese method and 24.3 mds for indigenous method with manure [2, p.45]. It is clear that adoption of improved method of cultivation in all important directions by the farmers will gradually increase the level of productivity and shorten the maturation period of the project. The economic justification of the project and the possibility of recovering the tubewell loans depends heavily on the success of the agricultural extension activity.

The Dynamics of Project Development

If the present tempo of installation of tubewells is to be maintained then the whole project may run into a situation where the success of the project will reflect the success of the project as a whole - any individual tubewell may or may not justify itself. The latter situation is created by the elements of uncertainty regarding the speed of adoption of improved method by the farmers in any particular area. If the speed of adoption is high the annual benefit will exceed annual cost at an early date and the individual installation may justify itself, otherwise it may not.[9]

If some flexibility with regard to time is introduced into the schedule of installation of tubewells the uncertainty element can be greatly minimized. It may be expected that as a result of both extension services and changes in farmers attitude towards improved practices or products there will be

---

9/ The benefit-cost ratio may be estimated by dividing the present value of expected benefits by initial investment where the present value of net benefits is $\sum_{i=1} \frac{Bi-Ci}{(1+r)}$ (B = value of additional output minus cost of production, C = annual cost of operation, maintenance and replacement, r = rate of discount and i = time period). The present value of benefits of distant years becomes smaller if r > 1. For example, if discounted at 8 per cent, the present value of Rs 100 after 10 and 20 years are Rs 46.32 and Rs 21.45 respectively. Therefore, even if the algebric sums are identical, an early concentration of net benefits gives a higher present value of benefits and so preferable, over an alternative where benefits are concentrated in later years.

an increase in adoption rate over time for non-irrigated crops like ans, aman etc. For example, if the farmers know the level and combination of different types of fertilizers to be used for aus and aman paddy and derive benefits from fertilization, they may be able and willing to use fertilizers for boro paddy. If they do not use fertilizers for aus or aman paddy they are not likely to use fertilizers for boro paddy. These experiences in better methods can be transferred to the production of irrigated crops. It is obvious that the experiences of the farmers will increase over time and if the installation of any particular tubewell is deferred for some years it may justify itself better then if it is undertaken now. If a tubewell is sunk now the net additional benefit will be lower than if it is deferred for some future years because of the lower productivity of irrigated crops in the early years caused by relative inexperience of the farmers in improved practices. In this sense we may say that a particular installation in 1964 may not now economically justify itself, it but may do so if undertaken in some future years. In selecting the areas for sinking tubewell villages where better method of cultivation have been adopted should be chosen. The installation of tubewells may be postponed for the villages where improved practices are not adopted untill such methods are adopted. It is only when the benefit rate or speed of adoption depends upon project age alone or the speed of adoption for boro paddy or other rabi crop depends only on the actual use of irrigation water that we can suggest the installation at present, if they are justified at all.

On Comparative advantage

The moral of the above discussion is that much of the success of the tubewell Project may actually be the success of the agricultural extension services. We have noted earlier how blending of the contributions of irrigation and use of improved practices can overestimate the net contribution by irrigation and conceal the weakness of the irrigation project. The important point here is that such a practice also helps to underestimate the net contribution by the agricultural extension services and may lead to misallocation of resources. A second and related problem is that with the introduction of irrigation facilities the intensity of cropping will also rise which, if continued without any artificial fertilization programme, may lead to serious depletion of the essential qualities of of soil and create long run problems.

The crop cutting experiment on amar paddy the in Comilla Kotwali Thana in 1963 [1] measured effects of variation in the degree of adoption of improved products or practices of cultivation on yield rate. It is observed that the average increase in yield per acre on account of the use of fertilizer, plant protection and intercultural practices with the best high yielding variety is 15.1 mds. Over the average yield obtained under country method, even though the average yield under country method is reported to be biased upwards. An increase in the differences may be expected over time. This means an increase in the differences may be expected over time. This means an increase of Rs 213.00 in gross revenue Rs 170.00 in net revenue per acre for aman crop only. If the additional net benefit from aus crop accured as a result of adoption of improved practices is added to the net additional benefits from aman crop the total is likely to exceed Rs 250.00. Since no irrigation water is used for these two crops the immediately achievable increase in net additional benefit can be ascribed to the agricultural extension services. Even taking into account the possibility that the farmers who have adopted improved practices are likely to be those who produce more paddy than average farmers, the net additional benefit remains substantial.

A useful way of allocating funds is to measure the benefit-cost ratio of any investment programme.[10/] Priority is to be given according to the ranking of the programmes in terms of the benefit-cost ratio. We have seen that the annual social cost of irrigation is more than Rs 70.00 per acre for tubewells and the extent of net benefit is insignificant from irrigation in Comilla area. On the other hand, the annual cost of an organised and adequate agricultural extension service is not likely to be more then Rs 15.00 per acre. Even with a top heavy extension service as planned in the Revelle Report [18, p.16] the cost per acre is not more than Rs. 15.00. Even though net benfits from aus and aman may be overestimated in the crop cutting experiments, the results are so overwhelming that a benefit-cost analysis places the extension services in a favourable position over the Irrigation Project and the economy will gain by transferring the current investment budgets from irrigation to concentration on the extension services. Only when

---

10/ See footnote 9; alo(4 ch.5).

the degree of adoption of better practices reaches certain level will the comparative advantage swing in favour of Tubewells Projects. The assertion, however, should not be generalised for the whole of East Pakistan. This paper has not explored all the alternative methods of irrigation. Moreover, there may be areas in East Pakistan where farmers responsiveness to irrigation water utilization and the extent of net benefits without any extension service may be sufficient to make the undertaking of irrigation projects justified. Even if benefit-cost ratio of agricultural extension services is higher than that of irrigation projects in those areas, irrigation facilities should not be deferred. An important point to be noted is that whereas the costs of irrigation is perpetual the cost of extension services need not be so. It has been adequately established in some parts of [illegible] E. Pakistan like Comilla Project area and in different parts of Mymensingh district area [5] that if the extension services fulfil certain basic conditions the response of the farmers can be highly satisfactory. There is no reason to believe that the farmers responsiveness in this respect will be insignificant in other areas of East Pakistan.

An attempt at introducing improved practices by primarily relying on demonstration farms, extension of cheap and adequate credit and supply of subsidized inputs like chemical fertilizers may, however, bring in dangerous consequences. The use of unbalanced and inappropriate dozes of fertilizer, spraying of wrong variety of insecticide at wrong time and a number of serious problems associated with each type of improved practice or product may not give farmers any additional benefit at all, the risk of negatice additional benefit also remains. After examining the data showing utilization of different types of fertilizers in East Pakistan a number of experts concluded that there has been much damage to the soil due to a high concentration of nitrogenous fertilizers. [7] An investigation on the rates of adoption of improved practices by the co-operative members of agricultural co-operative societies in Comilla Kotwali Thana [17] in May-June, 1964 shows that the farmers who have fully adopted the use of fertilizers according to the recommendation of the local agricultural staff constitute only 8.6 per cent. The farmers who partially adopted use of fertilizers constitute 70.7 per cent. Only 17 per cent of the farmers have adequate knowledge about chemical fertilization.

While the responsiveness of the farmers in fertilization is quite high the tempo may be short living. The use of unbalanced fertilizer mix leads to eventual reduction in yield per acre and may also burn the crop. This may build a resistance among the farmers to fertilizer as such. In such cases partial adoption instead of being a process towards full adoption, may actually lead to future rejection of the product or practice. The problem is not only to arouse interest among the farmers but also to help them with specific information, personal guidance and assistance. If an adequate extension staff is not available to begin with, it may be better to concentrate on a few items or in a smaller area than to take up everything at a time or a large area and create impasse for the future. Indeed it is due to the critical shortage of both administrative talents and technical personnel that seriously affects the efficiency of an strategy based on package programme. The strategy implied may be protracted process but there may not be any royal road to agricultural development.

At this stage of the Pilot Project there is no question of temporary suspension of the Project. It may be suggested that the agricultural extension activities should be intensified both in the project area and elsewhere. But there is a problem.

The planned objective of turning the KTCCA into a financially self supporting organisation (now subsidized) has provided it with a motivation to allocate investment with an eye to possible realisation. From the macro economic point of view there are a number of investments, say extension services, which are highly socially profitable but because the benefits of such investments are diffused into the whole economy, they (benefits) cannot be "internalized" by a micro-unit (the KTCCA). There are reasons to fear that in setting priorities between the Tubewell Project and extension services the KTCCA may face an awkward predicament unless the proposed drive for self-sufficiency is put into abeyance. Does the choice offered to the KTCCA need necessarily be one of the second bests?

R E F E R E N C E S

[1] Akhtar, Farkunda and S.A. Rahim, Yield Rates on Aman Paddy in Comilla Thana, 1963. (Comilla: Pakistan Academy for Rural Development, March, 1964, mimeographed).

[2] Alim, A. Rice Cultivation in East Pakistan. (Government of Pakistan, Ministry of Food and Agriculture).

[3] Choudhury, S.D. and Mohd Ashraf Ali, Report on Survey of Cost of Production of Jute in East Pakistan. (Central Jute Committee, Pakistan).

[4] Eckstein, Otto. Water Resource Development (Cambridge; Massachusetts, Harvard University Press, 1961).

[5] Ferguson, Ben R. A Report of the Operation of a New Extension System for East Pakistan (Pakistan, US Agency for International Development, July, 1963).

[6] Haq, Mahbubul. Strategy & Economic Planning (Karachi: Oxford University Press, 1963).

[7] Hendry, James B. and U. Hpu. East Pakistan Agriculture During the Third Five Year Plan, July, 1964, mimeographed.

[8] Pakistan Academy for Rural Development. A New Rural Cooperative System for Comilla Thana, Third Annual Report, 1963 (Comilla: Pakistan Academy for Rural Development, 1963).

[9] Pakistan Academy for Rural Development. Annual Report of the Japanese Experts, 1962. (Comilla: Pakistan Academy for Rural Development, 1962).

[10] Pakistan Academy for Rural Development, The Comilla Pilot Project in Irrigation and Rural Electrification. (Comilla: Pakistan Academy for Rural Development, August, 1964).

[11] Pakistan Academy for Rural Development. The Comilla Pilot Project in Irrigation and Rural Electrification. (Comilla: Pakistan Academy for Rural Development, 1963).

[12] Pakistan Academy for Rural Development. Yield of Boro Paddy in Comilla Thana Area, a Preliminary Report, Research and Survey Bulletin no.7. (Comilla: Pakistan Academy for Rural Development, July, 1964).

[13] Pakistan, East, Agricultural Development Corporation. Scheme on Power Pump Irrigation in East Pakistan, supplementary-1, (Dacca: East Pakistan Agricultural Development Corporation, November, 1963, mimeographed)

[14] Pakistan, East, Water and Power Development Authority. Ground Water Development and Pump Irrigation in the Northern Districts of East Pakistan, Form P.C.-1, revised. (Dacca: East Pakistan WAPDA, October, 1963, mimeographed)

[15] Pakistan, East, Water and Power Development Authority. Gumti Flood Control and Irrigation Project, Agricultural Report, volume III, part I. (Karachi: Associated Consulting Engineers Ltd., November, 1963, mimeographed).

[16] Pal, Mati Lal, The Determinants of the Domestic Prices of Imports, Research Report no. 22, Pakistan Institute of Development Economics. (Karachi: Pakistan Institute of Development Economics, mimeographed).

[17] Rahim, S.A., Partial and Full Adoption of Improved Practices in Comilla Cooperatives, Research and Survey Bulletin no. 8. (Comilla: Pakistan Academy for Rural Development, October, 1964).

[18] White House, Department of Interior Panel on Waterlogging and Salinity in West Pakistan. Report on Land and Water Development in the Indus Plain. (Washington, D.C.: Supdt. Doc., January, 1964).

APPENDIX I

Monthly Rainfall, 1961-July 1964,
Comilla Station

Month	1961 Monthly mean in inches	1962 Monthly mean in inches	1963 Monthly mean in inches	1964 Monthly mean in inches
January	0.00	0.49	0.03	0.07
February	0.80	0.25	0.20	1.39
March	0.16	0.20	0.55	0.74
April	5.38	7.17	5.42	8.36
May	7.08	8.66	12.18	9.46
June	27.29	15.50	19.44	14.33
July	15.31	18.12	18.16	27.72
August	12.54	9.92	15.20	
September	5.95	2.94	5.54	
October	4.95	7.12	21.97	
November	0.00	0.00	0.96	
December	0.00	0.00	0.00	

Source: WAPDA Div no. II (Hydrology), Comilla.

APPENDIX II - A

Cost of Lift Pump Operation on the Gumti

A. Unit cost of Relevant Pump Operations on the Gumti

1. One raft, containing one 4-cusec electric pump

(a) Electric pump	Rs. 3,852
(b) Raft	Rs. 1,000
(c) Fittings	Rs. 5,000
(d) ½ mile of 400 volt Line	Rs.11,898
	Rs.17,250

2. One raft, containing two 2-cusec electric pumps

(a) Electric pump (3187 x 2)	Rs. 6,374
(b) Raft	Rs. 1,000
(c) Fittings	Rs. 500
(d) ½ Mile of 400 volt line	Rs.11,898
	Rs.19,772

3. One raft, containing one 4-cusec diesel pump

(a) Diesel Pump	Rs. 8,612
(b) Raft	Rs. 1,000
(c) Fittings	Rs. 500
	Rs.10,112

4. One raft, containing two 2-cusec diesel pumps

(a) Diesel pump (8,480 x 2)	Rs.16,960
(b) Raft	Rs. 1,000
(c) Fittings	Rs. 500
	Rs.18,460

Source: The Pilot Project [10, . Ch. 6.]

APPENDIX II - B

I. Cost of Deep Tubewells, with electric connections

1. Pipe (175 ft)	....	Rs. 2,800
2. Strainers	....	Rs. 4,125
3. Electric Pump	....	Rs. 3,500
4. Electric connections and structures	...	Rs. 275
5. Labour charges	....	Rs. 2,000
6. Overhead	....	Rs. 2,500
7. Reserve for dry holes	......	Rs. 2,000
8. ½ mile of 400 volt line	......	Rs. 3,432
		Rs.20,632

II. Cost of Deep Tubewells, with diesel engines

1. Pipe (175 ft.)	Rs. 2,800
2. Strainer (125 ft)	Rs. 4,125
3. Diesel motor and pump	Rs. 7,500
4. Cost of fitting, etc	Rs. 500
5. Labour charges	Rs. 2,000
6. Overhead	Rs. 2,500
7. Reserve for dry holes	Rs. 2,000
	Rs.21,425

Source: The Pilot Project [10, Ch. 7].

APPENDIX II - A

Cost of Lift Pump Operation on the Gumti

A. Unit cost of Relevant Pump Operations on the Gumti

1. One raft, containing one 4-cusec electric pump

(a) Electric pump	Rs. 3,852
(b) Raft	Rs. 1,000
(c) Fittings	Rs. 5,000
(d) ½ mile of 400 volt Line	Rs.11,898
	Rs.17,250

2. One raft, containing two 2-cusec electric pumps

(a) Electric pump (3187 x 2)	Rs. 6,374
(b) Raft	Rs. 1,000
(c) Fittings	Rs. 500
(d) ½ Mile of 400 volt line	Rs.11,898
	Rs.19,772

3. One raft, containing one 4-cusec diesel pump

(a) Diesel Pump	Rs. 8,612
(b) Raft	Rs. 1,000
(c) Fittings	Rs. 500
	Rs.10,112

4. One raft, containing two 2-cusec diesel pumps

(a) Diesel pump (8,480 x 2)	Rs.16,960
(b) Raft	Rs. 1,000
(c) Fittings	Rs. 500
	Rs.18,460

Source: The Pilot Project [10, . Ch. 6.]

APPENDIX - III

Cost of Installation of Deep Tubewells in two villages

		South Rampur	South Kali Kapur
1.	Pipe 6" dia.	Rs.1764.00 (98ft)	Rs.2,052.00 (114 ft)
2.	Strainer 6" dia.	Rs.4080.00 (120 ft)	Rs.3,808.00 (112 ft)
3.	Ends (Pocket) 4 ft.	Rs. 120.00	Rs. 120.00
4.	Gunny Bags	Rs. 45.00	Rs. 67.50
5.	Shingles (65cft)	Rs. 195.00 (85 cft)	Rs. 255.00
6.	Engine & Pump	Rs.3,187.00	Rs.9306.00
7.	Labour charges	Rs. 539.00	Rs. 555.00
8.	Electric installation	Rs.1,752.17	Rs. ......
9.	Pumphouse construction	Rs.1,902.63	Rs.1,827.93
10.	Fittings		Rs. 556.32
11.	Overhead	Rs. 894.00	Rs. 926.00
		Rs.14,478.80	Rs.19,473.75

Source: The KTCCA Engineering Division.

Concluding Remarks

The conclusions arrived at in this paper are based on two years of experiences in Comilla area only. For a number of reasons Comilla may not be a fair representation of the whole of East Pakistan. Average annual rainfall in the province varies from 40 inches to 120 inches and there is also variations in the time distribution of rainfall. In the areas where average annual rainfall is low supplemental irrigation will not only open up the possibility of raising winter crops more extensively but also may play a great part in raising yields of even wet season crops like aus or aman paddy. This may be true of the whole of the western part of East Pakistan. In the Northern districts of East Pakistan the farmers grow a number of cash crops which are irrigated by indigenous methods whereas in Comilla area the farmers are not generally experienced in raising cash crops. With the inauguration of irrigation facilities it is, therefore, likely that the farmers in the North Bengal areas will have substantially more gross benefits from irrigation than their counterparts in Comilla area. The results of winter irrigation in the depression areas in Mymensingh and Sylhet may be more favourable than that of Comilla area.

Our assumptions about technological changes in agriculture may also be proved very conservative. It may be that as a result of introduction of irrigation facilities there will be a rapid improvement in adoption of better product or practices throughout the province. While our stand in this respect is quite clear, an optimist may draw his own conclusions.