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THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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THE EFFECT OF TUBEWELL ON INCOME AND EMPLOYMENT: A CASE STUDY IN THREE VILLAGES IN KEDIRI, EAST JAVA, INDONESIA

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ABSTRACT

Indonesia is developing ground water sources for agricultural purposes through the use of tubewell. The effects on farm income and employment, as well as the feasibility of tubewell investment, are investigated. Data were collected from 66 tubewell users, 55 non-users and 30 farm laborers. Users were categorized according to the years of operation. Farm analyses were completed for two alternative cropping systems. Findings were that the introduction of tubewells generated increases in croppi intensity, production and farm income. Increase in income varied with the length of tubewell operation. Financially rice-rice-soybean is better than rice-rice-corn, yet economically the reverse is true. The use of tubewells was financially and economically feasible. Tubewells generated increases in employment and income for laborers. Sensitivity analysis showed that the program would still be profitable to farmers even if paying the whole cost of the environment. Users were categorized according to the years of operation. Farm analyses were completed for two alternative cropping systems.

INTRODUCTION

Background

Increasing food production remains the first priority in agricultural development in Indonesia. The program is essentially carried out using two major approaches simultaneously, namely: (1) efforts to increase production per unit area, and (2) efforts to increase the crop area. The second approach is primarily implemented outside Java through the opening of new tidal swamp and upland areas.

Notwithstanding serious efforts to increase food production, the rate of increase is not very promising. Within Pelita I the increase in rice production was 4.6 percent per annum, decreasing to 3.8 percent per annum within Pelita II. On the other hand the demand for rice is steadily increasing at the rate of 4 percent per annum (Teken, 1974).[1/] The increase in demand is due to: (1) population growth, (2) income growth, and (3) the shift in diet from non-rice to rice.

According to Teken and Kuncoro (1978), the constraints in rice production through the intensification program can be divided into two broad categories, namely: (1) constraints preventing the increase of area for intensification[2/] and (2) constraints with respect to the improvement of the quality of the program. In the period 1974-1976 the area of intensification increased at only 4.5 percent per annum (Teken and Kuncoro, 1978). This limitation was more apparent in the dry season. According to Montgomery (1979), only 47 percent of the total lowland area can be devoted to rice in the dry season (2.60 million ha out of 5.50 million ha). For Java the figure is only 35 percent (1.04 million ha out of 3.00 million ha). Here we see that the limiting factor is irrigation.

To support rice intensification the government continues to develop more irrigation infrastructure. Within Pelita I 1.6 million ha of irrigation has been rehabilitated, improved or extended. Within Pelita III about 765 thousand ha will be developed.

The development shown above is of surface water resources alone, such as dam, water tank, river and so on. Besides these, the development of ground water resources has been initiated. This is done through a

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[1/] Some experts have the opinion that this estimate is too low. Five percent per annum is probably better. As an example see: Leon Mears 1976. Indonesia's Food Problems Pelita II/III, Ekonomi dan Keuangan Indonesia, vol. XXIV, No. 2 June 1976.

[2/] Only well irrigated lowland is suitable for intensification, where the risk of the program is low while the response is high.

pilot project carried out by the Project for Ground Water Development (P2AT), Directorate General for Irrigation, Ministry of Public Work. The location of the project is, among others, in Gunung Kidul area (DIY), Madiun (East Java), Semani (West Sumatra), Kediri - Nganjuk (East Java) and Madura.

With the introduction of tubewell it is expected that the crop area can be increased, particularly in the dry season. It is realized that an additional cost has to be paid but this can be compensated with the increase in production. Yet little is presently known how far the increase in production outweighs the increase in cost needed to cover investment and operation expenses.

Besides farm income, employment opportunity is of special concern, demanding special attention in Pelita III. The effect of a program should be traced further to the impact upon employment opportunities that will have a crucial effect on income distribution.

Based on the above considerations research is needed to investigate the effect of the introduction of tubewells on farm income and employment.

Objectives

There are two main objectives of this research. First is to determine the effect of tubewells on farm income and employment. Second is to know the feasibility of the program in conjunction with the pilot project sponsored by the government.

More specifically the objective can be formulated as follows:

(1) to determine the effect of tubewells on cropping pattern, cropping intensity, level of input use, production, and farm income

(2) to determine the effect of tubewells on employment opportunity

(3) to determine the effect of tubewells on labor use and income of farm laborers

(4) to estimate investment criteria such as Benefit Cost Ratio (BCR), Internal Rate of Return (IRR), and Net Present Value (NPV) in terms of both financial and economic considerations.

METHODOLOGY

Theoretical Framework

Farm production is a combination of two environmental factors, namely physical and non-physical (Lubis, 1978). The physical environment consists

of land, water, solar energy, temperature and moisture. Non-environmental factors consist of labor and capital.

Production at the farm level can be increased by improving the quality of environmental factors. Yet not all of these factors can be changed, e.g. solar energy. It can be postulated that production is a function of the environmental factors together with management factors. Changing management factors will, directly or indirectly, change the level of production.

The change in water availability through irrigation will cause some changes in the production process. Munandar (1978) suggested that better irrigation will make it possible to realize the use of better technology. The availability of irrigation makes it possible to increase the use of fertilizer, HYVs, pesticide, and other input factors. The method and level of application of these factors will determine the level of production. Therefore, besides direct effect on the level of production, improvement of the irrigation system affects production indirectly through changes in factor use. Yet we also see the level of production depends on other factors as well, such as prices of input and output, extension, credit program and so on. Production is also increased by increases in cropping intensity within the existing area. The relation between these factors is summarized in Figure 1.

Estimates of Increased Cost and Return

We can use two kinds of approach to determine the effect of tubewells on farming. First farms using tubewells can be compared with farms not using tubewells. Second, we can compare performance of individual farmers before and after the introduction of tubewells.

The first approach is based on the assumption that environmental factors are the same except for use of the tubewell. The second approach is based on the assumption that there was not change with respect to technological components other than tubewells. The error will be greater the time period used in the comparison. Based on the research findings of Bantilan et al. (1978) in Philippines, we see that the result of observations within the two different periods is almost the same, suggesting that farmers are, in general, poor in remembering what happened prior to the establishment of tubewells.

Therefore it was decided that in this research the approach of comparing the users and non-users within the same period of time would be better. The increase in cost is estimated through the difference between users and non-users. The same is true with the differences in earnings.

For additional comparisons other information was collected relating to farming before and after the introduction of tubewell. It included cropping patterns, cropping area, types of input use and the associated

level of application such as fertilizer, pesticide, HYV, seeds and level of production achieved. This additional information will give further insight into the problem.

Data relating to labor utilization and income farm laborers were collected by comparing the situation before and after the introduction of tubewell based upon interviews with laborers. It was decided not to draw samples of laborers from the area where there were no tubewells, because labor is believed to be mobile, so that such information will be biased.

Sampling

The Project for Ground Water Development in Kediri - Nganjuk area had three centers of development. First, Plemahan development center where 32 tubewells were in operation.[3/] These tubewells were located in eight villages, 22 of which were concentrated in three villages. Second, the Keras development center having 22 tubewells between 18 villages. The third development area was located in Pace kecamatan, Nganjuk kabupaten having 11 tubewells between six villages.

Plemahan kecamatan, where the number of tubewell is the largest within a few number of villages was chosen as the site for this study. We would thereby obtain sufficient samples from within a uniform production environment. The length of tubewell operation in the three chosen villages was about the same, the earliest was five years except in Pace where the earliest operation was six.

Three villages having the largest number of tubewells in Plemahan kecamatan were Sidowarek with 13 units, Sukoharjo with 3 units, and Plemahan with 6 units. In other villages there was only one or two. To obtain close-by tubewell samples Sidowarek and Sukoharjo were taken as purposive sampling area. Plemahan was too far away from the two villages so that the production environment could not be considered homogenous.

To obtain an indication of the relative increases in production among the tubewell samples over time we divided the samples into four categories. The first category was one year operation, followed by two years, three years and five years categories. The number of samples is shown in Table 1.

For each category a number of farmer samples were drawn using stratified random sampling, based on the tubewell that irrigated their field. This stratification was needed because it was believed that tubewell performance varied and would thus generate variation in production. The difference

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[3/] Situation as of April 1980.

in tubewell performance may be due to differences in power rating and the adequacy of the ground water resources underneath. The farmer samples were drawn within each stratum using fully random procedure.

A tubewell operating in a village may serve an area beyond the village borders. Thus only 12 tubewells were chosen in Sidowarek, the other one unit serving an area outside the village. Further it appeared that two tubewells in Sidowarek mainly served an area in Sukoharjo village. Therefore the sample farmers belonged to Sukoharjo. Allocation of farmer and laborers samples with respect to the tubewell categories is shown in Table 2.

Samples for non-users were taken from Sukoharjo and Ringinpitu. The latter is also a neighboring village close to the sample village. From Sidowarek village only samples of users were drawn, because the non-users category was very few. Random sampling procedures were used for the selection. From each user respondent only data of the tubewell irrigated parcels were collected.

A sample of laborers was also obtained. These were defined as households having the major source of income from wage labor. The sample was randomly drawn from Sukoharjo and Sidowarek. The number of samples from each village was 10 and 20 respectively.

Data Collection and Analysis

A preliminary reconnaissance study was conducted to determine the village samples, sampling frame and information related to cropping pattern. In the main survey primary data were collected through individual interviews.

Group interviews and interviews with desa officials and tubewell operator were also conducted. Secondary data on investments was collected from the P2AT file. In addition data from kecamatan agricultural office, agricultural extension center (BPP) and village offices were taken.

Data were analyzed manually. Farm income and labor absorption were estimated. The feasibility analysis for tubewells was based on three investment criteria, namely BCR, IRR, and NPV, economic as well as financial.

The number of samples in farm analysis relating to each of the cropping patterns was different because of variation between farmers. For tubewell users of three years category no farm analysis on corn was made because the sample was only one. The number of samples associated with each crop used in the farm analyses is shown in Table 3.

Sensitivity Analysis

In the financial and economic analyses, the magnitude of BCR, IRRI, and NPV are influenced by the changes in cost. Also the rate of interest affects the estimated value of BCR and NPV.

In financial analysis the investment is not paid by farmers. The result of the analysis will be modified accordingly.

Based on these considerations it is necessary to conduct sensitivity analyses to determine how the critical results depend on changes in factor prices. In this study sensitivity analysis is carried out along the following promises:

(1) 10 percent decrease in revenue, all other things constant

(2) 10 percent increase in cost, all other things constant

(3) 15 percent decrease in revenue, all other things constant

(4) 25 percent increase in cost, all other things constant

(5) Investment cost paid by farmers, all other things constant

(6) Investment cost paid by farmers, while revenue decreases by 25 percent.

Specifications (1) and (2) were used for economic analysis alone. The rest were used for both economic and financial analysis.

FINDING AND DISCUSSION

Brief Outline of P2AT Project in Kediri - Nganjuk

The Project for Ground Water Development in Kediri - Nganjuk has an area within two kabupatens, Kediri and Nganjuk (West Java). Of these 37 thousand hectare are considered to have good potential for ground water development. For the whole area about 1,100 tubewells are needed (P2AT, 1979). At the end of 1979 69 tubewells were operating, servicing and area of 2,945 ha.

Tubewells used in P2AT Kediri - Nganjuk area consist of three types of pump, namely centrifugal, turbine, and submersible. In Plemahan all are turbines adapted to the depth of the ground water. The power source is Lister and Bedford diesel engine of 22.7-65.0 HP. Technical specifications of the pumps are shown in Table 4.

Data on the depth of each tubewell are not available, but the average is 47 m.

The area irrigated by each tubewell ranges between 23.6-51.8 ha with an average of 42.0 ha. To facilitate water distribution the area is divided into four to seven irrigation blocks. The area of each block ranges between 2.8-15.0 ha depending on topography and distance from the pump,

Each unit is managed directly by the village headman. He is assisted, in daily operations, by an operations manager, secretary, treasure, water manager and pump operator.

Water distribution is based on a crop rotation system with intervals depending on the water requirement for each crop.[4/] To get the allotment needed a farmer should make an application to the respective block leader one day earlier in accordance with the designed schedule. The block leader will send it to Jogotirto[5/] and finally to the tubewell operator.

Changes in Farm Management

Cropping pattern. Cropping pattern throughout the year depends very much on climate, especially rainfall. This is especially true for non-users of tubewells, so that 58.5 percent of the respondents can only grow one or two crops per year. The main factor is the lack of water associated with the low of rainfall. The average annual rainfall in Tamahan is only 216.1 mm with 83 rainy days.[6/]

For the users of tubewells the dependence on rainfall was far reduced. More than 95 percent of the respondents grew three crops per year. The most important crops were rice, soybean and corn. The various cropping patterns are shown in Table 5.

Within the four categories of users we observed similarity of crop pattern. The most conspicuous was the pattern rice-rice-soybean, especially in the three years category of tubewell. Next of importance was the pattern rice-rice-corn. Rice appeared to be most important crop chosen by farmers. Two possibilities can be used to explain this fact. First, rice is the most profitable. Second, subsistance farmers are consumption oriented. Yet further discussion is considered outside the scope of this study.

Even though the majority of non-users could only grow two crops per year, the choice of crops was similar to the choice of tubewell users.

The two most important alternative patterns were selected for income analysis. First was the rice-rice-soybean pattern for tubewell users compared to rice-soybean pattern for non-users. The second alternative was rice-rice-corn pattern for users, and rice-soybean-corn for non-users.

Cropping intensity. Cropping intensity is important to determine the income earning potential of land in one year. In this study only the

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[4/] Rice is irrigated once a week, while palawija once in 15 days.

[5/] Jogotirto is a village official in charge of irrigation.

[6/] Average for 11 years.

magnitude of index will be analyzed. For tubewell users, due to the availability of water, the chosen pattern was the same, associated with cropping intensity of 300 percent (Table 6). For non-user the cropping intensity index varied depending on the chosen pattern. The index was highest when the rice-soybean-corn pattern was used (256 percent). With the rice-soybean pattern the index was only 196 percent.

The level of inputs. The use of seeds, fertilizer and pesticide are discussed here. The changes in labor input are discussed later.

Analysis of input use is only for the wet season rice grown by all farmers. Input use for soybean and corn cannot be compared because of the difference in season. Tubewell users grow soybean or corn in the wet season (September - November), while non-users grow the crops in the dry season (May - July).

In the wet season 100 percent of tubewell users grew HYV (IR 36), compared to 80 percent for non-users. Before the introduction of tubewells 68 percent of the users grew HYV (PB 5/PB 8). The rest grew IR 36, Pelita and local varieties. The adoption of HYV was probably not due to the introduction of tubewells, but rather the serious Brown Plant Hopper infestation in 1976/77.

The quantity of seeds differed between users and non-users (Table 7 and 8). For users the application rate was 2 - 38 percent lower compared to non-users. Irrigation improvement seems to enchance efficient use of seeds.[7]

For all categories of users the level of fertilizer was higher by 2-6 percent compared with non-users. The change was much higher when we compare the levels before and after the introduction of tubewell, ranging between 6-68 percent. Thus non-users appear to have also increased fertilizer use.

Similar results were also observed for pesticide use. For the users the level was 3-20 percent higher compared to non-users. The difference before and after the introduction of tubewell ranged between 17-33 percent.

Based on the previous discussion we can conclude that the introduction of tubewell does enhance the use of fertilizer and pesticide, while the level of seed application can be reduced.

Farm Income Analysis

The farm income analysis is based on cropping pattern and cropping intensity already discussed in previous sections. Income is calculated as the total net return. Net returns per hectare for each crop is shown

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[7] Based on group interviews it was revealed that before the introduction of tubewell some of the seedlings did not germinate due to lack of water. Sometimes seeding was required twice.

in Annexes 2 to 5. The estimated cost used in the analysis includes both purchased cost and imputed cost.[8] The result of the calculation is shown in Tables 9 and 10.

The estimate of the increase of income in one year period is based on two types of major cropping pattern for users and non-users. The patterns associated with users are rice-rice-soybean and rice-rice-corn. For non-users the chosen patterns are rice-soybean and rice-soybean-corn.

Table 9 shows that the rice-rice-soybean pattern compared with the base pattern of rice-soybean gives an increase of income ranging between Rp 100.40 - Rp 224.30 thousand (77 to 172 percent). The highest income is shown by the two years farm category. The reason for this is not apparent. A similar picture is observed for the rice-rice-corn pattern. The increase of income ranges from Rp 83.3 thousand to Rp 197.4 thousand (64 to 152 percent). There was no pattern of this kind in the three years category.

When we use rice-soybean-corn as the cropping pattern base, the increase of income is shown in Table 10. For the rice-rice-soybean pattern the increase per hectare ranges from Rp 119.9 thousand to Rp 243.9 thousand, or 108 to 220 percent. The largest increase happened in the two years category. For the rice-rice-corn pattern the increase ranges from Rp 102.8 thousand to Rp 216.9 thousand or 93 to 196 percent.

The increase of income of tubewell users is due to two factors. First, the increase of cropping intensity. Second, the increase of production for each of the crop component (Annex tables 1 to 4).

Data on the increase in income for the four user categoreis show that the increasing trend is continuing over time. According to P2AT officials the increase continues up to the sixth year of operation.

Wehn we consider the increase of income, we see that the pattern of rice-rice-soybean is better than the rice-rice-corn. The difference is due primarily to the high price of soybean compared to corn (Annexes 1 to 4).

Financial and Economic Analysis

Cost and benefit. Our primary concern in this section is the direct cost, namely the difference between the cost with project and the cost without project. The overall cost component consists of investment cost, operation cost, maintenance cost and farm cost.

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[8] Family labor and seed are estimated using current wage and price,

Investment costs can be divided into the mechanical on the one hand and supporting facilities on the other. Mechanical costs are procurement cost for tubewell and its power source, well construction, tubewell building and installment, canal construction, road construction and miscellaneous expenses such as the procurement of containers for fuel. The market price for a tubewell unit was Rp 17.6 million at time of the study or Rp 418.8 thousand per ha[9/]. The economic price was calculated at Rp 17.1 million per unit or Rp 407.3 thousand per ha. Investment data are shown in Table 11, while more details are presented in Annex 5.

Part of the investment needs periodical replacement. Pump and a power source have a lifetime of 10 years. For this replacement Rp 10.8 million is needed, or Rp 258.1 thousand per ha (market price is equal to the economic value). For facilities replacement of cars is needed in five years, the market price of Rp 177.5 per unit of Rp 4.1 thousand per ha. The associated economic value is Rp 183 thousand or Rp 4.45 thousand per ha.

Operation and maintenance cost consist, among others, of fuel, oil, grease, pump and machine repairs and the salary of operator.

Financially considered, operation and maintenance cost ranges between Rp 554.8 - 843.4 thousand per unit or Rp 12.8 - 24.6 thousand per ha. The associated economic value ranges from Rp 1057.9 - 1438.3 thousand per unit or Rp 23.9 - 41.4 thousand per ha.

The magnitude of operation and maintenance cost by categories is shown in Table 12, the details of which are presented in Annex 6.

From Table 12 we see that operation and maintenance cost differs depending on the years of operation. There is a tendency that a new one has a higher operation time that means higher need of operation materials (Annex 7).

In the same fashion as we handle cost estimates, net return is calculated as the difference with and without project. We use the two types of cropping patterns discussed earlier plus one additional pattern, namely rice-soybean.

The project lifetime is taken as 51 years. This is based on the lifetime of tubewell with proper repair and maintenance. It is assumed that well construction is done in the second year. In the first year preparation activities are carried out, such as building construction, workshop and purchasing of project facilities. In the second year drilling begins together with the purchase of pump and accessories, installment and construction of canals. Operation begins in the third year.

[9/] An average for 24 units with an average service area of 42.02 ha.

Based on the previously discussed increase of production and income, we can assume that the flow of benefits increase continually from the third up to the eighth year (within the period of six years). Beginning the eighth year production is assumed constant. The flow of benefits is estimated at constant price based on the price level within the period of the study. The cash flows are shown in Annexes 8 and 9.

Investment criteria. At the discount rate of 12 percent the BCR for rice-rice-soybean pattern is 2.43, and for the rice-rice-corn pattern is 2.33 (Table 13). The IRR for both pattern exceeds 50 percent. It means that the increase of benefit is more than 50 percent above the additional cost. With such a high value for BCR and IRR we get an estimate for NPV of Rp 1618.4 thousand for the rice-rice-soybean pattern and Rp 1508.9 thousand for the rice-rice-corn pattern. Consistent with the previous discussion we see that the rice-rice-soybean pattern is financially superior.

For economic analysis the BCR for the rice-rice-soybean pattern is 1.19 and 1.47 for rice-rice-corn. The IRR's are respectively 29.81 and 47.62 percent. The NPV for rice-rice-corn pattern is more than double the NPV for rice-rice-soybean pattern. We see that in economic analysis the rice-rice-corn pattern is far superior compared to the rice-rice-soybean pattern. This is due to the low level of production for soybean that cannot be compensated with the economic price of soybean relative to corn (see price data, Annex 10).

Financially we see that a decrease in benefit by 25 percent or the increase in cost by 25 percent, tubewell investment is still viable. This can be seen in sensitivity analysis shown in Table 14. The same is true when the whole investment cost is paid by farmers.

Economic anlaysis shows that the decrease in benefit by 25 percent or an increase in cost by 25 percent makes the rice-rice-soybean pattern non-feasible. The BCR is reduced to 0.89, and IRR is less than 1 percent, while NPV has a negative value (Table 15). The investment is still feasible within the range of 10 percent increase in cost or 10 percent decrease in revenue.

Changes in Employment Opportunity

The use of mechanical technology in Indonesian Agriculture is controversial. This is primary centered around tractor use for land preparation and the rice huller which are believed to replace a huge amount of labor.

Tubewells are one form of the mechanization which have a different impact, in the sense that tubewells do not compete or substitute with labor,

In fact they are complementary. In this section we discuss this issue, looking at how far water made available by pump can generate additional opportunities for labor and hence provide additional income.

Labor absorption in farming. Similar to the general approach of estimating changes of income, changes in labor absorption will be estimated within a period of one year. By labor we mean human labor, both family and hired and the unit of labor is workhour.

In Tables 16 and 17 we show the estimates of labor absorption per hectare. For more details the data are presented in Annexes 11 to 14.

Besides the increase of income, the use of tubewell increases labor use opportunities. For the rice-rice-soybean pattern compared with rice-soybean pattern, the increase in labor absorption ranges between 65 and 78 percent (Table 16). For the rice-rice-corn pattern, the increase ranges between 70 and 77 percent.

When tubewell categories are considered we see that there is a weak trend in labor absorption increases parallel with the increase in the length of tubewell operation. It also appears that the rice-rice-soybean pattern absorbs more labor compared with the rice-rice-corn pattern. This is due primarily to the fact that soybean needs a more intensive care compared with corn. Woman labor appears to increase more (Annex 14).

Similar picture can be observed when the rice-soybean-corn pattern is used in the comparison. With similar analysis we see that tubewell investment can increase labor absorption by 35 to 46 percent for the rice-rice-soybean pattern. For the rice-rice-corn pattern the increase ranges between 39 and 45 percent.

Labor utilization and income. Information collected from farm laborers helps provide additional insight. Comparing the situation before and after the operation of tubewells, we have an estimate of labor utilization and income of farm laborers.

There are three major aspects which we would like to quantify, associated with work opportunties after the tubewell operation. First is the variation of labor activity throughout the year. Second, we have the total of labor utilized. This can be estimated when the first aspect has been revealed. Finally we want to know about labor income. These three aspects of labor can be seen in Table 18.

After the tubewell farm laborers can work the whole year round. We also see that work in the busy months increases. This is compatible with the increase in cropping intensity and improved farm practices after the tubewell. We see that working opportunities increase up to 93 percent, as does income. Additionally, 100 percent of laborer respondents said that after the tubewell it is easier for them to find jobs.

Labor migration between villages within the kecamatan is also lower after the tubewell program. Before the tubewell 33 percent of the respondents migrated between the villages. After the tubewell it dropped to only 13 percent. The number of respondents moving beyond kecamatan borders appears to be the same before and after, namely three percent. The lower rate of migration is considered parallel with the hypothesis that working opportunity is higher in the respective villages after the program.

Within the limit of methodological weaknesses and accuracy of data we can say that indeed tubewell generates employment in the agricultural sector.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Irrigation improvement through tubewell operation is able to increase the use of fertilizer and pesticide, while the use of seeds decreases. Cropping intensity also increases. This increases production and incomes. The increase in income tends to be higher the longer the operation.

Using investment criteria BCR, IRR and NPV we see that tubewell investment is feasible, both economic and financial. Economic feasibility criteria are higher compared to the financial, due to the fact that for rice and corn the economic value is higher than the financial value.

In financial terms the pattern of rice-rice-soybean is much better compared with the rice-rice-corn pattern. Yet economic analysis shows that the reverse is true. This is due primarily to the relatively high shadow price of corn.

Sensitivity analysis shows that tubewell investment is still feasible even when the whole investment and operation cost is paid by farmers. This is still true in case the revenue is reduced by 25 percent.

Besides the effect on farm income, the use of tubewell helps increase employment opportunity and income of farm laborers. Highest labor use is found in the rice-rice-soybean pattern.

Recommendations

Based upon the success of tubewell investment in Plemahan kecamatan, the system can be extended to the neighboring areas known to have a high potential of ground water resources. Exploration to identify the potential should also be extended to other areas to increase the use of value of land where water is the limiting factor of production.

To increase farm income and improve employment opportunity in the study area it is recommended to encourage the rice-rice-soybean pattern.

Corn and soybean yields are far below the potential yields estimated in experimental trials. The use of local varieties and low fertilizer level are the major causal factors identified. Intensificatio program for these crops is very much needed.

Even though it has been convincingly shown that tubewell investment is feasible, further research is needed to determine the capability of farmers to pay the investment and operation cost with due consideration of improved living standards.

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Table 1. The number of tubewell samples in three villages of Plemahan kecamatan, 1979/80

Year of operation	Number of samples
1	4
2	4
3	3
5	2
Total	13

Table 2. Allocation of farmer and laborers samples with respect to tubewell categories in three villages of Plemahan kecamatan, 1979/80

Tubewell category	Village			Total
	Sidowarek	Ringinpitu	Sukoharjo	
Tubewell users				
- 1 year operation	17	-	-	17
- 2 years operation	14	-	-	14
- 3 years operation	-	-	15	15
- 5 years operation	20	-	-	20
Total	51	-	15	66
Non-users	-	38	15	53
Farm laborers	20	-	10	30

Table 3. Number of samples in farm analysis associated with each crop in three villages of Plemahan kecamatan, 1979/80

Category	Crops			
	WS Rice[a]	DS Rice[a]	Soybean	Corn
Tubewell users:				
- 1 year category	17	14	6	11
- 2 years category	13	9	10	8
- 3 years category	15	13	14	b)
- 5 years category	25	15	15	9
Non-users	48	c)	43	21

a) WS = Wet Season; DS = Dry Season
b) Not analysed, one sample only
c) No dry season rice

Table 4. Technical specification of tubewell samples in Sidowarek and Sukoharjo, Plemahan kecamatan, 1980.

No.	Tube-well number	Engine type	Power (HP)	Type of pump	Water discharge (lt/sec.	Location of tubewell	Village irrigated	Area (Ha)	Beginning operation
1	010	Lister	41.25	Turbine	54	Sidowarek	Sidowarek	49.23	22-8-1974
2	012	Lister	41.25	Turbine	38	Sidowarek	Sidowarek	43.25	22-8-1974
3	022	Bedford	60.00	Turbine	38	Sidowarek	Sidowarek and Sukoharjo	42.19	1-9-1976
4	023	Bedford	60.00	Turbine	43	Sidowarek	Sidowarek and Sukoharjo	44.80	1-9-1976
5	043	Lister	41.25	Turbine	60	Sukoharjo	Sukoharjo	41.92	13-7-1976
6	054	Lister	22.70	Turbine	38	Sidowarek	Sidowarek	23.60	1-8-1977
7	055	Bedford	65.00	Turbine	48	Sidowarek	Sidowarek and Tuhjarak	44.00	24-8-1977
8	057	Lister	22.70	Turbine	24	Sidowarek	Sidowarek and Sebet	28.60	30-8-1977
9	061	Lister	22.70	Turbine	60	Sidowarek	Sidowarek and Banjarejo	40.50	3-11-1977
10	071	Lister	34.00	Turbine	43	Sidowarek	Sidowarek	51.80	26-8-1978
11	072	Lister	34.00	Turbine	38	Sidowarek	Sidowarek and Ringinpitu	49.80	26-8-1978
12	074	Lister	34.00	Turbine	38	Sidowarek	Sidowarek	47.30	31-8-1978
13	076	Lister	34.00	Turbine	43	Sidowarek	Sidowarek and Ringinpitu	40.10	31-8-1978
	Average	-	36.43	-	44.23	-	-	42.08	-

Table 5. Cropping pattern in three village samples, Plemahan kecamatan WS 1979 and DS 1979/80

Cropping pattern	Tubewell users by operation category				Non-users
	1 year	2 years	3 years	5 years	
	..... %				
1. Rice-rice-soybean	35.3	35.7	73.3	45.0	0
2. Rice-rice-corn	23.5	35.7	6.7	20.0	0
3. Rice-soybean-corn	0	7.1	0	5.0	22.6
4. Rice-soybean	0	0	0	0	0
5. Rice-corn	0	0	0	0	0
6. Others[a]:					
- 1 crop/year	0	0	0	0	3.7
- 2 crops/year	11.8	0	6.6	0	5.7
- 3 crops/year	17.6	21.5	6.7	10.0	0
- 4 crops/year	11.8	0	6.7	20.0	17.0
Total	100.0	100.0	100.0	100.0	100.0

[a] Many variations, not specified

Table 6. Cropping intensity index for tubewell users and non-users in three villages samples, Plemahan kecamatan, 1979/80

Crop	Users		Non-users	
	Rice-rice-soybean	Rice-rice-corn	Rice-soybean	Rice-soybean-corn
	%			
WS Rice	100.0	100.0	100.0	100.0
DS Rice	100.0	100.0	-	-
Soybean	100.0	0	96.2	83.4
Corn	0	100.0	0	73.0
Total	300.0	300.0	196.2	256.3

a) For all tubewell categories

Table 7. Changes of input level per hectare for users and non-users in three villages, Plemahan kecamatan, WS Rice 1979/80

Farmer categories	Seeds (kg/ha)	Fertilizer (kg/ha)	Pesticide (lt & kg/ha)
1. Tubewell users:			
- 1 year category	33.7	482.9	3.1
- 2 years category	38.4	465.2	3.4
- 3 years category	53.5	480.1	3.6
- 5 years category	51.5	483.0	3.3
2. Non-users	54.7	454.4	3.0
3. Difference (1-2):			
- 1 year category	-21.0	28.5	0.1
- 2 years category	-16.3	10.8	0.4
- 3 years category	-1.2	25.7	0.6
- 5 years category	-3.2	29.5	0.3

Table 8. Comparison of input use before and after the introduction of tubewells in three village samples, WS rice 1979/80

Farmer by tubewell category	Seeds (kg/ha)	Fertilizer (kg/ha)	Pesticide (lt & kg/ha)
1 year category			
- after	33.7	412.9	3.1
- before	33.4	391.1	2.6
- change	0.3	21.8	0.5
2 years category			
- after	38.4	405.2	3.4
- before	34.8	342.6	2.8
- change	3.6	62.6	0.6
3 years category			
- after	53.5	480.1	3.6
- before	54.9	285.4	2.7
- change	-1.4	194.7	0.9
5 years category			
- after	51.5	483.9	3.3
- before	55.3	426.8	2.8
- change	-3.8	57.1	0.5

Table 9. Increase of farm income per hectare by comparing users and non-users performance in three village samples, Plemahan kecamatan, using the base pattern of rice-soybean, 1979/80

Cropping pattern and category	Users of tubewell	Non-users	Increase Value	Increase Percent
	..... Rp 1 000			
Rice-rice-soybean				
- 1 year category	230.6	130.2	100.4	77.08
- 2 years category	354.5	130.2	224.3	172.29
- 3 years category	242.9	130.2	112.7	86.53
- 5 years category	303.6	130.2	173.4	133.21
Rice-rice-corn				
- 1 year category	213.5	130.2	83.3	63.95
- 2 years category	327.6	130.2	197.4	151.59
- 5 years category	259.8	130.2	129.6	99.49

Table 10. Increase of farm income per hectare by comparing users and non-users performance in three village samples, Plemahan kecamatan; using the base pattern of rice-soybean-corn, 1979/1980

Pattern and category	Users of tubewell	Non-users	Increase	
			Value	Percent
	..... Rp 1 000			
Rice-rice-soybean				
- 1 year category	230.6	110.7	119.9	108.35
- 2 years category	354.5	110.7	243.9	220.38
- 3 years category	242.9	110.7	132.2	119.48
- 5 years category	303.6	110.7	193.0	174.40
Rice-rice-corn				
- 1 year category	213.5	110.7	102.8	92.90
- 2 years category	327.6	110.7	216.9	196.02
- 5 years category	259.8	110.7	149.1	134.75

Table 11. Tubewell investment cost and facilities in Plemahan kecamatan, 1979/80

Cost component	Market price	Shadow price
	..... Rp 1 000	
1. Well contruction	3 057.0	3 037.5
2. Tubewell building and facilities	1 962.0	1 707.0
3. Canal contruction	701.3	500.6
4. Pump and accesories	11 854.3	11 854.3
5. Others: fuel containers	15.0	15.0
Total tubewell cost	17 589.6	17 114.4
6. Supporting project facilities	2 391.0	2 335.5
Total investment cost (1 + 2 + 3 + 4 + 5 + 6)	19 980.6	19 449.9

Source: Calculated based on Hunting Technical Services Ltd. and Sir. M. Mc. Donald & Partnert, 1980. Kediri - Nganjuk Project Phase 3A, Interim Report. Directorat General of Water Resources Development, Jakarta.

Table 12. Operation cost and maintenance of tubewell in 1979 (Rp 1 000)

Tubewell category	Operation cost and maintenance/unit		Area per unit (ha)	Operation cost and maintenance/unit	
	Market price	Shadow price		Market price	Shadow price
1 year category	843.4	1 458.3	47.25	17.8	30.4
2 years category	842.0	1 415.1	35.18	24.6	41.4
3 years category	554.8	1 057.9	42.97	12.9	24.6
5 years category	593.5	1 106.5	46.24	12.8	23.9

Source: Calculated based on Laporan Eksploitasi Pompa Tahun 1979, P2AT Kediri - Nganjuk.

Table 13. Values for BCR, IRR and NPV of tube-well investment for farm development Plemahan kecamatan, 1979/80[a]

Analysis and pattern	BCR	IRR (%)	NPV (Rp 1 000)
Financial			
- rice-rice-soybean	2.43	>50	1 618.4
- rice-rice-corn	2.33	>50	1 508.9
Economic			
- rice-rice - soybean	1.19	29.81	522.6
- rice-rice-corn	1.47	49.62	1 236.5

[a]Discount rate 12 percent.

Table 14. Financial sensitivity analysis of tubewell investment, Plemahan kecamatan, 1979/80

Sensitivity analysis	BCR	IRR (%)	NPV (Rp 1 000)
Rice-rice-soybean			
- assumption 1	1.82	> 50	930.5
- assumption 2	2.06	> 50	1 335.3
- assumption 3	1.76	> 50	1 888.3
- assumption 4	1.32	30.26	500.0
Rice-rice-corn			
- assumption 1	1.75	> 50	848.6
- assumption 2	2.01	> 50	1 326.3
- assumption 3	1.68	46.72	1 073.1
- assumption 4	1.26	26.52	415.7

Note:
1. Assumption 1: Revenue decreases by 25 percent, other things constant.
2. Assumption 2: Cost increases by 25 percent, other things constant.
3. Assumption 3: Tubewell investment cost paid by farmers, other things constant.
4. Assumption 4: Tubewell investment cost paid by farmers, and revenue decreases by 25 percent.

Table 15. Economic sensitivity analysis of tubewell investment, Plemahan kecamatan, 1979/80

Sensitivity analysis	BCR	IRR (%)	NPV (Rp 1 000)
Rice-rice-soybean			
- assumption 1	0.89	<1	-313.1
- assumption 2	0.95	4.93	-182.7
- assumption 3	1.07	18.49	188.6
- assumption 4	1.08	20.07	237.3
Rice-rice-corn			
- assumption 1	1.11	20.20	275.2
- assumption 2	1.18	27.77	584.0
- assumption 3	1.33	36.18	851.6
- assumption 4	1.34	37.37	975.3

Note:
1. Assumption 1: Revenue decreases by 25 percent, other things constant.
2. Assumption 2: Cost increases by 25 percent, other things constant.
3. Assumption 3: Revenue decreases by 10 percent, other things constant.
4. Assumption 4: Cost increases by 10 percent, other things constant.

Table 16. Increase of labor absorption per year per hectare as reflected by tubewell farmers compared with non-users having the rice-soybean pattern, Plemahan kecamatan, 1979/80.

Pattern/ category	Tubewell users	Non-users	Increase	
			Total	Percent
		work hour		
Rice-rice-soybean				
- 1 year category	3670	2070	1600	77
- 2 years category	3408	2070	1337	65
- 3 years category	3690	2070	1620	78
- 5 years category	3528	2070	1457	70
Rice-rice-corn				
- 1 year category	3511	2070	1440	70
- 2 years category	3555	2070	1484	72
- 5 years category	3668	2070	1598	77

Table 17. Increase in labor absorption by tubewell users per year hectare compared with non-users having the rice-soybean-corn pattern, Plemahan kecamatan, 1979/80.

Pattern/ category	Tubewell users	Non-users	Increase	
			Total	Percent
		work hour		
Rice-rice-soybean				
- 1 year category	3670	2425	1146	45
- 2 years category	3408	2524	883	35
- 3 years category	3690	2524	1166	46
- 5 years category	3530	2524	1003	40
Rice-rice-corn				
- 1 year category	3511	2524	986	39
- 2 years category	3555	2524	1030	41
- 5 years category	3668	2524	1144	45

Table 18. Monthly variation of labor activity, labor use and income of farm laborers in Sidowarek and Sukoharjo after the tubewell, 1979/80.

Variable	Before the tubewell	After the tubewell	Increase
Number of busy months	5	7	2
Number of slack months	4	5	1
Number of empty months	3	0	-3
Work-hour/HH/year	383	1619	781
Income/HH/year (Rp)	69830	134879	65049 (93)

Note: a. Busy months means higher than average.
b. Slack months means lower than average.
c. Empty months means no farm activity at all.
d. HH means household.
e. Working-hours expressed in term of money, figures in parentheses are percentages.

Annex 1. Income analysis per hectare of WS rice in three village samples, Plemahan kecamatan, 1979/80

Farmers category	Production (qt)	Value (Rp)	Total cost (Rp)	Net return (Rp)
Tubewell users				
- 1 year category	42.0	325 836.0	94 071.6	148 541.2
- 2 years category	46.0	356 868.0	181 780.0	175 088.0
- 3 years category	47.2	366 177.6	200 298.0	165 879.6
- 5 years category	47.7	370 056.0	200 552.7	169 503.9
Non-users	38.4	297 907.2	166 730.4	131 176.8

Annex 2. Income analysis per hectare for DS rice in three village samples, Plemahan kecamatan, 1979/80

Farmers category	Production (qt)	Value (Rp)	Total cost (Rp)	Net return (Rp)
Tubewell users				
- 1 year category	35.9	278 512.2	193 347.3	85 164.9
- 2 years category	44.5	345 231.0	202 805.0	142 426.0
- 3 years category	35.7	276 960.6	206 356.4	70 604.2
- 5 years category	41.6	322 732.8	204 051.5	118 681.3
Non-users[a)]	-	-	-	-

[a)] No rice in the dry season.

Annex 3. Income analysis per hectare for soybean in three village samples, Plemahan kecamatan, 1979/80

Farmers category	Production (qt)	Value (Rp)	Total cost (Rp)	Net return (Rp)
Tubewell users				
- 1 year category	5.85	153 679.5	156 822.7	(-3 143.2)
- 2 years category	6.86	180 212.2	143 189.3	37 022.9
- 3 years category	6.24	163 924.8	157 533.6	6 391.2
- 5 years category	6.66	174 958.2	159 490.6	15 467.6
Non-users	5.73	150 632.2	151 643.4	(-1 011.2)

Annex 4. Income analysis per hectare for corn in three village samples, Plemahan kecamatan, 1979/80

Farmers category	Production (qt)	Value (Rp)	Total cost (Rp)	Net return (Rp)
Tubewell users				
- 1 year category	18.94	150 573.0	170 813.5	(-20 240.5)
- 2 years category	24.36	193 662.0	183 597.3	10 064.7
- 3 years category[a)]	-	-	-	-
- 5 years category	19.80	157 410.0	185 845.1	(-28 435.1)
Non-users	16.20	128 790.0	155 740.0	(-26 950.0)

[a)] No corn was grown.

Annex 5. Investment cost of tubewell, Plemahan kecamatan, 1979/80

Cost component	Market price	Shadow price
	..... Rp 1 000/unit	
1. Well construction:		
- transportation	256.5	250.5
- drilling	1 206.0	1 206.5
- pump tube	822.0	822.0
- reducer	81.0	81.0
- siet filter	63.0	49.5
- coarse filter and tube	565.5	565.5
- operation test	63.0	63.0
sub-total	3 057.0	3 037.5
2. Pump house & accessories:		
- pump house	1 410.0	1 269.0
- discharge box	105.0	94.5
- tunnelling	51.0	48.0
- acces culvest	111.0	100.5
- road	48.0	43.5
- operator facilities	84.0	75.0
- land purchose	153.0	76.5
sub-total	1 962.0	1 707.0
3. Canalization:		
- canal	141.0	94.5
- construction	240.0	216.0
- land purchose	180.0	90.0
- contingencies (25 %)	140.3	100.1
sub-total	701.3	500.6
4. Pump and accessories:		
- power source	5 745.2	5 745.2
- pump	5 031.4	5 031.4
- spare parts (10 %)	1 077.7	1 077.7
sub-total	11 854.3	11 854.3
5. Miscellaneous:		
- containers	15.0	15.0
Total cost for tubewell investment (1+2+3+4+5)	17 589.6	17 114.4
6. Cost for project facilities	2 391.0	2 335.5
Total investment cost (1+2+3+4+5+6)	19 980.6	19 449.9

Source: Hunting technical service Ltd. and Sir M. Mc Donald & Partners. 1980. Kediri-Nganjuk Project Phase 3A. Interim Report. Directorate General of Water Resource Development, Jakarta (recalculated).

Annex 6. Operation cost and maintenance of tubewell, Plemahan kecamatan, 1979/80 (Rp 1000)

Category and serial number	Fuel: Market price	Fuel: Shadow price	Oil[a]	Grease	Operator salary	Maintenance cost	Miscellaneous[b]	Total/unit: Market price	Total/unit: Shadow price	Area/unit (Ha)	Cost/ha: Market price	Cost/ha: Shadow price
1 year category:												
C71	489.0	674.9	13.2	4.3	150.0	99.8	387.9	733.2	1307.0	51.80	14.2	25.2
C72	547.3	755.3	22.5	2.7	138.8	157.8	387.9	869.1	1465.0	49.80	17.5	29.4
C74	558.3	770.4	50.0	2.3	147.7	111.9	387.9	869.8	1469.8	47.30	18.4	31.0
C76	584.2	806.2	30.0	4.3	144.9	137.9	387.9	901.6	1511.5	40.10	22.5	37.7
Average	544.7	751.7	30.3	3.4	142.5	126.9	387.9	843.4	1438.3	47.30	18.2	30.9
2 years category:												
C54	390.3	538.5	38.3	3.8	150.0	91.4	387.9	674.0	1210.1	23.60	28.6	51.9
C55	441.1	600.7	31.6	7.4	148.2	225.4	387.9	854.8	1410.3	44.00	19.4	32.1
C57	408.6	561.0	57.8	0.5	138.8	151.0	387.9	734.7	1277.0	28.80	25.5	44.3
C61	711.3	981.6	79.5	2.5	175.0	138.3	387.9	1104.6	1762.8	47.50	23.3	37.5
Average	487.3	672.5	51.8	3.6	152.3	146.5	387.9	842.0	1415.1	34.2	25.3	43.1
3 years category:												
C22	243.5	336.0	30.6	6.0	150.0	37.6	387.9	467.7	948.1	42.19	11.1	22.5
C23	362.0	499.6	8.3	4.5	150.0	142.3	387.9	667.1	1192.6	44.90	14.9	26.6
C43	304.1	419.6	45.3	1.3	150.0	29.3	387.9	529.6	1033.0	41.92	12.6	24.6
Average	303.2	418.4	28.0	3.9	150.0	69.7	387.9	554.8	1057.9	43.0	12.9	24.6
5 years category:												
C10	308.1	425.1	70.0	4.4	150.0	10.8	387.9	543.2	1048.1	49.23	11.0	21.3
C12	350.6	483.9	75.4	3.0	150.0	64.7	387.9	643.7	1164.9	43.25	14.9	28.9
Average	329.4	454.5	72.7	3.7	150.0	37.8	387.9	593.5	1106.5	46.24	12.95	24.1

Note: a) For oil, grease, operator salary and maintenance cost, market price and shadow price are equal.

b) Including overhead cost, salary for village officials, block leaders, technicians, and fuel supply assistance. This is needed for economic analysis.

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Annex 7. Material use and operation hours of sample tubewell, 1979

Category/serial No.	Fuel (lt)	Oil (lt)	Grease (kg)	Operation time Day	Operation time Hour
1 year category					
071	13 972.5	40.5	5.5	224	2 783.50'
072	15 638.5	50.0	3.5	211	2 639.45'
074	15 951.0	111.0	3.0	216	2 902.55'
076	16 691.7	67.3	5.6	259	2 835.15'
Average	15 563.4	67.2	4.4	228	2 789.53'
2 years category					
054	11 150.0	24.5	4.9	198	2 880.00'
055	12 603.5	70.3	9.6	206	2 360.00'
057	11 615.9	128.5	0.7	249	3 607.50'
061	20 323.5	176.8	3.2	248	3 378.20'
Average	13 910.7	115.0	4.6	225	3 056.21'
3 years category					
022	6 957.0	68.5	7.7	165	1 420.00'
023	10 343.0	18.5	5.8	188	2 038.00'
043	8 687.5	100.0	1.7	201	1 723.30'
Average	8 662.5	62.3	5.1	130	1 727.10'
5 years category					
010	8 802.0	155.5	5.7	189	1 732.30'
012	10 018.3	167.5	3.9	196	2 058.35'
Average	9 410.2	161.5	4.8	193	1 895.33'

Source: Laporan Eksploitasi Pompa Tahun 1979, Sub P2AT Kediri - Nganjuk (Recalculated).

Annex 8. Flow of project benefit at current market price

Year	Rice-rice-soybean pattern			Rice-rice-corn pattern		
	With project	Without project	In-crease	With project	Without project	In-crease
	..... Rp 1 000					
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	758.4	442.4	315.6	754.6	442.4	312.2
4	784.0	442.4	341.6	776.4	442.4	334.0
5	807.1	442.4	364.7	799.0	442.4	356.0
6	838.7	442.4	396.3	823.8	442.4	381.4
7	867.7	442.4	425.3	850.2	442.4	407.8
8-51	899.7	442.4	457.3	877.4	442.4	435.0

Annex 9. Flow of project benefit at shadow price level

Year	Rice-rice-soybean pattern			Rice-rice-corn pattern		
	With project	Without project	In-crease	With project	Without project	In-crease
	..... Rp 1 000					
1	-	-	-	-	-	-
2	-	-	-	--	-	-
3	969.5	580.3	389.2	1 052.1	580.3	471.8
4	997.9	580.3	447.6	1 079.5	580.3	499.2
5	1 024.2	580.3	443.9	1 105.8	580.3	525.5
6	1 062.4	580.3	482.1	1 139.8	580.3	559.5
7	1 096.6	580.3	516.3	1 171.9	580.3	591.6
8-51	1 132.8	580.3	552.5	1 205.9	580.3	625.6

Annex 10. Market and shadow price level of farm input and output, Plemahan kecamatan, 1979/80

Output and input	Unit	Market price	Shadow price
		..... Rp	.....
Rice[a)]	kg	77.58	96.35
Soybean[b)]	kg	262.70	216.02
Corn[b)]	kg	79.50	111.11
Rice seed	kg	149.54	185.00
Soya seed	kg	283.87	233.62
Corn seed	kg	109.24	152.88
Urea	kg	70.00	126.38
TSP	kg	70.00	118.33
Pesticide	lt/kg	1 442.78	6 250.00
Fuel	lt	35.00	48.30
Oil	lt	450.00	450.00
Grease	kg	775.00	775.00
Human labor	MH	88.33	66.66
Animal labor	TH	187.50	187.50

a)In the form of unhusked grain harvest dry.

b)In the form of dry grain.

Annex 11. Labor utilization per hectare for WS rice, in three village samples, Plemahan kecamatan, 1979/80

Labor	Tubewell users				Non-users
	1 year category	2 years category	3 years category	5 years category	
	..... labor hour/ha				
Family labor					
Man	188.29	141.60	154.48	203.78	141.34
Woman	82.08	56.87	59.89	51.67	49.06
Child	0	0.67	27.33	0	29.13
Animal	49.76	60.24	50.15	65.29	39.49
Hired labor					
Man	217.61	255.44	284.96	287.61	234.51
Woman	692.91	787.69	719.57	761.67	646.13
Child	44.80	40.11	148.91	84.12	71.68
Animal	36.97	31.11	56.11	31.33	33.67
Total					
Man	405.89	397.04	439.43	491.39	375.85
Woman	774.98	844.56	779.46	813.35	695.21
Child	44.80	40.56	351.04	84.12	100.81
Animal	86.73	91.35	106.26	96.62	73.16

Annex 12. Labor utilization per hectare for DS rice, in three village samples, Plemahan kecamatan, 1979

Labor	Tubewell users			
	1 year category	2 years category	3 years category	5 years category
	..... labor hour/ha			
Family labor:				
Man	240.68	176.54	134.87	185.81
Woman	80.56	35.66	42.94	63.73
Child	0.56	6.43	37.38	0
Animal	49.22	47.51	248.03	39.68
Hired labor:				
Man	301.43	316.09	258.57	361.90
Woman	697.23	782.54	666.17	666.61
Child	51.70	35.37	94.84	73.88
Animal	10.87	64.71	80.83	22.88
Total:				
Man	542.11	492.63	393.44	547.71
Woman	777.79	818.20	709.11	730.34
Child	52.26	41.80	132.22	73.88
Animal	60.09	122.22	328.86	62.56

Annex 13. Labor utilization per hectare for soybean, in three village samples, Plemahan kecamatan, 1979

Labor	Tubewell users				Non-users
	1 year category	2 years category	3 years category	5 years category	
	..... labor hour/ha				
Family labor:					
Man	221.55	90.66	149.95	171.38	161.44
Woman	129.18	24.65	76.79	88.25	76.79
Child	0.96	1.10	77.78	5.14	38.45
Animal	40.48	m 6.91	11.11	57.06	16.91
Hired labor:					
Man	367.37	236.39	238.45	217.19	253.28
Woman	353.45	420.00	342.81	305.14	404.11
Child	0	0	0	0	0
Animal	8.87	7.75	19.16	31.10	23.70
Total:					
Man	588.92	327.05	388.40	388.57	414.72
Woman	482.63	444.65	419.60	393.39	380.90
Child	0.96	1.10	77.78	5.14	38.45
Animal	49.35	14.66	30.27	68.16	40.61

Annex 14. Labor utilization per hectare for corn, in three village samples, Plemahan kecamatan, 1979

Labor	Tubewell users[a]			Non-users
	1 year category	2 year category	5 years category	
	..... labor hour/ha			
Family labor:				
Man	217.54	226.57	209.76	193.79
Woman	82.20	56.17	68.44	85.97
Child	0.76	0	2.00	12.71
Animal	74.72	41.90	67.31	45.91
Hired labor:				
Man	400.60	478.91	484.20	328.12
Woman	211.68	158.23	162.90	165.13
Child	0	0	0	0
Animal	27.50	62.67	41.48	63.76
Total:				
Man	618.14	705.48	693.96	521.91
Woman	293.84	214.40	231.34	251.10
Child	0.76	0	2.00	12.71
Animal	102.22	104.57	108.77	109.67

[a] There is no corn for 3 years category of tubewell.

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