

Short Report Series
On Irrigation Management Transfer

Number 1

**"CAN FARMERS AFFORD TO USE THE WELLS AFTER
TURNOVER? A STUDY OF PUMP IRRIGATION TURNOVER
IN INDONESIA"**

Sam H Johnson III and Peter Reiss

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Program on Local Management

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Explanatory Note

The purpose of the Short Report Series is to disseminate concise information on irrigation management transfer or turnover experiences and issues world-wide to a broad range of people--policy makers, planners, researchers, donors and officials in both public and non-governmental organizations--who are concerned with the irrigation sectors of primarily developing countries. Our goal is not to promote irrigation management transfer per se, but to enhance the knowledge base available to decision makers and advisors as they face questions of policy adoption and strategies for implementation.

By "irrigation management transfer" we mean the turnover of responsibility and authority for irrigation management from the government to farmer groups or other non-governmental entities. It generally involves the contraction of the role of the state and the expansion of the role of the private sector in irrigation management. This may involve changes in policies, procedures, practices and the performance of irrigated agriculture. It may or may not involve "privatization" of ownership for irrigation system assets. The Short Report Series addresses such questions as follows.

"What is the range of different models of turnover or local management for recently-developed irrigation, which are being applied world-wide?"

"What are the effects of management transfer on the productivity, profitability, financial viability, equity, efficiency and sustainability of irrigation management in particular, and of irrigated agriculture more generally?"

"What are the perspectives of farmers, managers, policy makers, urban consumers and other stakeholders in irrigated agriculture about irrigation management transfer?"

"What socio-technical conditions, institutional arrangements and change processes seem to lead to successful results?"

"What adjustments in government may be needed as a result of turnover to provide support to locally-managed irrigation systems and to improve productivity in the public sector?"

The Series is produced by the Program on Local Management of the International Irrigation Management Institute (IIMI). Individuals wishing to contribute to the Series or otherwise correspond about the Series, are invited to direct communications to:

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SHORT REPORT SERIES ON IRRIGATION MANAGEMENT TRANSFER

An Introduction to the Series

In the rush over the last century to expand the area of irrigated land for agriculture, governments world-wide have constructed thousands of expensive irrigation systems and have spent roughly US \$15 billion per annum for irrigation development over several decades since the 1950's. By the 1990's there were about 233 million hectares of irrigated land in the world, 73 percent of which was in the developing countries.

By the 1980's the tide of expenditure for new irrigation development suddenly began to wane. Decreasing funds available for irrigated agricultural development, disappointment with rapid deterioration of systems and poor management performance, and growing acknowledgement of positive farmer management capacities has led to widespread enactment of policies to turn over management for irrigation systems from government agencies to irrigators' or farmers' associations. Farmers are exerting increasing pressures to improve the responsiveness and cost-efficiency of irrigation management. Management transfer or turnover is a widespread strategy for addressing these concerns.

The transfer of management for irrigation to local organizations may involve a host of complex issues, such as new laws and policies, changes in the roles of the irrigation agency, new financing mechanisms, changes in human resource deployment and skills--both in the farming community and in government agencies, new modes of interaction between government agencies and farming communities, new roles for NGOs, and new demands for coordination and regulation of water resources at the watershed or river course levels.

Management transfer is occurring in numerous countries in Asia, Africa and Latin America. Management for subdivisions of large-scale irrigation systems is being transferred to farmers' organizations in countries as diverse as Mexico, the

Philippines, India, China and Nigeria. Entire systems have been transferred to local management in Colombia, Chile, Dominican Republic, Indonesia, Nepal and Senegal. Public tubewells are being privatized in Pakistan, Indonesia and Bangladesh. The trend is spreading to Central Asia and Eastern Europe.

In some traditional societies, such as in Indonesia, China, Thailand, the Peruvian Andes, Spain and Iraq, irrigation has been locally-managed with only little if any government involvement for decades or centuries. Early industrializing countries such as the United States, France, Japan and Taiwan have either developed irrigation within the private sector or have transferred management to the farming community several decades ago. Papers on the experience of such countries can also be included in the Series on Irrigation Management Turnover because of the lessons which can be drawn from local management models and problems and related to developing countries currently undergoing turnover programs.

For better or for worse, irrigation management transfer has the potential to have major impacts on irrigated agriculture in future years. Clearly there is an urgent need to examine this phenomenon--to understand how management transfer is being planned and implemented in various countries, to assess what are its actual results and impacts, and to consider what should be done, either to strengthen it, to modify it, or possibly to reconsider whether to do it at all in some situations.

We at IIMI invite contributions to this Series from both practitioners and researchers. We hope that the Series will stimulate new ideas and ultimately more effective approaches to irrigation management.



Jacob Kijne
Director for Research
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CAN FARMERS AFFORD TO USE THE WELLS AFTER TURNOVER? A STUDY OF PUMP IRRIGATION TURNOVER IN INDONESIA

Sam H. Johnson III and Peter Reiss¹

Introduction

With more than 5 million hectares of land now irrigated, the rapid expansion of gravity irrigation in Indonesia is over. The most favorable sites have been developed already, and the cost of building new systems now ranges between \$3,500 and \$7,000 or more per hectare. Meanwhile, urban expansion is steadily encroaching on irrigated land and currently is estimated to consume more than 30,000 hectares yearly. Yet, the Government of Indonesia (GOI) still faces the problem of extending the benefits of irrigated agriculture to the much poorer and drier areas of Eastern Indonesia, where the scope for enhanced gravity irrigation systems is extremely limited.

These concerns have prompted the GOI to pay increasing attention to developing surface water and groundwater sources through the introduction of pumps for converting rainfed land to irrigated land, or using irrigation to supplement inadequate surface supplies. Where the government has taken the lead in developing pump irrigation, the new systems generally have received extensive government assistance. Wells have been drilled free of charge, pump sets have been given to the farmers, canals have been constructed with minimal farmer equity investment, and agricultural inputs have been subsidized.

¹Sam H. Johnson III is Deputy Executive Director for Asia, Consortium for International Development, and Peter Reiss is Technical Director, USAID's Irrigation Support Project for Asia and the Near East (ISPAN). This paper is based upon a study, entitled "Policy Alternatives for Pump Irrigation in Indonesia, conducted for USAID/Indonesia by ISPAN.

Poverty alleviation concerns, particularly in the drier and poorer areas of Eastern Indonesia, underscore the importance of increased pump irrigation in Indonesia. Yet massive subsidies to irrigation, presently estimated at Rp. 1.0 to 1.3 trillion (about \$606 to \$788 million), raise questions about the public sector's ability to support further expansion. Unless the GOI and the donors address these issues, especially the economic ones, **there is a danger that the explicit and implicit subsidies in public sector promotion of pump irrigation will add to the public sector burden and create unsustainable pump irrigation systems.**

Understanding the role of pump irrigation in agricultural development will be crucial for the formulation of appropriate development policies for the next five years. In view of the present prevailing uncertainties about pump irrigation, the Ford Foundation and USAID, through its Small Scale Irrigation Management Project (SSIMP), believed that a detailed study of pump irrigation in Indonesia would be very valuable in providing an assessment of past and present experience and offering recommendations to guide future investment. As the World Bank is re-evaluating its investment strategy for groundwater development in Indonesia, these recommendations could assist the GOI and the Bank in formulating viable policies for development and expansion of pump irrigation. (Figure 1 shows the location of the sites included in the study.)

Background

Between the end of 1990 and 2005, the population of Indonesia is expected to grow by 26 percent, from about 183 to 231 million. Demand for food energy will increase by about 60 percent over the same period because real incomes are projected to increase from 4.1 percent per year between 1988-1995 to 4.7 percent per year by 2005. As a result of these trends, overall demand for cereals is expected to increase from 33.4 million metric tons (Mmt) in 1988 to 48.0 Mmt in 2005.

These new demands will have to be met by increasing productivity through intensified land use, improved crop yields, and bringing new lands into production. In land hungry Java, which has 60 percent of the nation's population but only 7 percent of its land, intensified land use and improved crop yields will be the only options. In addition, the area under irrigated rice is likely to shrink by 2005 because of urban expansion and the growth of rural settlements.

Reduction in agricultural land in Java will need to be compensated for by agricultural development elsewhere if production levels are to be maintained.

Groundwater from shallow aquifers is the primary source of domestic water supply for about 90 percent of the rural population, and shallow and deep aquifers provide almost 65 percent of the nation's industrial water requirements. The GOI started systematic development of groundwater for irrigation in the early 1970s, but public sector projects now irrigate only 28,000 ha, or 17 percent of identified potential of 168,000 ha. By contrast, and in terms of meeting national food production objectives, the informal groundwater sector currently irrigates 120,100 ha.

The principal agency in groundwater exploration and evaluation is the Directorate of Environmental Geology (DEG), which is responsible for hydro-geological mapping, evaluation of groundwater availability, studies of groundwater development, and conservation of groundwater resources in areas where large-scale groundwater abstraction occurs, such as Jakarta. Of other agencies involved in groundwater exploration and evaluation, the most important is the Directorate General of Water Resources Development (DGWRD), which is primarily concerned with all aspects of irrigation. Under DGWRD are the Sub-Directorate of Groundwater Development Planning (P2AT) and the Sub-Directorate of Groundwater Development (PAT). P2AT undertakes construction, while PAT assists with the establishment of water users associations (WUAs), agricultural monitoring, and operation and maintenance (O&M) of wells.

Carefully staged public sector groundwater development planning was common in the 1970s and early 1980s. Typical programs took up to 15 years to develop operating irrigation schemes. Examples of successful comprehensive groundwater development projects that consider both irrigation and water supply are the Greater Yogyakarta Groundwater Resources Study completed in 1984, and the ongoing Madura Island Groundwater Irrigation Project. These studies were extremely well documented over 8-12 years and provide valuable data for future activities.

More recently, pilot projects have been implemented without preceding resource investigations. This appears to be the model for the future and does pose problems. The SSIMP is attempting to develop pilot groundwater projects in Eastern Indonesia with little knowledge of the resource base and is experiencing great difficulty with siting wells, finding water and, consequently, building good relations with the WUAs.

The trend away from starting work in new areas with integrated surface water and groundwater resource planning by Public Works to an increasing focus on small-scale project implementation without pre-investment planning is eroding the confidence of the provincial governments and local farmers in pump irrigation from groundwater. Under the present system, the design irrigated area is the selling point; in new areas, the risk of failing to achieve this is high because little is known about the resource, and failure to deliver damages confidence in groundwater. However, an ambitious schedule of ongoing or planned programs, using this 'hit or miss' investment strategy, hopes to bring an additional 53,000 ha of land under groundwater irrigation by 2005.

Institutional Setting

P2AT is a project-oriented, rather than a permanent, entity. To date, most of its projects have been initiated with technical assistance from bilateral donors, particularly the Overseas Development Administration (ODA) of the British Government. Its approach has centered on feasibility studies and deep tubewell pilot projects using imported turbine pumps, in the belief that the largely untapped deep groundwater resources offered the best potential for the expansion of irrigated agriculture. Shallow groundwater has been considered a more limited resource already being exploited by the farmers. P2AT operates under direction from Jakarta and tends to ignore the need to establish support at the local level.

It imports its drilling and pumping equipment and well components and emphasizes the training of staff, and thus has established itself as a well-equipped implementing agency with a limited number of competent professionals. The planning, design, and construction of tubewell systems are determined primarily by technical considerations, including aquifer potential, degree of water shortage, layout of existing surface water canals, and topography. Although village officials are consulted about drilling sites and access routes, beneficiary farmers are given no opportunity to participate in the implementation process.

As a result, some early tubewells, particularly in Madura, were sited in areas where the local communities resented an externally imposed government facility. Subsequently, sociological studies were given importance in the site selection procedure in Madura, and beneficiary farmers were consulted at critical stages of the design and construction phases.

Some of the tubewells, particularly in Madiun, were too large to be managed by the water users associations (WUAs), which often included as many as 400

farmers in a 100 ha command area. Although the theory was that economies of scale would reduce the unit cost of water, the farming community was simply unable to manage the technology adequately. **P2AT has learned from its mistakes and now focuses on a command area of around 30-50 ha with no more than 150 farmers.**

Initially, P2AT paid little attention to the institutional requirements to sustain tubewell operations, considering this to be the responsibility of the Provincial Irrigation Service (PRIS). P2AT subsidized tubewell O&M for the first two years, after which it turned over the systems to PRIS, representing the local government. However, in most cases PRIS was not prepared to accept this responsibility since it had been excluded from P2AT technical assistance and viewed the groundwater schemes as something of a burden.

P2AT has its own workshops intended for later transfer to the local government through PRIS, except in Central Java, where pumpset maintenance and repair services have been left to the private sector. Although the workshops are well equipped and the staff is well trained, employee motivation and management generally are poor. The workshops are not run as commercial operations and are not empowered to sell spare parts to the general public and organizations like the WUAs.

In Indonesia, water users associations (WUAs) for both surface and lift irrigation systems have the rights to elect their officials, to establish by-laws consistent with provincial level model constitutions, to raise their own revenues and to own property. However, WUAs are not legal entities with contractual rights.

The pump system WUA has an executive committee which includes a chairman, secretary, treasurer and operator. The operator is a key figure responsible for determining water allocations, running and maintaining the pump and keeping records of the hours of use or the area irrigated by farmers and sometimes also collecting the water fee. Water user association meetings deliberate on water allocation plans, agricultural extension, crop selection, use of water fee funds for maintenance or other uses, preparation for turnover or support services, electrification, conflicts and other organizational matters.

Present Policy

Present GOI policy is to reduce the subsidy to the agricultural sector. For the first two years of groundwater irrigation projects using deep or shallow wells, P2AT

provides a fuel and lubrication allotment in addition to handling all major repairs. Thereafter, responsibility for O&M of the pump is to be turned over to the local government, which in turn expects the WUA to take charge.

Unfortunately, in the implementation of most of the public groundwater pump irrigation schemes, the responsibility for major repairs and eventual replacement, although implicit in the transfer, has been less clear. In fact, only in the case of a special project in Yogyakarta has responsibility for O&M as well as for major repairs and replacement of most of the pumps been turned over completely to PRIS.

Pump Turnover Process

In 1984, the GOI instituted a program to transfer pump schemes of less than 500 ha to the local government which, after two years turns over responsibility to the WUA. It is the second stage (transfer to the WUA) which we refer to as "turnover." In practice, because P2AT continues to provide assistance, official turnover of the assets to the local government may not take place for another 10 years. To date, out of 3,000 public sector irrigation systems approximately 1,000 have been officially handed over. This includes 600 pumps in East Java and 48 in Yogyakarta where, despite the formal transfer, P2AT continues to provide assistance with pump operator salaries and maintenance and replacements.

During the first two years of operation, most if not all costs are subsidized by P2AT, including the operator's wage, all maintenance, and all repairs. In theory, these subsidies enable the WUAs to build up a cash reserve for operations once the subsidy is removed. Farmers cover maintenance of the quaternary systems and honoraria for the executive committee. After the first two years, P2AT continues the fuel allotment, sometimes at a reduced level, makes major repairs (those costing more than Rp. 1 million), and maintains the tertiary system. Other responsibilities are assumed by the WUA.

The following sequence of activities occurs in the official process of pump management turnover to WUAs:

- 1) WUA "pre-campaigns" are held at the village level before drilling to explain project strategies and obtain commitment from the farmers to future farmer obligations;

- 2) A formal WUA introduction and scheme design review is held after drilling and positive feasibility assessment by P2AT. The proposed design is reviewed and formation of a WUA is discussed;
- 3) Approximately 1 to 3 months before operations begin, and following a brief period of deliberations, the WUA is formed, a constitution is established and leaders are elected;
- 4) Immediately prior to scheme operation and after informal discussions among WUA members, specific WUA bylaws are established;
- 5) Also immediately prior to scheme operation, short training workshops (2-3 days) are held for WUA officers, held jointly for several schemes. Training emphasizes organizational, administrative and financial management. Training for pump operators is separately conducted in six-day workshops which emphasize technical aspects.

The Study Team observed that in practice the P2AT adopted the same approach used by the Directorate of Irrigation 1 for formation of WUAs for gravity irrigation units when it began forming pump user associations in the early 1970s. Staff generally did not consult with farmers in drilling, system planning or O&M work plans.

After a number of unsuccessful attempts to develop groundwater systems, P2AT revised its approach somewhat. Several general meetings were held by the P2AT staff with the farmers when the WUA was under formation. They discussed construction plans and the need for and roles of a WUA. WUAs are formed after drilling, but **users still pay a limited role, if any, in determining the location of the well.**

Only after one or two years, do members of the WUA elect the executive committee of the WUA. After the election, the P2AT staff present formal rules and responsibilities which are agreed to and signed by the executive committee members. In Central Java and Madura, the P2AT relies upon community organizers supplied through consultants on contract to work with farmers during the period of association formation. Nominal community organizers elsewhere in East Java and in Yogyakarta are actually P2AT staff who appear to be more comfortable providing technical than managerial support.

P2AT has formed WUAs for deep tubewells in Yogyakarta and East Java. Normally a single association is formed around a single pump. However, in some cases in East Java, an association might actually be a federation of pump groups. Each block of farmers manages a pump and has its own second-level executive committee. In Kediri, East Java, one WUA executive committee is responsible for 11 pumps.

In the private sector, Bina Swadaya, a Jakarta-based nongovernmental organization, has adopted an approach to lift irrigation development which focuses on relatively large pumps for river pumping in West Java. To date, drawing on funds provided by USAID and other international donor agencies, 14 pump systems have been installed in three West Java districts. Bina Swadaya has stressed institutional development using a model strongly reminiscent of efforts to improve surface irrigation performance in Indonesia and elsewhere. **Agricultural extension agents are trained by Bina Swadaya to serve also as community organizers in a pump systems and are given an honorarium for three years, which provides a mechanism for greater farmer participation than is the case in government-sponsored lift irrigation development.**

The change in WUA responsibilities is more dramatic after year two than after turnover. By year two, the WUAs generally have already taken on primary financial and technical management of the system. With formal turnover to the local government, the WUAs may have to pay the operator's fee and share costs of certain services with the local government. However, **in all study locations, although P2AT no longer has formal responsibilities, its staff continues to provide services. In practice, the WUAs often make informal payments to P2AT staff for small repairs.**

Following formal turnover to the WUAs, an expansion in the command area is possible because of the removal of P2AT restrictions on irrigation outside the design area. The transfer of responsibilities and formal turnover bring no changes in:

- frequency of general and executive committee meetings;
- system of water allocation and crop selection; and
- formal rules concerning roles and responsibilities of the WUA.

The fee and the method of payment are decided by the general membership of the WUA in an open meeting. Fee adjustments required by changes in fuel costs and the cost of pump repairs are decided in the same way. In a number of the systems, the executive committee will ask members for a temporary increase in the fee to cover the cost of minor repairs.

Payments vary in amount, sometimes seasonally, and are set by the hour, the season, or per plant, and may be paid in cash or in kind. Data from the study indicate that the rate of collection of pump fees by the WUAs is quite high. **Most operators claimed complete or near complete collection rates. The lowest rate mentioned was 95 percent.** The collection of payments is more difficult for additional requirements such as a connection for an electrical pump. **In one system, only half the farmers paid the fee initially but the rest responded when the executive committee cut off water to those who did not pay.**

After two years of operation, the fee is based on operating costs (pump fuel, oil, filter, and lubricant), the honoraria for executive committee members, the salary of the operator (although there is some variation in who is paid) and quaternary system maintenance. In a few cases, an amount for engine and pump replacement is included. The fee sometimes includes an amount for small repairs, but it is usually assumed that major repairs will be covered by P2AT before turnover and by the local government thereafter. As noted, when minor repairs are needed, the fees are usually raised to cover these costs on an ad hoc basis.

Most WUAs are not building up savings, often because of mistrust and squabbling among executive committee members. A few, however, have accumulated substantial savings beyond their immediate needs that they have used to increase income by investing in cattle or making loans to members. But all the WUAs have shown they are capable of managing their finances more than adequately; **all are able to cover their day-to-day costs.**

From this study it appears that there is a threshold of roughly US \$526 (Rp. 1 million) at which a WUA decides a bank account is necessary. Below that amount, the WUAs tend to keep their savings in cash. Record keeping is minimal and usually documents only pump use, with the name of the user and some measure of use recorded in a ledger. There are rarely any financial balance sheets, although sizeable savings are sometimes held by an executive committee member in cash or his own bank

account. This rather casual approach to management often leads to recriminations among WUA members.

Study Findings

Throughout Asia, successful pump irrigation programs have demonstrated that farmers can take complete responsibility for operation and maintenance provided:

- the pump system is working properly and operational costs are in line with the benefits obtained, enabling users to pay for the facilities;
- users have the requisite technical knowledge and easy access to spare parts; and
- the total number of users served by a system is small enough to be organized into a cooperative group.

When these simple requirements have been met, countries such as Bangladesh have found it easy to turn over pump systems to the WUAs. Economic viability depends on the degree of utilization of the pumps as well as the benefits obtained by the users. Without readily obtainable benefits, the farmers will not use the equipment. Yet, for the investment to pay off, the farmers must operate the pumps enough to spread the fixed cost of the equipment.

To encourage use of the pumps, the GOI provides a fuel subsidy; but, as the example from Yogyakarta in Figure 2 shows, once the subsidy is removed pumping hours decline rather than increase. Instead of the 300 percent increase in cropping intensity predicted by the planners for almost all the pump irrigated systems studied, average cropping intensity—which compares land actually irrigated with the design area—did not exceed 170 percent at the research sites.

One reason that annual pumping is much less than planned is that the area served is usually far less than the design area and, thus, the actual cropping intensity is much less than the planned cropping intensity. The World Bank argues this should be less of a problem with buried distribution systems, but to date most of these systems in Lombok have shown no higher cropping intensities than surface

distribution systems. For example, well T-10 with a design service area of 17.6 ha served only 4.1 ha in the first dry season and 4.23 ha in the second.

Data collected for the 1990/1991 cropping seasons as part of the field study indicate that in pump irrigation areas as much as 55 percent of input costs of some farmers are for water, although on average these payments are around 30 percent. The range of pump water charges found in the study are presented in Table 1, which shows that a farmer growing an irrigated crop during the wet season, as well as during the three possible dry seasons, might end up paying over US \$132 (Rp. 250,000) per ha in water fees in a complete crop year. Although the average is likely to be from US \$53 (Rp. 100,000) per ha to US \$79 (Rp. 150,000) per ha, this is still five to seven times the US \$9.50 to \$13 (Rp. 18,000-25,000) per ha now charged under the Irrigation Service Fee program.

Even with such high water fees, farmers in pump irrigation areas are paying only for O&M and contribute nothing toward capital investment. Table 2 shows that annual water fees paid by pump irrigation farmers in Madura (East Java) and Subang (West Java) cover approximately 50 percent and by pump irrigation farmers in Yogyakarta only about 30 percent of actual costs. **If interest, groundwater exploration and dryhole costs, and contractor and government line agency payments are added, the real costs are often three to five times what farmers are paying.**

It is possible to make an ex post analysis of the research projects from data on cropping intensities, the actual costs of the pump schemes, and the crop yields obtained by the farmers. All costs have been converted to 1990-91 rupiah, using the consumer price indexes of major cities near the research sites. Table 3 shows the annual hours of use per pump and the net returns for major irrigated and non-irrigated crops in the study. When farmers did not irrigate their wet season crops, they often had the same net returns as farmers without access to pump irrigation. This demonstrates the detrimental impact of not using the pumps for supplemental water during the wet season. In most of the schemes, particularly in poverty areas, farmers do not use the pumps in the wet season because of the high cost of fuel, which is surprising considering the difference in returns from irrigated and non-irrigated rice should easily cover this cost. Since the fuel must be paid for in advance, however, one likely explanation for the farmers' reluctance to use the pumps is that they cannot obtain credit for the purchase of fuel.

Three sets of benefit/cost (B/C) ratios were calculated, using actual pump cost data and data from the tables, by assuming a 30-year time frame, a 15 percent discount interest rate, and yields in the survey remaining constant over the 30 years. Because most of the wells sampled are mature wells, this assumption tends to overestimate actual life-of-project economic returns but is adequate for this analysis. The B/C ratios are presented in Table 4. The first set evaluates the benefits and costs as if the pumps had been developed without any outside assistance. The second set includes interest and local government assistance costs. The third set includes some of the international technical assistance costs.

The B/C ratios for less than half the public pump irrigation systems are 1:1 or better, based on the actual costs of the pump systems but excluding any interest payments, pump irrigation committee costs, expenses of maintaining the P2AT field offices and workshops, and the costs of major repairs and replacements. Only two of the NGO-supported systems in Subang in West Java have B/C ratios in better than 1:1, because of the emphasis on large irrigation systems serving much less than the design area, combined with relatively low yields and only two crop seasons a year. This occurred even though much of the construction was done by local labor instead of a contractor.

It is obvious from the other two sets of B/C ratios that, **when all the costs of development are included, pioneering efforts at pump irrigation in Indonesia has yet to prove itself economically viable**. The extensive involvement of outside consultants and excessively high installation costs compared with those in other countries in the region have pushed development costs beyond the level that returns from agriculture can support. **It is possible to justify the present high costs of public pump irrigation investment only in the limited areas where high-value specialty crops such as tobacco and shallots can be grown**.

Poverty Alleviation

Most pump irrigation systems have been installed in poverty areas with the idea that they would eliminate water shortages and, thus, improve farm income substantially. As expected, increases in cropped area have increased farm income. For all of the sample area the annual increase in farm income before payment of water fees is \$217,240 (\$181.62/ha or Rp. 345,078), and after payment of water

fees it is \$159,082 (\$132.98/ha or Rp. 252,662). Therefore, based on design area, annual farm incomes have increased by approximately \$133/ha after payment of fees. Assuming an average farm size of 0.5 ha, **annual farm family income has increased by \$66.50 per year compared with the income of farmers without access to pump irrigation.**

Welfare Concerns

Although fees are higher than in areas served by surface irrigation systems, they are still less than half the real costs of providing water. The annual costs of equipment and operation--ignoring interest costs, line agency expenses, contractor fees, taxes, duties, and other indirect costs--are approximately \$173,260 (Rp. 329.2 million). If farmers were required to purchase the equipment, the income increase would have been \$43,981, or \$36.83 per ha (Rp. 69,977) of design area. Thus, **GOI assistance has amounted to a welfare transfer of approximately \$100 (Rp. 190,000) per ha per year, or \$50 (Rp. 95,000) per farm family per year assuming the average farm is 0.5 ha.**

Conclusions

Although almost one-third of the public pumps have been turned over to PRIS units and WUAs, P2AT is continuing to provide some degree of assistance. For the older pumps in East Java, this covers major maintenance; for the newer pumps in East Java, Madura, and Lombok, it also includes an allocation of fuel and lubricants, major repairs, and often a stipend for the pump operator. Only in Yogyakarta have most of the pumps been turned over to a PRIS unit that can oversee WUA management independently from the P2AT.

In spite of government assistance, the service area is less than designed and pumping hours continue to decline or remain static at best. However this is not primarily a technological failure. **A large part of the problem has to do with the failure to include agricultural extension and credit facilities in the programs.** As a result, the pumps are not used enough to reach the desired cropping intensities, and crop increases do not provide the expected increases in income. This is particularly true in poverty areas, where

farmers do not have the means to prepare the land properly and purchase the needed inputs.

Another factor has been the installation of systems far beyond the skills and resources of the WUAs to operate and maintain them. **In numerous cases, inappropriate deep well turbine pumps, large imported diesel engines, and expensive distribution systems have proven to be too sophisticated for the local users and have required spare parts and specialized tools not available in the area and sometimes not even in the country.** In order to keep these systems operating, P2AT has been forced to maintain field staff long after the project was scheduled to terminate, thus defeating the policy of encouraging the local government and the WUAs to assume full responsibility for management.

However, the vast majority of wells are still operational and a number have exceeded their design life, indicating that the support services provided by P2AT have been adequate even though they have not fully complied with the policy of turning over all responsibility to the local government. Because many of the schemes are located in poverty areas where farmers are less technically advanced, the demands on P2AT have been heavy and the GOI's willingness to meet them shows a genuine concern for equity and poverty alleviation.

Nevertheless, the GOI must make some firm decisions. The technology used cannot be sustained without continuing assistance. If the objective is to achieve complete turnover of pump irrigation systems, the **GOI will either have to restrict technology to what is appropriate for the farmers, or create in the private sector, or within PRIS, a deep well turbine pump maintenance capability.** Considering the small area to be developed and the far-flung expanse of Indonesia's islands, there will always be a need for some degree of government assistance in tubewell maintenance.

Governments in a number of Asian countries, governments and international donors have encouraged investment in sophisticated imported technology, which they impose through government programs on poor and marginal farmers who would be more satisfied with simple shallow wells and centrifugal pumps. As long as governments are willing to provide maintenance and supply spare parts not available in the local market, the availability of small-scale technology of this sort is not a technical issue. However, if the objective is to eliminate government subsidies and achieve sustainable pump irrigation, **the appropriateness of**

deep well turbine pumps has to be seriously reconsidered and other agricultural support, particularly credit, must be integral part of the process.

Table 1

Typical Water Costs per Season per Ha for Pump Irrigation at Research Sites¹

Province/Area	E. Java Nganjuk/Kediri	Madura South & East	W. Java Subang	Yogyakarta G. Kidul
Wet Season (rice)				
Maximum				
\$/ha	13.44	36.18	40.10	24.02
Rp./ha	25,542	68,750	76,187	45,630
Minimum				
\$/ha	2			
Rp./ha				
Dry Season 1				
Maximum				
\$/ha	52.40	52.63	71.31	46.67
Rp./ha	99,569	100,000	135,484	88,667
Minimum				
\$/ha	3.19	28.94	33.73	3.20
Rp./ha	6,056	55,000	64,081	6,077
Dry Season 2				
Maximum				
\$/ha	51.17	65.50	No	58.14
Rp./ha	97,229	124,444	Pumping	110,467
Minimum				
\$/ha	9.81	17.91		15.79
Rp./ha	18,638	34,028		30,000
Dry Season 3				
Maximum				
\$/ha	51.97	No	No	48.95
Rp./ha	98,750	Pumping	Pumping	93,000
Minimum				
\$/ha	39.47			11.81
Rp./ha	75,000			22,440

¹ Based on the averages for all the pumps surveyed in the area where Rp.1900 = \$1.00

² Farmers with a payment of Rp 0 did not irrigate but grew a rainfed crop.

Table 2

Annual Pump Irrigation Water Fee Payments versus Actual Annual Costs for Pumps

Province and Area (m ³)	Annual Water Pumped per Irr. ha Served/yr	Actual Average Payment per Irr. ha/yr (US \$)	Total O, M & Capital Costs per Irr. ha/yr ¹ (US \$)	Total Water Costs per cu m (US \$/m ³)
E. Java	8086	\$111 211,667 ²	\$246 467,323	\$0.031 68.90
Madura	7780	\$93 176,500	\$201 381,119	\$0.023 43.77
Yogyakarta Gunung Kidul	8081	\$72 136,991	\$266 504,676	\$0.033 62.70
W. Java Subang	8843	\$66 123,610	\$103 194,908	\$0.012 22.80

¹ Average annual costs over 25 years, including capital investment and O&M costs, but excluding interest, contractor, and P2AT overhead costs, and WUA Executive Committee payments. These costs are calculated on the basis of the largest amount of land served at least once in a command area. For example, if the design area is 30 ha and the maximum area irrigated area during the first dry season is 28 ha, the total fees are an average for that 28 ha, not for the number of hectares irrigated per year which might be 0 + 28 + 20 + 5 for a total of 53 ha.

² Indonesian Rupees at Rp.1900 = US \$1.00.

Table 3

Pumping Hours and Net Returns in 1990/91 \$ for Major Irrigated and Non-Irrigated Crops

TUBEWELL NAME	Orignl Design Area (ha)	Annual Pumping Hours (hrs)	Wet Rice Inside (\$/ha)	Wet Rice Outside (\$/ha)	Dry1 Rice Inside (\$/ha)	Dry1 Maize Inside (\$/ha)	Dry1 Maize Outside (\$/ha)	Dry2 Maize Inside (\$/ha)	Dry2 Maize Outside (\$/ha)	Dry3 Maize Inside (\$/ha)	Dry1 Soya Inside (\$/ha)	Dry1 Soya Outside (\$/ha)	Dry2 Soya Inside (\$/ha)	Onions1 Inside (\$/ha)	Onions Outside (\$/ha)	Onions2 Inside (\$/ha)	Tobacco1 Inside (\$/ha)	Tobacco Outside (\$/ha)
Mad. 009	23.50	1326	347	250			83		83					228		228		
Mad. 088	44.20	2357	484	363				72									879	539
Mad. 094	42.90	1371	447	276					173								617	478
Mad. 097	39.70	2160	412	358				118	55								865	713
Mad. 102	32.30	942	428	357				34									784	553
Ngen. 116	20.54	1141	538	358	327	238	126	144										
Ngen. 117	21.56	1082	534	422	313			325										
Ngen. 138	24.12	1185	252	213				186		104	133	97	131					
Ngen. 153	32.97	988	425	365	408	197	155	178		255			344					
Ngen. 152	43.93	1196	388	242				148			197	117						
Ngen. 174	44.14	1075	452	365				116			175	128						
Kad. 010	49.21	2180	315	285	196	120	110	148						841				
Kad. 061	37.95	1423	231	214		135	83	334						391	83	173		
C.K. 005	46.40	3299	291	303					134		246	98	148					
G.K. 008	49.00	2718	217	200						214	190	132	203					
G.K. 011	30.50	2817	188	183	98					116	275	94	36					
G.K. 019	44.00	3015	199	161	260			88		286	145	89	117					
G.K. 020	11.00	1418	182	86				111		168	259	89	245					
G.K. 021	62.00	3004	200	157						141	153	98	91					
G.K. 022	41.20	2522	478	161	86			190		286	243	89	176					
Sidajaya	72.00	2436	231	252	181													
Sidamuly	90.00	1838	271	210	213													
Chihambi	200.00	1378	246	273	223			175										
Kiaran	91.00	3176	269	225	224			105										

Note: Based on data collected in research sites related to 1990/91 seasons. Those without data were collected at the same time, but were supplemented with data from other sources when necessary.

Table 4

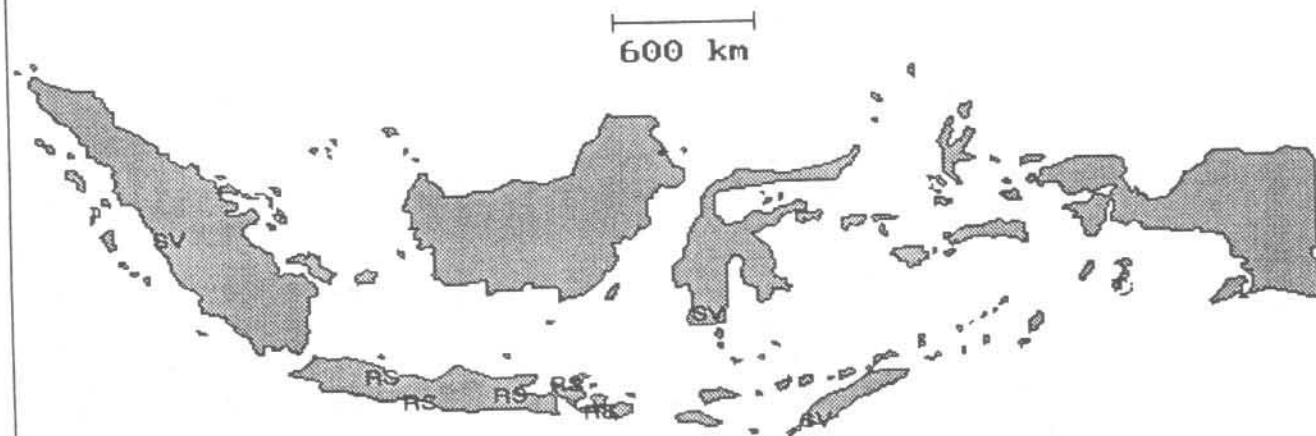
B/C Ratios for Research Wells

TW	Design Area (ha)	Irrigated Cropping Intensity (%)	Total Irrigated Area (ha)	B/C ¹ Ratio	IRR ¹ (%)	B/C ² Ratio	IRR ² (%)	B/C ³ Ratio	IRR ³ (%)
E.Java Madura									
TW 09	23.50	80.9	19.00	0.85	9.0	0.74	3.0	.61	
TW 066	44.20	233.5	103.21	1.46	31.0	1.27	24.0	1.04	17.0
TW 094	42.90	190.0	81.51	1.15	19.0	1.00	15.0	.81	9.0
TW 097	39.70	200.0	79.40	1.32	25.0	1.14	20.0	.93	12.0
TW 102	32.30	178.3	57.60	0.94	13.0	0.80	9.0	.65	2.0
Averages				1.14	19.4	0.99	14.2	.81	
Nganjuk									
TW 116	20.54	95.9	19.70	0.99	15.0	0.86	9.0	0.69	
TW 117	21.56	133.6	28.80	0.96	14.0	0.83	8.0	0.69	
TW 138	24.12	115.1	27.76	0.69		0.61		0.50	
TW 152	43.93	124.0	54.46	0.99	15.0	0.87	0.91	0.71	3.0
TW 153	32.91	96.8	31.87	1.30	24.0	1.12	19.0	0.92	12.0
TW 174	44.14	102.0	45.03	0.53		0.44		0.37	
Averages				0.91		0.78		0.65	
Kediri									
TW 10	49.21	117.8	57.92	1.48	29.0	1.28	23.0	1.06	17.0
TW 061	37.95	200.0	75.90	1.89	42.0	1.64	35.0	1.30	24.0
Averages				1.69	35.5	1.46	29.0	1.18	20.5
Owner	11.30	273.7	30.91	4.42	195.0	3.98	170.0		
Renter	4.53	256.3	11.61	1.03	17.0 ⁴				
Yogya Karta									
TW 05	46.40	194.7	90.33	0.92	12.0	0.80	5.0	0.66	
TW 08	49.00	190.1	93.13	0.93	13.0	0.79	7.0	0.64	
TW 11	30.50	286.0	87.22	0.85	9.0	0.74		0.60	
TW 19	44.00	169.0	85.84	1.11	19.0	0.97	14.0	0.79	5.0
TW 20	11.00	254.0	27.94	0.45		0.39		0.32	
TW 21	62.00	198.5	123.10	0.63		0.54		0.44	
TW 22	41.20	168.9	69.60	1.28	24.0	1.10	18.0	0.75	4.0
Averages				0.88		0.76		0.60	
W.Java									
SIDAJAY	72.00	166.7	119.52	1.09	20.0	0.97	13.0	0.83	3.0
SIDAMUL	90.00	113.0	101.70	0.88	8.0	0.78		0.67	
CIHAMBU	200.00	95.0	190.00	0.59		0.53		0.44	
KIARSARI	91.00	158.0	143.78	1.11	23.0	1.02	16.0	0.90	8.0
Averages				0.92		0.83		0.71	

¹ B/C ratios are calculated at 15% interest rate spread over a 30-year operating slice of the systems.² B/C ratio and IRR includes an additional amount to account for interest and local government expenses.³ B/C ratio and IRR accounts for all development costs including contractor and outside technical assistance.⁴ Rents small centrifugal pump at Rp. 700 per hour for 1,000 hours per year.

Figure I Location of Research and Other Sites Visited

Research Sites and Other Sites Visited in Indonesia



RS - Research Site for Data Collection

SV - Pump Irrigation Sites Visited to Observe Activities

**Figure II Annual Operating Hours - Gunung Kidul
With and Without Fuel Subsidy**

