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SEDERHANA (SIMPLE) IRRIGATION AND LAND DEVELOPMENT

- INDONESIA -

ABBREVIATION/ACRONYMS USED:

1. GOI - Government of Indonesia
2. Dep.Agr. - Department (Ministry) of Agriculture
3. DGWRD - Directorate General Water Resources Development
4. DGFC - Directorate General Food Crops
5. SLWC - SubDirectorate Land & Water Conservation
6. AAETE - Agency for Agriculture Education Training and Extension
7. BAPPENAS - National Development Planning Board
8. FAR - Fixed Amount Reimbursement
9. IFY - Indonesian Fiscal Year - April 1 - March 31
10. BIMAS - Crop Intensification Program - production inputs supplied on credit basis.
11. INMAS - Crop Intensification Program - production inputs supplied on cash basis.
12. IPEDA - Regional Development Contribution - a type of land tax.
13. Repelita - Five-Year Plan
14. Repelita I - April 1969 - March 1974
15. Repelita II - April 1974 - March 1979
16. Repelita III - April 1979 - March 1984
17. IRR - Internal Rate of Return
18. MT - Metric Ton
19. Ha(s) - Hectare(s) 10,000 square meters or 2,471 acres.
20. Ir. - University graduate engineer
21. STP - Special Tertiary Program of the DGWRD. 3 year target is 360,000 Ha.
22. CTP - Complementary Tertiary Program of the DGFC. 3 year target is 140,000 Ha.
23. P3A - Persatuan Pertani Pemakai Air = Water users association/Irrigators association
24. Sawah - Rice Field
25. BRI - Bank Rakyat Indonesia
26. BIE - University Graduate Irrigation Engineer
27. STM - Technical High School Graduate Engineer

Local Government Organization

1. Province - Headed by Governor
2. Kabupaten (District) - Headed by Bupati (District of chief)
3. Kecamatan (Subdistrict) - Headed by Camat
4. Desa (Village) - Headed by Lurah or Kepala Desa (Village Chief)

Table of Contents

MISSING PAGE
NO. 1-3

SECTION II - INTRODUCTION

1. The Irigasi/Reklamsi Sederhana Program

The Government of Indonesia's Simple Irrigation and Reclamation program, referred to in most of this report by the initials of its Indonesian title, IRS, is a program of government investment in hundreds of irrigation and reclamation schemes (primarily the former), scattered throughout Indonesia and located at the lower end of the size spectrum of publicly-supported land and water development projects in Indonesia. Officially the extent of the individual schemes, teferred to throughout this report as "subprojects", is not supposed to exceed 2,000 hectares of net cultivable land. Considering 500-odd subprojects launched in the first three Indonesian fiscal years of the program, 1974/75 through 1976/77, the mean target hectareage of irrigated rice land (referred to by the Indonesian word "sawah" in most of this report) amounted to roughly 330 ha. per subproject. *Taking into account 782 subprojects programmed through IFY 1978/79, thepercentage distribution of subprojects by region is as follows:

Java/Madura	21%
Outside Java/Madura - subtotal	79%
Sumatra	48%
Sulawesi	18%
Kalimantan	7%
Nusatenggara	5%
Other (Bali and Maluku)	2%

The Indonesian Government's objective in launching the program was to realize a number of opportunities for quick-yielding investment in irrigation and reclamation that fell outside the scope of existing land and water development programs under the aegis of the Directorate-General of Water Resources, Ministry of Public Works, notably 1) the large-scale rehabilitation projects carried out within the framework of PROSIDA and assisted by loands/credits from the World Bank/IDA, 2) the large-scale "Khusus" (special) projects falling outside PROSIDA's network, and 3) the Sedang/Kecil (medium/small-scale irrigation) program. The principal criterion in selecting locations for IRS subprojects was from the

*Targets revised on based on 1977 survey conducted by Sub-directorate of Land and Water Conservation, Directorate General of Food Crops, Department of Agriculture.

start, and continues to be, that construction of the major works required to deliver irrigation water should be capable of completion within a short time (initially one year, although that constraint has been progressively relaxed), and that agronomic and socio-economic conditions in the area should ensure a quick response by local farmers (in a few cases, Transmigrants) by way of shaping new sawahs and expanding the production of rice, to the extent sawahs did not already exist in an area. The program was thus addressed to several major goals of Indonesia's Second Five-Year Development Plan (Repelita II), among them increasing food production, enhancing the incomes of peasant farmers, and giving a relatively greater impetus to economic development in provinces outside Java, and enhancing the institutional capacities of all parties involved to carry-on such decentralized irrigation development activities.

2. USAID involvement on IRS

Early in the course of the IRS program the United States Agency for International Development, considering that the program was an embodiment of theprinciple expressed in AID's Congressional Mandate that the thrust of the development effort should be aimed at raising the living standards of the rural poor majority, expressed interest in allocating a portion of its development aid to Indonesia to IRS. In June 1975 AID approved a loan of $20 million for the program, the bulk of which was to be used to finance a portion (42½%) of the capital costs of subprojects undertaken during the IFY's 1976/77 and 1977/78. Other allocations were made in the loan to finance staff training for the Directorate-General of Water Resources and Food Crops; provide resident and short-term consulting services to both agencies and finance survey and design of new project development, including tertiary canals and farm service ditches. An additional $3.7 million was added to the Loan Agreement by amendment in October 1976.

3. The IRS evaluation

Soon after arrangements for AID assistance to IRS were completed USAID/Jakarta and the two GOI Directorates-General began laying plans for an interim evaluation of the program covering technical, economic and social aspects, designed to assist USAID and AID/Washington in deciding whether IRS would be an appripriate object for a second loan during U.S. Fiscal Year 1978, and also to provide data for the GOI to use in its continuing program of monitoring development activities. The two Directorates-General organized invaluable and otherwise unobtainable data for the evaluation by conducting comprehensive enumerations in late 1977 of 500-odd subprojects executed during the first three years of IRS (see point 4(C) below).

Early in 1978 three independent American consultants were engaged by USAID to conduct the evaluation in close consultation with officials of the two D.G.'s. They were:

Clive Gray, Fellow, Harvard University Institute for International Development, former director, HIID advisory group, Government of Indonesia (team leader).

Henry Gembala, consultant, Experience, Inc., formerly irrigation engineer, Soil Conservation Service, U.S. Department of Agriculture.

John Duewel, Ph.D. candidate in rural sociology, Cornell University, former Participating Consultant (in Indonesia) Agricultural Development Council.

According to terms of reference agreed between USAID and representatives of theGOI, theoverall objective of the evaluation was "to assess (IRS') progress to date in achieving its stated goals, and to recommend ways and means of enhancing its effectiveness in serving these goals in future."

4 Modus operandi

To fulfill their assignment the consultants were asked to operate in the following ways:

A) To observe IRS subprojects in the field, discussing progress achieved, problems encountered and future prospects of the program with benefitting farmers, other local residents, provincial and local officials and consultants working in the field or out of provincial or kabupaten (district) offices;

B) To discuss all issues concerning IRS with GOI and USAID officials and consultants based in Jakarta;

C) To utilize the findings of, and where relevant, guide the processing and analysis of data collected under, four evaluation surveys of IRS, conducted respectively during 1976-78 by:

a) The Directorate-General of Water Resources Development - a 21 page, 390-information-bit questionnaire completed by local Irrigation Service officials in respect of 535 subprojects, emphasizing technical aspects of program execution;

b) The Directorate-General of Food Crops - two surveys, i) a 56-page, 780-bit questionnaire completed mainly by agricultural extension agents in respect of 517 subprojects, concentrating an socio-economic factors and changes related to IRS implementation; and ii) a detailed short essay questionnaire administered by two-man teams of university/ag. college graduates working in the Provincial Agricultural Services to village officials, irrigation leaders and farmers in 54 locations (20 of them IRS subprojects) in 10 provinces, stressing institutional and organizational workings of local irrigation systems; and

c) Survey Agro-Ekonomi - five monitoring/evaluation reports supplying baseline socio-economic data and discussing IRS implementation problems in 71 subprojects in 15 provinces; and

D) To consult IRS program documentation, the engineering and agricultural consultants' resports, and secondary data sources - e.g. agricultural statistics and irrigation surveys - obtainable in Jakarta.

Consultant Duewel arrived in Indonesian on February 1, remaining through the first week of June. During the first 2½ months of his assignment he visited (see map) 32 irrigation systems in six provinces, 15 of them IRS subprojects; participated in three Directorate General of Food Crops regional workshops on its 517-subproject survey; took part in a water users' association workshop in Bali; and assisted in preparation, field-testing implementation and analysis of the second D.G. Food Crops survey described above.

Consultants Gembala and Gray arrived on April 4 and 6 respectively, departing Indonesia on May 26. During their first month they made one short field trip to West Java and two one-week trips to Sumatra and Sulawesi-Kalimantan, visiting a total of 32 IRS projects (plus one "Khusus" project) in seven provinces.

5. The Evaluation Report

The bulk of the consultants' draft report was submitted to the Directorates-General of Water Resource Development and Food Crops and USAID/Jakarta on May 22-23. The policy conclusions and recommendations were discussed at length in a meeting chaired by Water Resource Development Director General Ir. Suyono Sosrodarsono on May 24, attended by senior members of his staff, a representative of the Sub-directorate of Land and Water Conservation, Directorate-General of Food Crops, representatives of USAID and the three consultants. Following this meeting the report was revised and completed, and scheduled for submission in final form to interested parties in the GOI and USAID during the first week of June.

The authorship of substantive portions of the report is as follows: Section III Policy Conclusions and Recommendations - Gray with assistance by Duewel; Section IV Economic Benefit - Cost Analysis of Irigasi/Reklamasi Sederhana - Gray; Section V, Socio-Institutional Evaluation of the Sederhana Program - Duewel; Section VI Engineering Evaluation of the Sederhana Program - Gembala and Section VII Training also by Gembala. Appendices authored by individual consultants are so identified.

Acknowledgements

Two Indonesian Government agencies provided major counterpart support to the evaluation, both in Jakarta and in the course of the consultants' field trips. These are the Directorate-General of Water Resource Development, with specific reference to the Directorate of Programming (Direktorat Bina Program) at the center and the heads and staffs of theirrigation divisions of the provincial Public Works Services in the field; and the Directorate-General of Food Crops, with specific reference to the Sub-directorate of Soil and Water Conservation, Directorate of Plant Protection, at the center, and units of this sub-directorate in theprovincial agricultural services in the field. The consultants are greatly obliged to the heads and staff members of these agencies for the time which they spent accompanying members of the team and explain the complexities of IRS to them, for concrete support in the form of data and other materials relating to IRS, and for logistical support in conveying team members to more than 60 subprojects all over the country. A special debt is acknowledged to Drs. P. Tambunan, senior economist, Directorate of Programming, D.G. Water Resource Development, and to Ir. N. Sinulingga, staff member, Sub-directorate of Soil and Water Conservation, each of whom devoted the equivalent of many man-days to guiding the consultants to an understanding of the realities and issues of IRS, and coordinated much of thedata and logistical support provided by their respective agencies.

The consultants also want to express their gratitude to Ir. Suyono Sosrodarsono, Director General of Water Resources, for two opportunities to engage with him and his senior staff in a thorough exchange of views on IRS as well as to Mr. Sunardi, Director of Food Crops Protection for his kind assistance and to Ir. Otje S.R. Bratamidjaja, Chief of the Sub-Directorate of Land and Water Conservation, for his active participation in the evaluation process, including repeated field trips with Consultant Duewel.

Finally, the consultants are indebted to USAID/Jakarta for this oppotunity to participate in an exercise that has turned out to be a great professional challenge and will hopefully in future prove to be of some benefit to Indonesia's development concerns. They are grateful to USAID as a whole for its share of the logistical support provided them during the study, and to individual staff members for fruitful discussion of key issues. Special gratitude is expressed to Mr. Thomas Niblock, USAID director, for three opportunities to exchange views on matters of substance, and to Mr. William Larson, chief of USAID's Rural Development Division, and his staff, which backstopped the evaluation, including particularly Mr. David Devin, who acted as coordinator for the exercise and provided numerous insights into the issues faced.

SECTION III - CONCLUSION AND RECOMMENDATIONS

1. Conclusion of benefit-cost analysis

Preliminary benefit-cost analysis in Section III, first on 132 subprojects yielding before-and-after data in the Directorate General of Food Crops (Agriculture) survey cited in Section I, then on revised target hectareages for 500-plus subprojects, applying nation-wide average yield estimates computed by the Central Bureau of Statistics (BPS), provides indicators that IRS is on its way toward covering the social opportunity costs both of the capital invested in it, assuming a 15% discount rate, and the labor engaged in producing rice on its paddy fields, assuming shadow wage rates ranging from Rp. 260 to Rp. 460 ($0.63-$1.11) per day.

2. Progress in meeting targets of first AID loan

The following summary comments are offered in regard to progress achieved in meeting the three principal targets of AID's first loan to IRS:

i) Increasing rice production. As indicated in Section III, the 132 "mature" subprojects surveyed by Agriculture appear to have increased annual production of wet unhulled rice by between 37,000 and 49,000 tons already by the 1976/77 crop year. This is equivalent to increased production of 22-29,000 tons of milled rice. Using nation-wide yield data the entire set of 517 subprojects surveyed, constituting about 90% of the subprojects undertaken in the first three years of IRS, offer promise of increasing wet paddy output by nearly 700,000 tons, equivalent to about 400,000 tons of milled rice, from project start to completion.

ii) Increasing incomes of the rural poor. As indicated in Section IV, the beneficiaries of the program are peasant farmers the vast majority of whom will cultivate less than one hectare of IRS sawah. Some 80-90% of them fall into income classes below the $150 per capita level determined by AID as the poverty line. A large percentage of beneficiaries are farmers whose sawahs lie in the lower reaches of existing communal irrigation systems and who therefore prior to IRS faced water shortage in the dry season. With 80% of IRS projects located out-side Java, the proportion of landless laborers in the subproject areas is very small--80% of subprojects covered in the Agriculture survey reported few or no such individuals. The socio-institutional analysis indicates, thus that no major income groups are being excluded from the project for structural reasons.

iii) <u>Strengthening GOI institutional capacity to implement IRS.</u> Recent events suggest that the rate of expansion towards which IRS seemed to be building as AID assistance for the program was agreed was in fact beyond the capacity of the provincial irrigation services to supervise adequately, both as to planning & design and to construction. Thus, according to figures supplied by the Directorate-General of Water Resource Development (hereafter Dit. Jen. Pengairan), the target hectareage of major works completed during 1976/77 was the same as that for 1975/76 (about 49,000 ha.), while during 1977/78 it declined drastically to about 21,000 ha, as execution of many subprojects was stretched out over longer periods than originally planned. Meanwhile the Irrigation Service was subjected to increasing pressure from local populations and government bodies to conduct repairs or extend main canals in earlier-year subprojects that were not meeting their objectives; hence the 95,000 ha. "improvement" category covering 75% of thesubprojects included in the1978/79 program.

Clearly theprovincial services are facing considerable stress in reviewing contract designs to ensure their adequacy ~~considerable stress in reviewing contract designs to ensure their adequacy~~ to site conditions while at the same time keeping on top of the building contractors. Still, it was the consultants' impression in the course of fild visits to more than 60 subprojects in ten provinces that for the most part the services are responding to this stress and that the manifold increase in man-years of experience accumulated since the start of IRS by provincial office staffs, the kabupaten section chiefs and the field supervisors on irrigation works is beginning to show via better judgment as to what is and is not feasible.

From their perspective of two years of experience in the field the AID-financed engineering consultants, provided through a contract with IECO, report positive changes both in general staff capability and in receptivity to the expatriate engineers' recommendations on subproject planning and design. The enhanced interest in integrating the consultants into the irrigation services' provincial structure (see Section below) is as much a sign of increasing absorptive capacity as it is of recognition of the services' own weaknesses. In some provinces lying on the outer fringes of the "regions" which the foreign consultants are assigned to serve the evaluation team heard what appeared to be sincere complaints about the brevity of their periodic visits.

It has proven unexpectedly difficult to secure data from Dit. Jen. Pengairan's Jakarta headquarters about numbers of staff assigned to IRS activity in the provincial services, and the increase therein since the start of IRS. Data was still being sought at the time this report was due.

Turning to the agricultural side, one again there are indications of a growing awareness in the provincial services of Agriculture's important role in assisting the farmers, individually and through water users' associations, to make optimum use of new irrigation water supplies. In most provinces agricultural staff have prepared tertiary layouts for a subset of projects and at the very least held initial discussions with farmers about installing them. Like their IECO Counterparts in the irrigation services the SINOTECH advisors in Agriculture cite concrete evidence of enhanced capacity of their counterparts. It is clear that in a number of locations junior agricultural staff have given substantial amounts of time that can exclusively be devoted to Sederhana related activities.

The delay in achieving targets regarding institutional formation and the implementation of tertiary development activities should in part be understood as reflecting these staffing problems. In contrast to Dit. Jen Pengairan which has been involved with the Project for over 4 years, Agriculture's direct involvement has been limited to two years. An important factor in initial delays, was the fact that the construction on major works was sometimes incomplete, delayed or beset with technical deficiencies. Moreover, the carrying out of land development and construction activities at the farm level is a more labor intensive process, involving consultation with farmers. In this regard, while the delay in agricultural follow-up may have slowed the pace of improvements in water management, it has not forestalled the realization of substantial benefits from IRS by farmers using traditional methods to put the water to use.

It appears that USAID expectations with respect to the development of formal institutional capability for operation and maintenance, whether on the part of the provincial irrigation services, water users' associations, or some other agency, have also not been met. It was explained to the team by none other than the Director General himself that any expenditure by his organization on O&M of IRS projects now must be funded within the framework of new project expenditure. Thus, a significant share of the 95,000 ha. of "improvements" on old schemes included in the 1978/79 capital budget should more correctly be regarded as maintenance and repair, and should in theory be covered out of current revenues of the subprojects in question.

Nevertheless, the absence thus far of any special provision for O&M of IRS subprojects in Dit. Jen Pengairan's financial system, on the whole has not prevented these projects from being maintained--where technically and financially feasible--by the communities involved. Lack of O&M by the local irrigation service provides incentives for on going community initiative which has characterized village systems throughout Indonesia historically. The results may not be as elegant as a western irrigation engineer would want to see in his own country, but the system may be the more economic precisely for that reason.

Where it would undoubtedly make sense to institutionalize some capacity for O&M is in regard to major works, notably those whose construction and repair involves the use of masonry and cement. In some locations visited and studied, imperfections or deterioration in existing structures had complicated maintenance and water delivery, at least temporarily.

3. Improving current procedures of project implementation and follow-up.

i) Feedback on major works design. The evaluation team had reached the conclusion, based on discussion with provincial irrigation officials and engineering advisors, that perhaps the greatest single improvement in the preparation of major works could be achieved by requiring design contractors to return to the field with preliminary layouts and finalize these in their home offices only after consultation *in situ* with local engineering staff. In many cases this implies raising the design allocation per hectare above the present Rp. 7,000, but the additional expenditure should have an enormous pay-off by way of saving staff time now devoted to correcting the contractors' mistakes, not to mention improving the efficiency of structures and channel.

ii) Operation and Maintenance. Recognizing that it is desirable to leave responsibility for a major share of O&M in the hands of local communities, we nevertheless feel that Dit. Jen. Pengairan should institutionalize a capability for routine handling of maintenance and repair of major works. This would be designed to enable the provincial irrigation service to respond quickly to situations beyond the control of the farmers, in lieu of having to wait to include a subproject in the ensuing year's DIP (Dafter Isian Proyek or project funding document). The team recommends that a general provision for O&M designed to enable a provincial irrigation service to move rapidly on emergency repairs of major works on IRS subprojects (perhaps catering jointly to similar needs on Sedang/Kecil and other types of projects as yet lacking flexible arrangements for such work) be instituted on a trial basis in at least one province during the next fiscal year.

iii) Monitoring and evaluation. The evaluation team was concerned to learn that Survey Agro-Ekonomi's monitoring program of irrigation schemes had been discontinued before it had yet reached the stage of yielding results by way of before-and-after comparisons. They feel that such work should continue under the auspices of one government agency or another, on the basis of return visits to subprojects for which a good deal of baseline data have now been assembled. SAE's contribution could be improved by focussing their data collection on a small range of parameter that serve as the primary indicators of subproject success or failure, first and foremost these being the change in annual gross cropped hectareage of sawah land. Through a scientific sampling procedure SAE could fill the present gap in reliable data on this key measure. We understand that BAPPENAS has taken the position that it is up to Agriculture rather than Pengairan to sponsor such survey activity. Accordingly, we recommend that either Dit. Jen Pengairan or USAID pursue this matter with the Directorate General of Food Crops, in order to prevent a lengthy hiatus in the collection of sample survey data.

4. Future IRS investment policy.

i) Subproject selection procedures. Much thought and effort have gone into establishing the current computerized system, and the continuous evolution of procedures appears to have led to a steady improvement in subproject selection. All agree that there is still room for improvement. In some provinces visited by the consultants Agriculture officials have a largely passive role in the process, although in principle an active input from Agriculture is indispensable. The consultants suggest that Dir. Jen. Pengairan should encourage an expanded role for the BAPPENAS (Provincial Development Planning Agencies) as a coordinating agency between Pengairan, local government, the Directorate General of Food Crops and other agencies interested in the location of IRS subprojects. Ideally, no proposed location should be accepted for consideration by Dit. Jen Pengairan/Jakarta until the BAPPEDA certifies that the necessary local consultation has taken place.

The consultants also feel that the computerized questionnaire for project selection (latest revision) has become unwidely, soliciting respondents' impression of a whole range of socio-economic variables where the lack of data is such that a comparison of answers among subprojects and provinces is more likely to mislead than to promote rational selection. The consultants feel that a revamping and simplification of the questionnaire is called for.

ii) Subproject selection criteria. The team agrees with the basic benefit-cost approach underlying the current selection criteria, however it should be applied in such a way as to allow benefits perceived by different population groups to be weighted differentially, the weights increasing according to the relative degree of socio-economic deprivation currently faced by a given group. It should be noted that weighting of benefits to give preference to activities favoring poor and/or isolated classes of society is supported by modern benefit-cost theory. Adoption of such a weighting procedure implies deviating from the farmer emphasis given in IRS subproject selection to maximizing production of rice. Following that emphasis, IRS tended to favor locations with pre-existing communal irrigation systems. Now, however, we understand that the goals of social justice and regional equity in growth will receive greater emphasis in Repelita III, starting in 1979. This implies a corresponding change in emphasis for IRS selection.

There is a need to develop special selection criteria appropriate to different classes of subproject investments, (a) extension of existing subproject areas, (b) improvement of old projects not yet functioning properly, (c) continuation of uncompleted projects from the year immediately preceeding and (d) new subprojects.

iii) Supplemental investments in existing IRS subproject areas.

a. Introduction. It was indicated earlier that IRS already appears to be giving a favorable return on investment prior to the realization of substantial additional public investment in tertiary/quarternary network development, land-clearing and sawah-formation. We believe that additional investments in IRS subproject areas should not be dictated by an imperative to bring all the initial target hectareage into production within X number of years, within the framework of a complete tertiary/quarternary delivery network. In other words, execution of such investments should not be regarded as an essential condition for making each IRS subproject "functional".

In many areas the data available on water discharge and efficiency of conveyance are too uncertain to guarantee the feasibility of irrigating the full stated target hectareage from the major works as initially planned. In other areas the costs of land-clearing and the availability of manpower to work additional sawahs within a given period of time are uncertain.

We therefore recommend that an incremental benefit-cost approach should be taken in planning such investments. At each point in time only those investments should be undertaken that will generate sufficient additional net benefits, compared with the situation that would prevail in their absence or under some alternative arrangement, to ensure a positive Net Present Value at the prevailing social opportunity cost of capital (say 15%).As suggested above, these benefit -cost calculations too should take into account appropriate income weights for disadvantaged and isolated groups in society.

b. Land-Clearing. Specially with regard to land-clearing, direct government intervention in a subproject area should proceed only following careful investigation of the question as to why the local population has not previously felt a need to bring the area at least under dry-land cultivation, not to mention rainfed sawah. We question whether in most IRS subprojects with uncleared land included in the target hectareage a justification exists for undertaking mechanized land-clearing. We suggest that any government intervention in this area should be restricted initially to a pilot approach, aimed at experimenting with, and establishing the cost parameters associated with, a series of alternative techniques. (Note: Selection of an area for Transmigrant settlement increases the likelihood that government intervention in land-clearing will give a more favorable return than other alternatives.)

c. Sawah formation. With regard to sawah-formation we suggest that any program of capital assistance from government should take note of the fact that in many IRS subprojects farmers are already shaping sawahs with their own resources, group of farm families helping out successively on each other's plots. In areas where sawah-formation has apparently been delayed notwithstanding the delivery of irrigation water, the causes for this delay should be examined and means sought to remove obstacles to the farmers' own initiative. For example, in cases where questions of land tenure create a bottleneck, the local government authorities and Dit. Jen. Agraria should be pressed to give priority to land titling or some intermediate measure that will give farmers adequate security for their investments. If the delay is attributable to the fact that the local population prefers to stick with alternative means of livelihood, and apparently considers the opportunity cost of sawah formation to be too high, evidence should be sought as to whether manpower will be available to farm the sawahs once they are formed. (The Survey Agro Ekonomi reports testify to cases where prepared sawahs have returned to bush notwithstanding the availability of water, essentially because of the high opportunity cost of the labor required to farm them. In these cases plantation crops typically presented a more attractive source of livelihood to the people.)

Before promugating a broad program of assistance for sawah-formation the government should consider carefully the possibility that a substantial number of farmers who would otherwise form sawahs with their own resources will not sit back and wait until the government assistance comes through. Without adequate follow-up in terms of concrete assistance such a policy might conceivably slow down the overall rate of sawah-formation, rather than accelerate it as intended. Moreover, the creation of potential dependency relationships is obvious.

d. Tertiary/Quaternary Development. Finally, with regard to tertiary/quaternary distribution netwroks, it should be kept in mind that Indonesia has already attained higher national average rice yeilds than Philippines (cf. FAO Monthly Bulletin of Agricultural Economics and Statistics, Nov. 1975), while growing most of her rice without the benefit of such systems. Tertiary/quaternary systems should be viewed not as an essential link in the chain of investments required to yeild a favorable return on the cost of IRS major works, but rather as an opportunity for additional investment aimed at further expanding irrigated area by making limited water supplies cover larger hectareages, as well an enhancing yields by facilitating improved water management and creating a corresponding stimulus to increase the use of modern inputs. Our own observations in the field indicate that many IRS subprojects offer attractive opportunities for public and private (the farmers') investment in this respect, but it should not be assumed that such will be the case in every subproject in the immediate future. Thus, for example, evidence should be gathered with respect to the degree of incline at which the additional cost of canals offset higher yields associated with improved water management, and the target area for completion of delivery networks should be recalculated to eliminate such areas.

The recent government decision to transfer responsibility for design and construction of tertiary/quaternary systems on IRS subprojects to the Directorate General of Water Resources Development (Dit. Jen. Pengairan) poses both an opportunity and a danger : an opportunity in the sense that Dit. Jen. Pengairan has a higher demonstrated capacity than the Directorate General of Food Crops (Agriculture) to implement works on the ground, but a danger in the sense that Dit. Jen. Pengairan has less capability than Agriculture to comprehend local farming systems and determine how to lay out each network with the maximum positive and minimum disruptive impact. Based on experience in the execution of IRS major works (see above), the consultants see a likelihood that design of the tertiary/quaternary systems will be assigned to contractors working under budget constraints that deprive them of the opportunity to develop their lay-out in close consultation with the local population and Agriculture officials. The result is likely to be a set of designs not adequately fitted to local farming systems and land ownership, whose imposition will face rasistence from the local population. The consultants urge that Dit. Jen. Pengairan's design contractors be required to review their preliminary lay-outs in the field, and obtain formal clearances of local village chiefs and Agriculture staff before finalizing the designs in their home offices. Budgets for design work should include liveral provision for such consultation, otherwise far larger sums are likely to be wasted.

The policy of complete subsidization of the construction and completion of tertiary layouts also raises some questions. It leaves out the possibility of voluntary contributions of labor from farmers, and tends to establish the principle of reimbursement for any activity taken. Senior Department of Agriculture policy makers also have expressed concern about the tendency for the government to assume too much of the costs of such activities. Doing so may dampen future community responsibility for O&M. Such policies in large part are based on analysis of major lowland systems which have different organizational parameters in comparison with most IRS locales, and which have less demonstrated capacity to undertake ongoing O&M. Future evaluation of such policies in the Sederhana context would be appropriate, leaving open the possibility of modified approaches tailored more to IRS community capacities and needs.

5. Staff Development.

The consultants were impressed by the detailed evaluation which several provincial irrigation chiefs were able to provide concerning the adequacy of the pre-service education and in-service training obtained by different levels of their staff. These officials gave specific recommendations for lengthening the periods of training provided by the Directorate-General's training institutions and for strengthening various components of different course curricula. The consultants feel that these recommendations add up to a need for an expnaded training investment. At the time of completion of this report we were still receiving data needed to draw up a comprehensive training proposal.

6. Principles of future USAID assistance.

The consultants feel that USAID has already made a constructive contribution to the IRS program, primarily by virtue of the technical assistance it has financed, since there is no evidence that the expectation of receiving its capital assistance, of which none has been disbursed thus far, has so far affected the program's scale or content. They regard it as important to distinguish between the priority attached to a particular activity associated with the program, and the possibilities for AID loan assistance for that activity. For instance, a potential problem arises in the case of institutional development--specifically as it concerns water users' associations. Support for the formation of water users associations is a high priority activity of the greatest social importance, and one in which the ear-marking of external financial assistance may provide useful incentives for internal activity. The procedural constraints within which AID operates, however, may pose some difficulties in allocating capital assistance to this project activity. Essentially, AID usually attributes its money to end-uses that can be followed concretely by its auditors. The question of how effectively a specific water user's association is functioning is a difficult matter for auditors to pursue, if that were to be a measurement criteria. On the other hand, support for the extension and training activities associated with forming and upgrading the capcity of local associations would seem to be a worthy undertaking. It is hoped, therefore, that some means may be found to accomodate this objective.

i) Technical assistance

Engineering. The evaluation team saw indications in the field that the contributions of the IECO/Sinotech engineering consultants to project design and execution are becoming increasingly valued by their Dit. Jen. Pengairan counterparts. In consultation with USAID it has now been tentatively agreed that this assistance be expanded and reorganized in such a way as to amalgamate it more effectively into the Directorate General's own structure. Our team supports this request, and offers two additional points to be taken into account in programming the assistance in future:

1. It is imperative that the engineers to be stationed in Indonesia acquire a working knowledge of the Indonesian language before they arrive in the country. This matter is too important to be left to individual preference, or to be handled via part-time or after-hours lessons while the individual works on another assignment. We recommend that USAID and the contractor accept the principle that substantial resources have to be allocated to language instruction, including the candidate's full salary while he undergoes a full-time course of instruction lasting not less than, and possibly longer than, two months. Before being finally cleared to come to Indonesia each condidate should have to attain an acceptable score on a language test administered by an independent body. A system of financial incentives and penalties should be established to ensure that both the candidate and his employer are motivated to have him complete the language course successfully. Likewise, resident consultants would be expected to undertake such training, to the degree feasible, to bring language skills up par.

2. The contractor's present terms of reference require its staff to inspect completed subprojects and certify whether or not they meet reasonable standrds. An AID Implementation Letter requires that it receive a copy of the engineer's certification along with each application for reimbursement in respect of a subproject. De facto the engineers are place in a position of certifying projects on behalf of USAID. To the Evaluation team they expressed a wish to have this link between themselves and USAID severed, feeling that among other things the current procedure detracts from the time they can devote to assisting in earlier stages of subproject implementation (i.e. it diverts staff resource from higher-priority "preventive" work to "curative" activity.) Our team feels that the requirement also puts the engineering contractor in a delicate position half-way between two clients in the respective roles of lender and borrower, and thus hampers the engineers' integration into the Dit. Jen. Pengairan organization. We propose that the certification role be dropped from the contractor's terms of reference, and that USAID accept a corresponding burden on its resident direct-hire staff to carry out whatever degree of inspection it considers necessary to ensure that subprojects accepted for reimbursement will stand up to scrutiny by AID auditors. If our recommendation on AID reimbursement procedures (see below) is accepted, the additional staff burden will be less than would be the case under current procedures.

Agriculture. As in the case of the IECO engineers the consultants heard generally favorable reports in the field concerning the contribution of the Sinotech staff assisting the Land and Water Conservation subdirectorate of the Directorate General of Food Crops. There was some concern expressed, however, about the lack of integration of some of the technical staff--in part stemming from communication problems. As in the case of Engineers, resident and prespective staff should be required to reach an Indonesian language proficiency level-sufficient to participate in situations where the usage of English is not an option.

Some major questions were raised by Indonesians about the utility of short-term consultancy assignments. They also noted the need for greater attention and sensitivity to existing community organizational modes. The tendency of the outside consultants has been to push an idealized version of organization not always in accord with Indonesian realities. The short-term consultancies should probably be pressed down. Sino-Tech staff members themselves believe that the agency could profitably use some technical assitance from agronomists, however staff members of the subdirectorate have indicated to the evaluation team that they do not see the need for such assitance and do not expect to request it. Indications are, however, that Sinotech will be asked to provide another technician to work in the Cent: 1 Region, considering that the team manager now assigned here is alone and has to devote much of his time to administrative duties.

Training. The consultants feel that far too small a portion of the technical assistance provided thus far has been devoted to strengthening the training institutions involved on both the engineering and agricultural sides of IRS, including preparation of comprehensive proposals for lengthening and upgrading the curricula of several of the courses currently offered. We recommend that the next phase of USAID assitance provide for a full-time training adviser with expertise both in the field of technical education itself and in estimating requirements for and programming expansion of this sector. One of his tasks should be to prepare case studies based on IRS experience for use as teaching materials, consonant with the guided self-teaching approach, in the training institutions involved under both Dit. Jen. Pengairan and the Department of Agriculture. Departing and resident IECO and Sinotech advisers might be brought back on short-term consultancy visits to contribute to this process of case study preparation.

Social Science. Preliminary indications from some of the involved Indonesian parties is that there might be a useful role that could be exercised by a rural sociologist and an agricultural economist. This would be to work on a full-time basis with government officials concerned with 1) institutional development of irrigation water management, and 2) socio-economic monitoring of both IRS and the Sedang/Kecil (medium-and small-scale) irrigation development program. Assistance in the second category would enhance the government's capcity to provide data needed to support future applications for foreign assistance, among other objectives. Experience heretofore with a succession of brief consultancy visits, including that of the present evaluation team, suggests that this is an inadequate approach to the task of helping to monitor such a complex development activity as IRS.

At the same time it is up to the Government of Indonesia to decide whether such assitance would be useful, and no outsiders should try to cajole the Government into accepting it. If the Government agrees with these proposals, the three full-time advisers concerned with training, institutional development of irrigation water management and socio-economic monitoring might be provided as a team by a contractor separate from those now providing assistance on the technical side, although alternative options, should also be explored.

ii) USAID reimbursement procedures.

The consultants agree with views expressed on both the government and AID sides that current reimbursement procedures are so cumbersome as to impose a high opportunity cost in terms of scarce administrative and technical talent that has to be devoted to their implementation. At the same time it is not clear that any corresponding social benefit flows from the current system. Dit. Jen. Pengairan's decisions to return, in 1978/79, to half of the projects from IRS's first three years and conduct "mopping-up" operations clearly results from pressure by local populations, government authorities, irrigation officials and other government personnel to deliver the promised water to the sawahs. It is not clear that USAID reluctance to approve certain subprojects for reimbursement has had a constructive impact on program implementation apart from those pressures.

By way of simplifying the reimbursement procedures we propose that AID capital assistance be attributed to a sub-set of projects involving less complex technical problems, easier access by AID staff for inspection purposes, and/or relatively large investments, with a view to accelerating the process of drawing down/attributing the AID funds. This might be accomplished by targeting AID capital assitance for major works construction on the basis of covering, say, 65% of the cost of two-thirds of the subprojects, rather than the current intended 42½% of capital costs of all subprojects.

Again, it is important to note that the question of how AID's assistance is attributed is entirely distinct from that of what specific subprojects are actually carried out. The fact that it is administratively simpler to attribute AID money to subprojects meeting the conditions listed above need in no way lessen the chances of inclusion in IRS of subprojects aimed at raising the living standards of populations in remote mountainous areas.

SECTION [illegible]

ECONOMIC BENEFIT-COST [illegible] SYSTEM [illegible]

A. General

The only data available on [illegible] across the [illegible] program as a whole [illegible] already registered by it are those [illegible] from [illegible] Directorate General of Food Crops [illegible] or Agriculture) survey carried out [illegible], cited in Section [illegible] above. [illegible] also recorded in a [illegible] studies prepared [illegible] on behalf of the Directorate General [illegible] Development. The [illegible] and [illegible] by the SAE [illegible] are listed in Appendix Table [illegible]. In general, apart from some discussion of the progress of [illegible] together with problems encountered in [illegible] the [illegible] and farmers' [illegible] [illegible]

[illegible]

[illegible]

indicated that 65% of the subprojects were already supplying irrigation water, and 35% were not. About 25% supplied water to between 1 and 40% of the farmers in the relevant area and 40% of the farmers.

It should be noted that many of the 171 subprojects reported as not yet functioning were served by pre-existing village irrigation systems, and were therefore not entirely without water pending successful completion of the relevant IRS scheme. Another subset of the 171 comprised reclamation projects, for which the question of water delivery is not relevant. The answer to this question in the cases of the 30-odd reclamation projects indicate some confusion on the part of the enumerator. Some left the question blank, others answered "0%", including the case of one South Kalimantan project visited by two of the consultants where cultivation was already underway as a result of the subproject lowering the water level.

Another index of the extent to which IRS has already delivered irrigation water is provided by the enumerators' responses to a question concerning farmers' attitudes toward the water supply situation, given in Table IV:

Table IV-1

Farmers' attitudes toward irrigation water supply

Percentage of reporting subprojects whose enumerators classified "most" farmers as considering the present water supply, compared with the situation before the subproject, to be:

	Worse	About the same	Somewhat better	Much better	[illegible]
Rainy Season	7	38	44	11	19
Dry Season	10	45	40	5	22

C. Intensification of Land Use

Turning to the question of land use, the [illegible] were asked to estimate hectarages in various [illegible]

(1) before the subproject (2) at the time of the survey (Oct. - Nov., 1977), and (3) according to plan after project completion. The coordinating office in the Directorate General of Food Crops (Subdirectorate of Land and Water Conservation) has endeavored to correct these figures for a number of discrepancies which appeared in the course of their analysis.*

Table III-2 shows changes in land use categories occurring up to the time of the survey as calculated by Agriculture.

Table III-2

Current land use in 516 IRS subprojects according to Agriculture survey (thousands of hectares)

	Irrigated sawah No. of crops per year One	Two	Total	Rainfed sawah	Total sawah Actual ha.	Gross cropped ha.*
1. At time of survey (Oct.-Nov.1977)	40	34	74	36	110	144
2. Immediately before each subproject	41	15	56	47	103	118
3. Change: (1)-(2)	-1	+19	+18	-11	+7	+26**

* Total area of single-cropped irrigated and rainfed sawah +2x area of double-cropped sawah.

** Gross of small area converted from dryland crops for which data not available.

* By way of illustration, in a random sample of 11% of the 517 cases, computer analysis detected obvious discrepancies among area figures in 41% of the sample. While this sub-sample [illegible] one third of the total sample showed total non-sawah area to have increased up to the time of the survey. It is not necessary that all the responsibility for these errors fall on the shoulders of the enumerators - errors occurred both in transferring data to coding sheets and subsequent card-punching.

The table suggests that, within about 3½ years from the official start of the program, and of course a much shorter space of time following completion of the first projects, IRS had induced an expansion of 18 000 ha. in irrigated sawah, of which about 60% represented upgrading of pre-existing rainfed sawah and 40% represented conversion of non-sawah land. Considering changes in cropping intensity the data show the program to have expanded gross cropped hectareage by 26,000 ha. per annum (-19,000 x 2 - 1,000 - 11,000), less some area converted from dry land crops. The data do not permit a breakdown of the 7,000 ha. of new sawah by previous condition, i.e. dry arable, cleared but not cropped, forest, or swampland.

It is not possible to attach a confidence interval to the estimates in Table III-2. The consultants' field visits and discussion with enumerators, other officials and farmers give rise to two observations: firstly, the estimate of the proportion of irrigated sawah that is cropped twice a year may be slightly on the high side reflecting the enumerators' view as to potential rather than fully realized use; and secondly, it is clear that some enumerators overlooked a significant amount of land-clearing and sawah-formation that had gone on since the start of their subproject. In some cases this is because the enumerator had been assigned to the subproject area only recently and was unaware of new sawah formation that had taken place two or three years ago in anticipation of subproject irrigation. For example the economic consultant spoke with a group of farmers in South Kalimantan who accounted for 11 hectares of recent sawah formation in anticipation of water delivery that has not materialized due to a leaky weir, yet the questionnaire submitted by the recently assigned PPL shows no expansion of sawah.

There appear to be other cases in which the enumerator, whether the local PPL or some other official, has not had sufficient contact with a subproject area to know what is going on by way of land development. For example, the questionnaire submitted for a project in South Kalimantan reports the entire area of 600 ha. as uncleared swampland, yet when flying over the subproject on departure from Banjarmasin two of the consultants saw that at least a third of the area had been cleared. A previous discussion on site with a farmer indicated that land-clearing activity had started in this area as early as 1977, had increased in anticipation of the subproject, and that a number of farmers had previously planted rice [illegible] (until the current season) because the [illegible] level [illegible] high.

Finally, the consultants saw some indications that land-clearing and sawah-formation, all of it carried out by the farmers themselves with no government assistance other than extension advice are on a rising curve as more of the subprojects start functioning. In both South Sulawesi and South Kalimantan the consultants saw land-clearing and sawah-formation proceeding at a respectable rate, having started in the six months since the Agriculture data were collected.

In summary, indications are that the Agriculture data more likely understate than exaggerate the benefit thus far generated by IRS in terms of expanding total arable area and specifically sawah.

The next question is that of IRS' future impact on land development. Based on its analysis of the questionnaires, the Subdirectorate of Land and Water Conservation estimates that the following non-sawah areas are subject to land-clearing (where appropriate) and sawah-formation within the framework of completing the 517 surveyed projects:

	Thousand hectares
Dry arable	22
Cleared bu not cropped (grass-or bushland known as alang-alang)	[illegible]
Forest	1[illegible]
Swamp and marshland	[illegible]
Total (rounded)	[illegible]

This gives the following summary picture [illegible] irrigated land development during subsequent stages of the 517 projects and from the beginning of the program:

Table IV-2

Future land u[illegible] in [illegible] IRS subprojects according to Agriculture [illegible]
(thousands of hectares)

	Irrigated sawah No. of crops per year One	Two	Total	Rainfed sawah	Total sawah Actual ha.	Gross cropped ha.**
1. Upon subproject completion (targets)	57*	115*	172*	6*	178	293
2. At time of survey (Oct. - Nov. 1977)	40	34	74	36	110	144
3. Immediately before each subproject	41	15	56	47	103	118
4. Changes: From now to subproject completion: (1) - (2)	+17	+81	+98	-28	+68	+149
Total associated with 517 subprojects: (1)-(2)	+16	+100	+116	-41	+75	+175

*These figures are taken directly from computer analysis of the questionnaires, after correction for a few major discrepancies but without adjustment by Agriculture. However enumeration of target sawah areas was clearly subject to fewer discrepancies than characterized estimates of other categories. That the figures sum to within 2,000 ha. of Agriculture's total target figure of 180,000 ha. suggests a fair degree of consistency.

** Total area of single-cropped irrigated and rainfed sawah +2x area of double-cropped sawah.

Taking into account cropping intensity, the figures imply an aggregate expansion of 153 000 ha. in gross cropped hectareage (~175,000 ha. less 22 000 ha. to be converted from dry land crops) less the area previously converted from dry land crops. Obviously this development cannot all be attributed as a benefit of government expenditure thus far budgeted for the

517 projects. Shaping (and to some extent clearing) of the 7 000 ha. of additional sawah already created in connection with IRS has occasioned opportunity costs to the farmers who undertook this development without government subsidies. Clearing and shaping of the additional 70 000 ha. envisaged by Agriculture, and establishment of tertiary/quarternary networks throughout the whole system as dictated by current high-level Government policy, will occasion further opportunity costs. We will return to the question of costs in a later section.

D. Impact on Agricultural Production

The two categories of IRS benefits discussed above, delivery of irrigation water to sawah land and creation of new sawah, do not represent social benefits in and of themselves but rather facilitate social benefits in the form of increased production and income. The Agriculture survey solicited information in respect of crop production in the last rainy and dry seasons before subproject execution, and in the rainy and dry seasons of the crop year 1976/77.* Comparison of these production data before and after subproject execution provides the only basis for estimating the macro impact of IRS on agricultural production up to the present time.

Data on harvested hectareages and yields, multiplied to give gross output were requested in respect of three categories of rice cultivation (sawah under BIMAS-INMAS, other sawah, and upland rice) plus maize, cassava, legumes and "other" crops cultivated in the subproject area). However, since PPL's in rice-growing areas are administratively responsible to the BIMAS organization, it is only natural that they are far better informed about rice cultivation, and inquiries in the field suggested that the data submitted in respect of crops other than rice were largely "guesstimates". Attempts to compute gross and net

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* Even so, substituting rice for other food crops as these are currently cultivated in most of the country substantially raises net value of output per hectare. A recent paper by Prabowo, Nyberg and Sardi of Gadjah Mada University ("Implications of Irrigation", undated paper commisioned by ILO/Jakarta Office estimates the per-hectare profitability of other food crops in Java as the following proportions of the profitability of rice at the latter's current floor price of Rp.54 [illegible] (day stalk paddy): maize--.16; cassava--.45; sweet potatoes--.56; peanuts--.60; soybeans--.33.(P.15).

Production estimates are meaningful for purposes of IRS evaluation only insofar as they relate to subprojects which were reported by the survey to be delivering water to at least a portion of the target sawahs (311 subprojects) and whose major works had been completed long enough before the survey tomake it possible for their impact to be reflected in a harvest recorded by the enumerators. In consultation with Agriculture officials a space of 14 months was selected for this purpose, reducing the relevant population of subprojects to 172 of which all but two were initially funded in the fiscal years 1974/75 or 1975/76. A further group of 40 subprojects was dropped on the ground that 1) no production was recorded for the 1976/77 rainy season, indicating either that harvest was incomplete at the time of the survey, or possibly that the crop was destroyed by pests, notably the wereng insect; or 2) notwithstanding a previous land-use classification of at least partly sawah, zero production was recorded for the last rainy season before the subproject, indicating crop failure. (Farmers interviewed during the consultants' field trips testified to a number of such occurrences.) Another 15 projects recorded positive production in both the last rainy and dry seasons before the subproject, and the 1976/77 rainy season, but zero output in the 1977 dry season. Here again it was assumed the enumerators had been unable to record the harvest, and dry season output was subtracted from the "last full year before" parameter, the rainy season data being retained.

Table IV-4 compares recorded rice output before and after the 132 IRS subprojects:

Table IV-4

Recorded rice output of 132 IRS subproject areas before and after the subprojects (thousands of tons of unhulled, undried rice--padi gabah kering panen)

	Rainy season	Dry season	Full year
1. 1976/77 crop year	104	55	159
2. Last crop year before subproject	86	24	110
3. Increase in production--(1)-(2)	18(21%)	31(125%)	49(44%)

As one would expect, the percentage increase in production is highest for the dry season, when irrigation makes possible a relatively greater expansion of cultivation.

Once again it is impossible to attach a confidence interval to these data. At the very least it is clear that a wide margin of error exists, reflected by the fact that the enumerators tended to give yield figures rounded to the nearest ton or half ton.* It also seems likely that some were motivated to demonstrate a positive impact of the IRS subproject. In the previously mentioned set of 172 mature subprojects there are 105 whose enumerators give yield figures for sawah under BIMAS-INMAS in both the last rainy season before the subproject, and the 1976/77 rainy season. Of the 105 cases 15% show a decrease in yields between before and after, 26% show no change, 12% show an increase of less than 10%, and nearly half (47%) show increases in excess of 10%. The weighted average increase reported is 7%. It is comforting that a sizable proportion felt no imperative to show substantial yield increases. Were the 47% who showed such increases measuring the impact of improved water supply, the effect of new disease--resistant varieties, or simply better climatic conditions, were they reflecting a doctrine that government investment necessarily increases yields, or was it some combination of these factors? Unless and until those administering the IRS program decide to commit the resources necessary to ferret out scientific estimates of the subprojects' impact on rice production, going so far as to undertake special crop-cutting in the subpro ect areas, no one will be in a position to answer this question reliably.

A different approach to estimating the impact of IRS investment on rice production is to apply, to the expansion of irrigated area, yield differentials calculated by the Central Bureau of Statistics (BPS) on the basis of its nationwide crop-cutting program carried out jointly with the Department of Agriculture. In each kecamatan a pair officials representing the two agencies, the mantri statistik and the mantri tani (not the PPL), take three rounds of crop-cuts during the year at scientifically chosen locations. They report the yields in conjuction

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* Out of 354 yield estimates given in an 11% random sample of completed questionnaires relating to the last rainy and dry seasons before subprojects three seasons starting with the dry season of 1976 and enumerators' estimates of "normal" rainy and dry season yields, 58% were odd or even multiples of 500 kg. This compares with an unbiased expected value of 20%, corresponding to the values 5 and 10 in the sequence 1-10.

with information about the type of irrigation characterizing each location, inputs used, participation BIMAS and other programs, pest problems, and size category of holding. Table IV-5 reproduces some of the results of BPS' unpublished computer analysis of this data, giving double emphasis to the nationwide average yields for rice produced under simple or village irrigation. Given the wide distribution of IRS projects and the margin of error associated with all parameters under discussion here it is permissible to focus on comparison of just a few summary magnitudes in the table. This is done in Table IV-6.

Table IV-5

Extracts from Central Bureau of Statistics (BPS) computer analysis of rice yields in Indonesia, calender 1976

(kg. of unhulled, undried rice--padi gabah kering panen)

	Type of fertilizer used				
Type of cultivation	(1) Artificial	(2) Manure	(3) Combination (1) and (2)	(4) None	(5) All areas--weighted average*
1. Semi-technical irrigation:					
Java	4301	3245	4165	3179	[illegible]
Outer islands	4245	5029	4027	3486	4050
All Indonesia	4295	3614	4160	3352	4193
2. Simple/Village irrigation:					
Java	4016	3162	4143	[illegible]	[illegible]
Outer islands	3971	2659	4224	[illegible]	[illegible]
All Indonesia	4009	3060	4148	3217	3825
3. Rainfed sawah:					
Java	3195	2537	3111	2832	3043
Outer islands	3462	2951	3164	2790	3075
All Indonesia	3226	2569	3120	2904	3052
4. Rainfed sawah and upland rice--weighted average:*					
Java	3043	2209	2369	2453	2747
Outer islands	3073	1991	3164	2063	[illegible]
All Indonesia	3047	2182	2127	2561	[illegible]

* Weights correspond to percentages of the total planted area in each category of irrigation and fertilizer use or lack thereof.

Definitions (translated excerpts from BPS crop-cutting manual):

Technical irrigation (yields not listed above but definition quoted here because it figures in the next definition)-- delivery canals are separate from drainage canals to facilitate full regulation and measurement of the supply and distribution of water. Systems normally have tertiary as well as primary and secondary canals, where the primary and secondary canals as well as structures are built and maintained by the government.

Semi-technical irrigation - same as technical, except that the government controls only the intake structure in order to regulate and measure the entry of water. The subsequent flow is neither measured nor controlled by the government.

Simple/village - water distribution and drainage systems are not regulated.

Source: unpublished computer print-out in BPS division of Agricultural Statistics, Food Crops section.

Table IV-6: Summary Comparison of rice yields under specified conditions of irrigation and fertilization

	Yield differential (kg/ha)
I. Simple/village irrigation versus rainfed sawah:	
No fertilizer: 3217 - 2904 =	313
Manure: 3060 - 2569 =	491
Artificial fertilizer: 4009 - 3226 =	783
Combination of manure and artificial: 4148 - 3120 =	1028
Average conditions of fertilization prevailing nation-wide: 3825 - 3052 =	773
II. Simple/village irrigation versus nationwide weighted average of rainfed sawah & upland rice:	
No fertilizer: 3217 - 2561 =	656
Manure: 3060 - 2182 =	87[illegible]
Artificial fertilizer: 4009 - 3047 =	[illegible]
Combination of manure and artificial: 4148 - 2427 =	17[illegible]1
Average conditions of fertilization prevailing nation-wide: 3825 - 2739 =	1086

Source: BPS data cited in Table II-5.

Taking a static view of things one would apply the yield differential corresponding to absence of fertilizer to measure the impact *per se* of introducing simple irrigation to rainfed sawah or upland rice cultivation. However, it is a commonplace that modern inputs enhance agricultural yields both through interactions as well as individual effects, and the advancement of smallholder agriculture is a dynamic process in which the results obtained by successfully applying one input enhance the farmer's motivation to increase the use of others, with multiple impact on his productivity. In Indonesia, assistance from BIMAS was until recently available only to irrigated rice farmers, since the authorities considered that an economic response to the package of inputs involved could only be achieved under irrigation.

It therefore seems appropriate to use the yield differentials corresponding to nation-wide average conditions of fertilizer application in the respective irrigation categories to estimate the impact on production of introducing simple irrigation. We will use figures of 3800 kg. as the expected yield of sawah under simple irrigation in both the rainy and (if applicable) dry seasons, and 3050 kg as the expected yield of rainfed sawah.

These yield coefficients provide a separate check on the plausibility of the production increase registered in the set of 132 subprojects presented in Table IV-4. The calculations are shown in the following Table IV-7:

Table IV-7: Computed rice output of 132 IRS subproject areas, based on BPS yield coefficients

	(1)	(2)	(3)	(4)	(5)	(6)
	Irrigated sawah			Rainfed sawah		
	Areas by no. of crops/yr. '000 ha. One	Two	Production, areas X 3800 kg = '000 tons	Area '000 ha.	Production, (4) X3050 kg= '000 tons	Total production, (3) + (5) '000 tons
1. 1976/77 crop year	10.8	11.932	131	4.7	14	145
2. Immediately before each subproject	10.4	4.482	73	11.[illegible]	35	108
3. Change in production: (1) - (2)						37

Source: area figures computed directly from survey rations for 132 subprojects.

Comparing Tables IV-7 and IV-4 we find computed production in the last full crop year before the respective subprojects, 108,000 tons, to be almost identical with the 110,000 tons recorded by agriculture's enumerators, the discrepancy being less than 2%. On the other hand recorded 1976/77 output of

Comparing Tables IV-7 and IV-4 we find computed production in the last full crop year before the respective subprojects, 108,000 t[illegible], to be almost identical with the 110 000 tons recorded by Agriculture's enumerators, the discrepancy being less than 2%. On the other hand recorded 1976/77 output of 159,000 tons is 10% [illegible] excess of computed output based on the relevant hectareages, leading to a recorded increase of 49,000 tons that is one-third in excess of the 37,000-ton computed rise in output. The comparison supports the hypothesis that the enumerators may have over-stated yield increases following execution of the IRS [illegible]b-projects but the possibility is also not excluded that a group of as few as 132 small areas may have achieved an average yield exceeding the BPS-computed nation-wide average by ten per cent.

The next step is to project IRS-area output through [illegible] completion of all 517 subprojects included in the survey by applying BPS yield coefficients to the hectareages presented in Table IV-3. This is done in Table IV-8 following:

Table IV-8: Projected rice production from 517 IRS subprojects

	(1)	(2)	(3)	(4)	(5)	
	Irrigated sawah			Rainfed sawah		
	Areas by no of crops/yr '000 ha.		Production, areas X 3800 kg. '000 tons	Area '000 ha.	Product-ion, (4)x 3050 kg. '000 tons	Total production, (3) + (5) '000 tons
	One	Two				
1. Upon subproject com-pletion (targets)	57	115x2	1,091	6	18	1,[illegible]09
2. At time of survey (Oct.-Nov.1977)	40	34x2	410	36	110	520
3. Immediately before each subproject	41	15x2	270	47	143	413
4. Changes in product-ion: From begin to now:(2)-(3)						+107
• Total associated with 517 subprojects:(1)-(3)						+696

Seeking to "calibrate" this model, we compare tot[illegible] production immediately before each subproject with total product[illegible] a[illegible] computed from the Agriculture survey production computed from the Agriculture survey for the last full year before the subprojects. The correspondence is striking (and largely coincidental, considering the many sources of error involved): the above figure of 413,000 tons compares with a figure of 411,888 tons computed from the survey.

The survey returns cannot be compared with the 520,000 tons of output projected on the basis of hectareages identified in the survey, because some of this sawah land will enter into production (as sawah) only during the crop year 1977/78, for which the survey provides no data. Of the 107,000 ton increase projected for the current crop year, between 35 and 46% - depending on whether one uses survey data versus production increases computed on the basis of BPS yield coefficients - is already accounted for by the 132 subprojects analyzed above. Considering that this group of subprojects accounts for only one-third of the increase in gross cropped hectareage of sawah recorded in the survey,* it is not unreasonable to expect the remaining two-thirds of the increased area to contribute the remaining 54-65% of the computed rise in output.

E. Benefit-cost analysis

It is now time to attach some values to the increased output, substract social opportunity costs of production and compare the net value of output with IRS development costs.

Unfortunately in making these calculations one cannot avoid using some fairly heroic assumptions, which imply wide margins of error. The first uncertainty concerns the price at which to value output. It seems [illegible] reasonable to assume that the social value of an additional kilogram of rice production in Indonesia is the foreign exchange cost of a kilogram of imports thereby averted. This supposition/requires that two values be determined: one, the long-term world market price (discounting general price inflation) for the standard quality of rice imported by Indonesia, and two, the exchange rate at which this is converted into rupiah. After consultation with U.S. Government sources it was decided to assume a world market price of $330/ton f.o.b. Bangkok which translates [illegible]

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*A total expansion of 2[illegible],600 gross cropped hectares [illegible] in Table IV-2. Table IV-[illegible] yields an analogous figure of [illegible] ha for the 132 subprojects ([illegible] + 11.[illegible] [illegible] 4.[illegible] 6,482 + 11.6 + 3.7).

c.i.f. Jakarta

Using the purchasing power parity formula it can be argued that the rupiah is currently overvalued, domestic prices having risen since 1972 some 30-40% more rapidly than the weighted average price level applicable to Indonesia's trading partners. (The oil boom permits Indonesia to maintain the Rp. 415/$1.00 exchange rate without encountering balance of payments pressures for the time being, while placing domestic producers of exports and import substitutes-- of which rice is the single most important item--in an unfavorable competitive position.) At the current exchange rate the c.i.f. price of a kilogram of rice works out to Rp. 145 ($0.35 x 415). At a long-run equilibrium exchange rate the rupiah price would almost certainly be higher; nevertheless considering the controversial nature of such an adjustment it is preferable first to calculate the benefit-cost of IRS at the prevailing exchange rate and see whether its justification requires a higher rate.

The next step is to translate a c.i.f. price of Rp.145 per kilogram of milled rice into an equivalent value for undried, unhulled rice.* The table of price margins decreed for official rice marketing agencies starting Feb. 1, 1978, gives a ratio of 1.0/0.59 for the wholesale price of milled rice to the price of dry unhulled rice delivered to village stores. A BPS table ("Daftar Konversi") gives dry gabah as 85% by weight of wet gabah. The price we are looking for thus works out to 0.85 x 0.59 x Rp.145 = Rp. 73.

To obtain value added, from the gross sale value of a kilogram of rice at farm-gate must be subtracted the value of inputs. According to the BPS, the average ratio of inputs to sale value for wet land rice in Indonesia is 0.075.** Accordingly, the net value of a kilogram of wet gabah at c.i.f. equivalent prices is 0.925 x Rp.73 = [illegible] kg. This is the figure that will be applied in the following analysis.

How to treat the opportunity cost of labor in benefit-cost analysis of investments aimed at raising smallholder productivity is a tricky question about which economists differ. Some argue in favor of assuming a zero opportunity cost in densely populated areas where output does not seem to expand with growth in the labor force. Others

* Padi gabah kering panen. Note that use of the word "kering" (dry) seems to be a misnomer for gabah at point of harvest.

** BPS, Survey Pertanian, January-April [illegible], p.27, [illegible] production costs included except labor and [illegible] argue that the gross value of additional output should always be offset by the disutility of the additional effort that has gone into producing it, even if the labor would otherwise have been idle during the time required to produce the commodity in question. This disutility is best measured by the lowest daily wage for which the manpower concerned is prepared to sacrifice leisure. Only where it is clear that, for example, expansion of rice output via IRS investment is accompanied by some reduction of previous output by the labor engaged in IRS subprojects is there general agreement that IRS' contribution must be calculated net of that reduction. How to measure the reduction is another question.

The matter is sufficiently complicated that it can best be handled by first calculating output value gross of farm labor costs, subtracting capital recovery on IRS investment allocating the residual value to the labor input, and seeing what figure emerges for the opportunity cost of a person-day of rice-producing labor.

The final item to be considered on the cost side is government expenditure on IRS development. In that connection it is useful to look at two magnitudes, 1) the costs of developing the 132 subprojects for whose increase in output up to last year the Agriculture survey has recorded some data and 2) development costs for the entire set of 517 projects. An estimate of the first datum is yielded by the Directorate General of Water Resources (Dit. Jen. Pengairan) survey cited earlier. The provincial irrigation officials who served as enumerators for the survey were asked to supply data on 1) the actual cost of construction during the subproject's first year, 2) the approved allocation for construction during year #2 (if relevant), 3) any additional amount of expenditure required to complete the project satisfactorily and 4) the actual cost of survey and design. Ex officio the enumerators had access to financial documents which could give them authoritative answers to questions 1 2 and 4; how far they supplied correct answers could only be verified by a laborious check against subproject records in Dit. Jen. Pengairan/Jakarta that would probably not make enough of a difference to be worth the effort. The answer to Question 3 invites the exercise of judgment on the part of the enumerator; how far enumerators may have given their own rough estimate of the additional work required and its cost, as opposed to relying on earlier projections which in many cases [illegible] understated the work required in order to [illegible] ceilings, is not known.

The total cost of Dit. Jen. Pengairan investment in the sub-set of 132 subprojects, computed from the survey data, amounts to Rp. 5.6 billion. For purposes of comparing it with the projected flow of benefits from the subprojects this amount should be adjusted upward for price inflation which occurred from the start of the program up to the point in time at which the assumed Rp. 73/ kg. average gabah price takes effect. On the other hand, part of the investment has served or will serve to supply water to sawah land coming into production only after the 1976/77 crop year on which the projection of benefits is based. By assuming that the two effects offset each other we will probably not be exceeding the margin of error associated with all figures in this exercise.

It may be argued that to Dit. Jen. Pengairan's investment should be added that potion of the Directorate General of Food Crops, expenditure on IRS which is attributable to the 132 subprojects. However these efforts are likely to have a significant payoff only in the medium-to-long run, once the tertiary-quaternary distribution networks are in place and the farmers appreciate the benefits of technical water management and have developed an institutional capacity to put it into effect. At that point the higher yields characteristic of semi-technical (perhaps even technical) irrigation systems - cf. the SPS data in Table IV-5 - will have replaced those prevailing under conditions of simple/village irrigation, creating additional benefits that we hope and expect will more than offset Agriculture's investment. For purposes of calculations concerning the short-run benefit-cost relationship of the 132 subprojects it may therefore be regarded as permissible to omit Agriculture's costs.

The cost of converting non-sawah land to irrigated sawah is another item of capital costs that should be taken into account. Table IV-7 shows that irrigated sawah in the 132 subprojects rose by 7,900 ha. -- [illegible] thousand single-cropped plus 7.5 thousand double-cropped -- from the last crop year before the respective subprojects up to the time of the survey. All but 1 200 ha. of this increase, or 6 700 ha. is accounted for by transformation of rainfed sawah. The 1 200 ha. conversion of non-sawah land was carried out by the farmers themselves with no government subsidies. Since the Agriculture survey [illegible] how much of it came from the four categories of non-sawah land, all of which involve sharply differing [illegible] clearing (where relevant) and sawah-formation, we have little basis for estimating the investment cost. If the cost per ha. averaged Rp.200,000.-, then the total cost will have amounted to Rp. 240 million, or only 4% of Dit. Jen. Pengairan's investment in irrigation facilities. We will ignore this cost element for purposes of the 132-subproject analysis.

We are now ready to compare benefit and cost values for the 132-subprojects. Multiplied times the assumed gabah price net of inputs, Rp. 67 1/2/kg., the previously estimated range of production increases, 37,000 to 49,000 tons, yields a range of benefits, gross of labor costs, amounting to Rp. 2.5 to Rp. 3.3 billion per annum, equivalent to 45-60% of the investment cost. Assuming a five-year economic life for the works constructed under IRS--or in other words that equivalent expenditure on repair and rehabilitation will be required to keep them functioning for the second half of a ten-year period-- together with a 15% social opportunity cost of capital as the discount rate, the annual stream of net benefits necessary to justify an investment is 30% of the amount of the investment. Thus the program is clearly yielding a favorable return if the opportunity cost of labor is ignored.

According to Prabowo-Nyberg-Sardi the production of a ton of dry stalk paddy on irrigated sawah in Indonesia requires on average 53 person-days of labor. * Using BPS conversion factors this implies 88 person-days for a ton of wet gabah. An opportunity cost of labor ranging from Rp. 260 to Rp. 380 per day leaves just enough output to cover the opportunity cost of the IRS investment (Rp. 260 if we use the computed production increase of 37,000 tons, Rp. 380 if we accept the more optimistic survey figure of 49,000 tons. The calculation runs as follows: the unit IRS investment cost, per ton of increased output, ranges from Rp. 115,000 to 150,000, depending on which estimate of the increase is used. Thirty per cent of these values, the annual amount necessary for capital recovery, is Rp. 34-45,000. Subtracted from the value of a ton of rice--Rp. 67,500, net of inputs--these figures leave a residual of Rp. 22,500-33,500. Dividing this range by 88 person-days yields daily labor costs of approximately Rp. 260-380.)

This range certainly does not understate the social opportunity cost of rural farm labor in labor-surplus areas of the country, although it probably does so in areas afflicted by labor shortage. On the other hand the relevant gabah price is generally higher in those areas, reaching values as high as Rp. 160/kg. in some South Sumatra subproject areas, according to the Agriculture enumerators.

• In summary it seems likely that the group of 132 mature subprojects taken as a whole was already, by the 1976/77 crop year, yielding a return sufficient to cover the social opportunity cost of both labor and capital.

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* Op. cit., coefficient implicit in the derivation of Table 33, Incremental Labor Required ..., from Table 32, Budgeted Rice Production ...

We turn, finally, to the whole set of 517 subprojects for which projected hectareages and output are given in Table IV-8. The Dit. Jen. Air investment cost in these subprojects (plus roughly 20 more not covered in Agriculture's survey) is most authoritately estimated by turning to past and current budget documents, the so-called "DIP's) (Daftar Isian Proyek or project breakdowns.) The following Table IV-9 summarizes budget allocations by Indonesian fiscal years (April 1 - March 31):

Table IV-9

Directorate General of Water Resources Development budget allocations for approximately 535 IRS subprojects started in the first three fiscal years.

(Rp. billions)

Indonesian fiscal year		Total budget for IRS (Plafond)	Attributable to approx. 535 subprojects started in first 3 years
1974/75		3.3	3.3
1975/76		5.5	5.5
1976/77		8.7	7.9 (a)
1977/78		10.4	3.3 (b)
1978/79		12.6 (c)	5.8 (d)
	Total	40.5	25.8

Notes

a. Plafond less survey and design component, nearly all of which is allocated to projects starting in subsequent years.

b. Amounts allocated in the DIP's to subprojects started through IFY 1976/77. Provincial office supervision (bimbingan) and other general expenses pose a problem--rather than allocate them according to the breakdown of project capital costs the simple procedure was adopted of including the total amount in cases of provinces where the bulk of capital expenditures was devoted to continuing projects, otherwise (in the case of most provinces) excluding them.

c. Draft budget, not yet finally approved by Department of Finance and Bappenas at time of preparation of this report.

d. Most expenditure on "old" projects is allocated under a special "improvement" (Penyempurnaan) program covering 285 subprojects, of which 91% date from IRS' first three years. General expenses were allocated as described in note (b).

Sources: Directorate of Irrigation annual budget documents or program execution reports.

For purposes of benefit-cost analysis of the entire set of 500-odd projects we cannot ignore costs of land-cleari.. and sawah-formation, inasmuch as the hectareage targets supplied by Agriculture (see Table IV-3 and page), and output projections derived from them in Table IV-8, assume conversion of 70,000 ha. of non-sawah land, of which only 22,000 is currently dryland arable. The Directorate General of Food Crops is proposing that government accelerate the conversion of this land by engaging contractors for land-clearing and providing credit to help the farmers do their own land-shaping. Involvement of contractors will occasion substantial per-hectare costs about which no solid data yet exist. (Mechanized land-clearing costs have been projected for the Luwu Transmigration project but clearing of large contiguous areas is a simpler proposition that opening up patches of forest ranging from less than a hundred to a few hundred hectares all over the country).

At an average cost to government of Rp. 400,000 for land-clearing and sawah-formation the expenditure on 70,000 ha. would amount to Rp. 28 billion, or roughly the same as Dit. Jen. Pengairan's projected total investment in irrigation development (Rp. 25.8 billion).

Once again the question of gov[illegible] investment in tertiary and institutional development arises. Thus far Agriculture has been allowed to budget Rp. 10,000 per ha. (Rp. 5,000 for survey and design plus Rp. 5,000 for materials for division structures) for development of tertiary networks on a fraction of IRS subprojects, in most cases numbering less than 20% of the projects in a given province. Additional expenditure would be incurred--there does not yet appear to be a standard sum per ha. for this item--via payments to farmers for digging canals and ditches under the Padat Karya and kabupaten INPRES programs. The total expenditure thus far envisaged is substantially less than the Rp.47,250 per ha. budgeted by PROSIDA for its World Bank-assisted schemes, of which Rp. 25,000 is allocated to structures, Rp. 15,000 via incentive payments to farmers digging canals a la gotong royong, and the remainder as honoraria to local management committees.* Assuming that roughly

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* Evaluasi Pelaksanaan Pembangunan Terier "PROSIDA", December 13, 1977.

one-third of the subproject area may be so steep as to make complete tertiary development uneconomical,** one is left with 120,000 ha. on which to carry it out. At a government cost of Rp. 40,000 per ha. this would add Rp. 3 billion to the total development cost of the 500-odd IRS projects under examination. However, as mentioned previously in analyzing the 132 member sub-set, it is logical to regard this development as associated with an advance from simple/village irrigation to semi-technical or even technical irrigation and thus to leave it aside in an initial benefit-cost analysis assuming yields characteristic of simple/village irrigation.

The benefit-cost comparison now works out as follows: increased output of 696,000 tons of gabah is multiplied times the assumed price of Rp. 67,500 net of inputs, yielding a gross annual benefit flow of Rp. 47 billion. From this we have to subtract foregone output on 22,000 ha. of dry land arable assumed to be converted to sawah. The BPS Survey Pertanian shows widely varying nation-wide average proceeds per hectare for upland crops in 1976. We assume a gross return equal to half that of irrigated rice, or about Rp. 140,000 per ha. in current prices. This gives foregone output worth about Rp. 3 billion, reducing the IRS benefit flow to Rp. 44 billion. Subtracting from this amount 30% of the Dit. Jen. Pengairan investment plus assumed land development costs, or 0.3 x Rp. 54 billion = Rp. 16 billion, the remaining Rp. 38 billion leaves room for a relatively high labor opportunity cost of Rp. 460 per day. (Equal to Rp. 38 billion divided by 696,000 tons times 88 person-days, the previously mentioned labor coefficient for production of one ton of wet gabah under irrigation).

Alternatively, if we assume no further land development beyond the levels reached at the time of the Oct.-Nov. 1977 Agriculture survey--and as noted previously the consultants saw many indications during their field trips that these figures have already been overtaken by events, namely the initiative of farmers taking advantage of the new irrigation facilities--then the calculus works out as follows: 107,000 tons of gabah (see Table IV-8 above) times Rp. 67,500 = Rp. 7 billion, which is just about 30% of the Dit. Jen. Pengairan investment recorded through 1978/79, leaving no residual to cover the opportunity cost of labor. In other words, if the area of sawah served remained at the level prevailing in late 1977, Dit. Jen. Pengairan's investment of Rp. 25.8 billion in IRS would not have been economic. Given the simplifying assumptions made here, each ten per cent step toward realizing the target hectareages specified in Table IV-3, provided the mix of new single- and double-cropped sawah and reduction of rainfed sawah accords with the expansion path defined in the table, adds about Rp. 50 to the return to labor (10% x Rp. 460).

** According to the Agriculture survey, the topography of 32% of the projects ranges from "rolling" (5-10% slopes) to "mountainous".

In conclusion, the 500-plus subprojects undertaken during the first three years of IRS show promise of a favorable benefit-cost comparison. This is, of course, subject to a number of caveats, the principal ones being: (1) the volume of irrigation water delivered as a result of the investments listed in Table IV-9 must be adequate to service 172,000 ha. of sawah, enabling two-thirds of this area to grow two crops a year; (2) the subprojects must be able to function for five years without further need for annual expenditure on "penyempurnaan" such as half of them have turned out to require in the current budget year; and (3) an average expenditure of Rp. 400,000 per ha. must be enough to clear (where necessary) and shape sawahs on 70,000 ha. of additional land.* On these issues the data available do not permit a definitive judgement, and further investigation is desirable.

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* It should be noted that the question of whether or not it is economic for government itself to make an investment of this or any other magnitude in clearing and/or shaping a particular area of land is a separate issue that should be considered independently in regard to each area proposed for development. The first factor to consider is what would happen to the land in the absence of direct government intervention--i.e. would the local population be motivated to convert it to sawahs using their own resources, and if so, how long would it take them to finish the job.

Table IV-A1 Irigasi/Reklamasi Sederhana projects surveyed by Survey Agro-Ekonomi, 1975-77

PROVINCE	NAME OF PROJECTS	S.A.E. REPORT
Aceh	Geunteut	01/78/L
	Geupeu	
	Garut	
	Uleu Keubang	
	Timbang Gajah	
	Paya Raof	
	Cubo	
	Rimba Raya	
	Alue Badeuk	
	Kr. Ulim	
No. Sumatra	Bulian	01/78/L
	Lau Simene	
	Perbarakan	
	Timbang Deli	
	Cinta Kasih	
	Sei Balai	
	Kp. Sukaramai	
	Kp. Benteng	
	Bukit Cermin	
	Namu Ukbilin	
West Sumatra	Bandar Kuah	2/77/L
	Batang Sasapn	
	Batu Kumbin	
Riau	Penyesauan	2/77/L
	Sei Jerang	
	Sei Buring	
Jambi	Semayo	2/77/L
	Cupak	
	Batu Lacait	
Bengkulu	Air Kemumu	2/77/L
	Suka Bulan	
	Lubuk Jala	
East Java	Karang Tambak	6/78/L
	Cempaka	
	Posuk Strek	
Bali	Apuan	6/78/L
	Langkih	
	Bang-Bang Biaung	

West Nusa Tenggara	Poak Rengge	6/78/L
	Mamben	
	Tarusan	
East Nusa Tenggara	Tasipah	12/77/L
	Bokis	12/77/L
	Lurasik	12/77/L, 6/78/L
	Kondamara	6/78/L
	Wolowaru	6/78/L
Cen. Kalimantan	Berengbekel	01/78/L
	Montalat I	
	Montalat II	
	Trinsing	
	Tewah*	
	Tempatas*	
So. Kalimantan	Rawa Taras	12/77/L
	Sei Tamiyang	12/77/L, 2/77/L
	Sei Tundakan	12/77/L
E. Kalimantan	Panarangan	2/77/L
	Palaran	
North Sulawesi	Kadumut	2/77/L
	Makonsar	
	Katulidon	
Central Sulawesi	Malino	12/77/L
	Mapanga	12/77/L, 2/77/L
	Maenusi	12/77/L, 2/77/L
	Jonooge	2/77/L
South Sulawesi	Panaikang	3/77/L
	Bollangi	
	Leworeng Kanan	
	Kanang	
South East Sulawesi	Ameroro	2/77/L
Maluku	Ikeo	1/78/L, 6/78/L

(Total of 18 provinces, 71 sub-projects)

* Projects on which construction had not yet started at the time of the survey.

SECTION V - SOCIO-INSTITUTIONAL EVALUATION OF THE SEDERHANA PROGRAM (IRS)

A. INTRODUCTION:

1. Introduction

With the launching of the Sederhana Irrigation Program (IRS) in 1974, the Indonesian government broadened the focus of its irrigation development strategies. Whereas previously capital intensive investment in and rehabilitation of major state operated lowland systems in Java had held center stage, IRS signaled the beginning of a shift to a more decentralized, geographically dispersed pattern of development. The government, in effect, began to give explicit recognition to the important existing and potential role that community irrigation systems have played, and will continue to play throughout its archipelago.

The irrigation development strategies in these smaller schemes which characterize existing and proposed IRS project locations differ from those found in the larger state operated irrigation systems. The government provides selective inputs, such as improved technologies and technical and organizational training to the communities involved, and where necessary, initiates the construction of major works. It does not, however, take responsibility for managing and operating these systems. The inputs, accordingly, are designed to enhance the capacity of the villages involved to extend, maintain and operate their own (primarily village) systems with a minimum of reliance on outside agencies. In contrast to the larger state operated irrigation networks which tend to foster dependency and which are frequently beset by local maintenance and water distribution problems, IRS in theory encourages village participation in and control of its own development.

The three major objectives of IRS should be considered in the light of the previous observations. These objectives are (1) to enhance the institutional capacities of the various parties involved to implement the program, (2) to improve the well-being of the rural populace, the majority of whom have low incomes, and (3) to increase rice production in Indonesia. This section of the evaluation will focus heavily on objective 1, giving particular attention to the question of the conditions under which local institutional capacities to carry out irrigation management functions can be promoted, and the impact of IRS on the same. It will be argued that given the kinds of technological, ecological and administrative parameters under which most Sederhana systems function, there are direct links between these local capacities and the achievement of welfare and productivity objectives for the rural populace over time.

2. Approach

The approach taken in this section of the evaluation is conditioned by several factors. These include (1) the kinds of data available for analysis, (2) the topics being covered elsewhere in the report, (3) the constraints imposed by the format of the report and the limited space allotted, (4) the policy concerns of interested parties and (5) conclusions arising from the analysis that need to be aired. Given these conditions, the following presentation of necessity will be less thorough and less systematic than desired. To compensate for this shortcoming, a more detailed and systematic coverage of the research findings is included as an Appendix, focussing specifically on institutional variations of local irrigation dynamics found in Sederhana systems. The lengthier Appendix presentation should be viewed as an essential component to Section V, rather than an annex. In a short presentation of the type permitted here there is a tendency to over-simplify what in reality are often institutionally diverse and varied situations.

3. Sources

The current analysis has drawn from 5 major sources of information which have been outlined in the Introductory Section. For the more detailed analysis of the socio-institutional components of IRS systems, however, particular reliance has been placed on (1) the field visits to 15 Sederhana locations and discussions with local farmers and with Agricultural and Irrigation Service personnel involved in implementing the program, (2) the detailed socio-institutional survey of irrigation dynamics in 20 IRS locations which were a part of the evaluation process and (3) participation in (a) a national seminar of water users association (P3A) leaders and (b) 3 regional workshops connected with the implementation of the Department of Agriculture survey.

4. Analytical Perspective and Policy Issues

A basic assumption undergirding the analysis undertaken is that variations in local organizational modes and capacities found in irrigation systems must be studied in the context of a variety of parameters. These include the surrounding ecology, technologies and physical layouts associated with the system, relative water availability, indigenous traditions and cultural patterns, the degree of autonomy vs. interdependency of the system, size and scope, agricultural cropping patterns, irrigation tasks and functions, etc. The list could go on. What is important is that unless these parameters are specified, it is difficult to move from the level of description to that of analysis.

Specifying such conditions (where possible) in the Sederhana context is important because policy decisions are being made in connection with past and future activities. These deal with the kinds of inputs and assistance that the bureaucracy should provide in improving the productive capacity of the systems. Related activities cover the range of construction of diversion weirs and major canals, elaboration of tertiary delivery systems, formation of water users associations and the formation of rice paddies.

Since the capacity of the communities to undertake such actions varies not only by activity type but also by existing skills and experience, there is a need for policy flexibility to adjust to such differences. For instance the capacity of communities to open up sawahs and construct delivery systems is likely (although not automatically) to be higher in those locations where rudimentary systems exist than in locations undertaking irrigation for the first time. The tendency is often to do too much rather than too little in the interests of speeding up the pace of development. The danger is that the ultimate purpose of government policy, to improve the productive capacity of communities to take on as much local level responsibility for operating systems as possible, may be undermined by the implementation methods used.

These observations are particularly pertinent in the Sedernana context since many of the policy assumptions regarding the on-farm development of irrigation channels are derived from an analysis of major lowland systems in Java, where tertiary networks either do not exist, or else are in a state of disrepair. The apparent decline in O & M capacity is attributed to such factors as technological-ecological constraints, bureaucratic inefficiencies and irregularities, lack of community level leadership and a decline in traditional patterns of village cooperation (gotong royong). There is considerable evidence from the analysis undertaken in this exercise, that the conditions found in state operated lowland systems are substantially different from those found in most [illegible] locales. This observation is similar to that of a recent FAO perspectus on Indonesia, which concluded that village irrigation systems are generally better maintained and more efficient in water control and distribution than state operated systems.

The preceding discussion is not meant to imply that village irrigation systems (existing and potential) are not in need of outside technical, financial, and organizational assistance. The positive benefits from such external inputs will be indicated subsequently. What it does suggest is the need for both planners and implementing [illegible] the institutional dynamics of small irrigation systems, [illegible] the conditions under which local operational capacities can be perpetuated or stimulated, and those under which they may be undermined.

B. GENERAL DESCRIPTION OF SEDERHANA PROJECTS

1. Existing Land Use Situation

The 517 IRS locations on which the evaluation was carried out cover three years of activities (1974/75-1976/77) and include approximately 174,000 hectares of realizable potential irrigated hectarage. Of this total, 59% (or 102,857 hectares of land) were already under some form of wet rice cultivation prior to the project--consisting of 46,877 hectares of rainfed land and 55,980 hectares of irrigated land. Irrigated land present prior to the project represented 32% of the potential target area, and was composed of 15,300 hectares of double cropping and 40,860 hectares of single cropping cultivation.

If we consider the IRS project locations from the standpoint of previous land use conditions, only 16% were classified as undeveloped land, while an additional 8% had some upland crops but no sawahs (rice paddies). The remaining 76% had rice paddies present in some portion of the project area (either rainfed or irrigated). Significantly, 50% came from locations categorized as consisting primarily of wet rice cultivation, and 55% of projects had existing irrigation systems--although often very rudimentary.

2. Location, topography and degree of autonomy

The IRS projects are fairly widely scattered throughout the archipelago encompassing 24 of 27 provinces. Approximately 80% of the projects are located outside of the island of Java. While the projects are influenced by a diversity of conditions, they generally are relatively small (330 hectares on an average) and employ relatively simple technologies. Actual sizes are considerably smaller, since the preceding average was calculated on potential, not existing area.

A distinguishing characteristic of most Sederhana locations is that of the relatively hilly topography. Only [illegible] of projects are [illegible] in flat terrain (under 2% gradient) and many of these are surrounded [illegible] adjacent to water sources originating in hillier terrain. Most employ some form of hill-terracing technology, the organizational implications of which will be discussed later.

Related to the question of topography is the fact that the [illegible] pre-existing IRS systems were situated primarily in the upper reaches or headwaters of watersheds, or else were generally self contained. From [illegible] locations on which agricultural survey data are available, [illegible]% reported no upstream systems while only 20% reported 2 or more. Likewise, [illegible] reported that there were no downstream systems. The relative autonomy of most of these systems remains a distinguishing characteristic in comparison with large state operated and primarily lowland systems.

3. Changes Introduced by Sederhana Activities

There have been a number of factors have delayed the achievement of irrigation land development activities under IRS, including incompleted projects, technical deficiencies, lack of interest by farmers and credit constraints. However, there have been some major achievements. First, 18,000 hectares of new land have been brought under cultivation (consisting formerly of 60% of rainfed sawahs and 40% dry land cultivation) to bring the irrigated cultivation total up to 74,000 hectares. Second, an additional 19,000 hectares have intensified rice cropping from one to two times a year. Third, improved water availability and water control on existing irrigated land have stimulated yield increments (particularly in lower portions of systems). Often these changes have taken place in part as a result of improved local organizational performance and capacity, frequently in conjunction with the formation of water users associations (P3A's). Significantly, in a very high percentage of cases, the presence of an existing irrigation system seems to have facilitated the switch to irrigated cultivation.

C. IRRIGATION ORGANIZATIONAL MODES AND CAPACITIES PRIOR TO IRS

1. Introduction

It is clear from the detailed case studies and field visits that the need for effective organization varies among systems, just as it may vary within systems and during different seasons of the year. These needs are often linked to specific irrigation tasks and functions dictated by the local irrigation environment, and the degree to which group mobilization is required. For instance, organizational arrangements are frequently introduced during dry season periods of water shortage to allocate scarce water more equitably and efficiently, which in turn are dropped during the monsoon rainy season. Just as there is considerable variability in the organizational tasks and functions associated with irrigation, there is also variability in the capacity of communities to carry out these tasks and in the specific modes they use. A common characteristic of most of these systems, however, is the relative vulnerability of their somewhat perishable earth, bamboo, and stone diversion weirs to destruction by sudden flood torrents (banjirs), which come gushing down swollen streams during heavy monsoon downpours. The repair and maintenance of these weirs demand a community group capacity to act in concert on sudden notice.

2. Review of Organizational Forms

1) Official Village Leadership. In most IAS systems studied, it is clear that the existing official leadership plays a [illegible] role in supervising and managing systems. The village headman frequently [illegible] ultimate authority over the system, including (1) resolving [illegible]

cannot be settled by informal arbitration at lower administrative levels and (2) presiding over the planning of major irrigation/agricultural activities. While such authority in large measure is derived from the headman's ultimate responsibility for the welfare of the community, it is also influenced by the fact that in most IRS systems there is a close over-lapping between village administrative bounds and the physical outline of the canal network. How the headman's authority is implemented in practice varies widely, in part depending on the degree to which irrigation tasks have become specialized and differentiated institutionally.

An important secondary role is played by hamlet heads presiding over village administrative sub-units, who often undertake the responsibility to mobilize households for major maintenance on canals and weirs. The hamlet is probably the primary and most effective village unit for corporate action--given its close kinship, residential and reciprocal labor-sharing bonds.

ii) Village Irrigation Specialists. Most IRS village irrigation systems had at least one village member assigned to carry-out and coordinate irrigation tasks. Larger systems sometimes had more than one such specialist--each being responsible for a particular component of the canal network. The duties of these irrigation specialists (often called ulu-[illegible]) vary. However, they usually involve (1) supervising water distribution, particularly during dry seasons and (2) seeing that irrigation works are maintained (either through direct personal effort or through coordination...

iii) Formal Organizations. Prior to extension inputs provided by agricultural personnel under IRS auspices, most systems did not have formally structured irrigation organizations (as defined by a constitution, procedures, regulations and membership). There were several exceptions to this generalization which emerged from the case studies. The general absence of formal associations of water users, however, does not imply that existing organizational modes were ineffective. Informal norms and sanctions often guided irrigation conduct and promoted cooperative action, particularly in situations where expected behavior patterns were well-defined by custom and tradition.

iv) Inter-Village Irrigation Linkages. Most systems studied retained considerable autonomy in running irrigation affairs. Only [illegible] systems reported even nominal outside participation in the management of irrigation upkeep and water allocation tasks prior to IRS. Where coordination of water distribution between villages was necessary, it was primarily conducted by lower ranking Irrigation Service personnel who [illegible] and turnout gates. In some cases where watersheds or local [illegible] were shared among several villages, formalized horizontal [illegible] evident. Likewise, inter-system coordination of irrigation [illegible] exercised by locally acknowledged and hierarchically [illegible] officials (such as the Sedahan Agung in Bali).

3. Organizational Capacities to Carry-out Major Construction and Land Development

i) Types of Activities. In a number of IRS systems studied in detail government sponsored construction represented only a step in a series of major irrigation improvements initiated by the villages concerned, usually with little if any outside technical assistance. Most of these locations had already existing, functioning irrigation systems. The construction of additional diversion structures and canals, the elaboration of farm level delivery channels and the formation of rice terraces represented net extensions to the existing networks. However, in two case studies in Lampung and North Sumatra, irrigation systems were built from scratch in the 1960's and early 1970's, one covering 400 hectares.

ii) Accompanying Conditions. The conditions under which these major extensions of irrigation systems were undertaken were diverse, and it is clear that not all irrigation communities have such internal dynamism and capacity. There were, however, several observable patterns that stand out. Most of these irrigation networks were operated autonomously. They had active village leaders and the requisite skills and technical knowhow available within the community. They were largely situated in hilly or mountainous terrain. While group activity was used to construct major works, individual cultivators usually were responsible for opening sawahs which was carried out primarily in stages. Significantly, the pace of major irrigation construction seems to have accelerated in some locations following the provision of annual subsidy incentives by the government through its subsidi desa program. These funds helped defray the costs of purchased construction materials. The value of the labor inputs provided free through voluntary gotong royong work usually substantially exceeded the value of purchased inputs. With the exception of several diversion structures and the lining of canals, these constructions were seldom made of cement or masonry.

4. Organizational Capacities to Implement Maintenance, Emergency Repair and to Carry-out Incremental Construction

i) Introduction. In contrast to many lowland irrigation networks where local level tertiary components of systems are often in a relative state of disrepair, the analysis of IRS systems indicates that for the most part they appear to have a fairly high capacity to maintain canals and to repair damaged structures. There are, however, variations in organizational procedures and capacities, both among and within systems, linked in part to the tasks imposed by the physical-ecologies of the micro irrigation environments and the technological physical layout of systems. It is therefore important to distinguish between (1) major maintenance typically initiated prior to the onset of a rice cultivation cycle, (2) 'extra-ordinary', emergency community mobilization to repair damaged weirs and/or canals, and (3) routine or ongoing maintenance carried out on a periodic or irregular basis.

ii) Major Seasonal Maintenance. A fairly high level of community labor is required for upkeep of village irrigation structures because of (1) the perishable nature of diversion weirs which are particularly vulnerable to damage and even destruction during monsoon storms, (2) the high silt content of many of the mountain streams and rivers and (3) natural vegetative processes which lead to the growth of weeds in unlined earthen canals. The fact that terraced rice cultivation usually leads to stable relationships with the surrounding ecology must in significant measure be attributed to the capacity of communities to perform irrigation organizational tasks effectively over time.

The following table drawn from the 55% IRS locations reporting functioning irrigation systems prior to project implementation indicates (1) the frequency with which upkeep and repair activities were undertaken and (2) the fairly wide variation among systems in upkeep work. Data from the

Table V-1. Frequency of Irrigation Maintenance and Repair Activities Prior to the Onset of IRS, taken from the 55% locations Reporting Functioning Systems

	Number of Times Activity Performed per Season					
	0	1	2	3	4-6	7+
Maintenance Activities						
Rainy Season	20.8%	20.0%	29.9%	12.0%	10.6%	6.7%
Dry Season	32.2%	24.7%	19.2%	5.4%	12.6%	5.9%
Repair Activities						
Rainy Season	21.1%	37.4%	20.8%	7.9%	8.3%	4.5%
Dry Season	44.7%	27.0%	10.9%	5.7%	9.3%	2.4%

field visits and the socio-institutional survey suggest that for most locations, the volume of cooperative work required to maintain and repair canals and weirs was considerably higher during the rainy season.

Most locations reported annual or semi-annual periods when the village acted together to repair structures and to clean canals. The commencement of such activities usually follow discussions among village and hamlet leaders, irrigation specialists and 'progressive farmers', during which time assignments are given to respective groups regarding the locations they are expected to clean. The actual repair and cleaning of canals (turun ke sawah--descend to the paddy fields) takes from a few days to three weeks. It is usually followed by a major celebration (and sometimes rituals and ceremonies at water sources and diversion structures), when maintenance, water distribution and planting schedules are discussed--prior to actual land preparation and planting.

Once decisions are made regarding the timing and schedules for cleaning canals, these decisions are conveyed to cultivators via hamlet heads (or the ulu-ulu). The ulu-ulu or village irrigation technicians usually coordinate the cleaning of major structures. Direct mobilization and supervision of groups working in gotong royong cooperative fashion is usually conducted by hamlet heads, who are assigned portions of the canal networks. Often these assignments are in the vicinity of what is recognized as a distinct hamlet cultivation location, with working groups consisting primarily (if not completely) of hamlet residents. The preceding generalizations really over-simplify what is in reality a much more complex situation with interesting variations and modifications--often reflecting adjustments to locality specific condition. What is significant is that local organization arrangements for the repair of major canal structures frequently took cognizance of the fact that the hamlet was probably the most natural social unit for mobilizing effective corporate action.

In over 90% of the villages visited or studied in detail, those required to participate in major seasonal maintenance were cultivating households (owner-operators or tenants), with each household responsible for sending one adult (usually male) to each location where the family had sawah holdings. In many of the villages from 20% to 30% of the households had multiple locations. Under special circumstances (i.e. sickness, absence from the village) households were permitted to hire substitutes (paid Rp. 200 to Rp. 500 for a half day's work) to undertake their allotted share of communal work. It was made clear across the board, however, that such substitutes represented only a small fraction of the total labor force (less than 3%). Absence from communal irrigation responsibilities for other than legitimate reasons was frowned on and considered a violation of community norms. There was a tendency, also, for repair and maintenance undertaken on major portions of the systems to be more formally organized than that undertaken on tertiary or farm ditch levels. At lower levels of the system, cultivators often worked individually or in small groups to clean portions of channels passing their respective fields.

iii) Emergency Repair or Damaged Irrigation Works. Given the kinds of perishable structures used for diverting water from mountain streams and rivers, in 80% of IRS locations communities were called upon to repair damaged or washed-out weirs and canals at least once during the monsoon season. Over 40% reported undertaking such endeavors two or more times. While the problem of damage to community irrigation works was less during the dry season, 55% conducted major repairs at least once. The need to mobilize labor at sudden call to rebuild damaged works has helped ensure that a community wide organizational capacity remains existent. Since community interests are threatened as a whole, all households are expected to participate, usually under the leadership of the village head. There is usually no question but that the requisite leadership will be forthcoming, and that community norms regarding responsibilities will be observed. One should not automatically assume, however, that the effectiveness and the speed with which community organizational potentialities can be activated under emergency conditions necessarily implies a similar effective capacity for more routine maintenance activities.

iv) Routine Maintenance. There is probably more variation in the organization of routine upkeep of village canals, dykes and diversion structures, and in the effectiveness in which these tasks are carried out, than there is in major maintenance or emergency repair. In many systems (1) routine maintenance is less formally organized, (2) may not involve the direct participation of hamlet heads and (3) often is carried out as the ulu-ulu or collections of cultivators see fit. The ulu-ulu usually has responsibility to see that major canals are maintained, while cultivators (as individuals or in groups) keep the channels passing their fields in working condition. Water distribution difficulties sometimes arise due to inattention to routine maintenance, with lower portions of systems taking the brunt of the negative consequences. Often this is because leadership roles and internal controls in routine upkeep are not effectively institutionalized across the canal network.

Some villages have long instituted regular schedules for conducting routine upkeep (i.e. once in five days or two weeks), supervised by either hamlet heads, irrigation specialists (full or part time) or leaders of water users groups. In such cases there usually is a greater likelihood that village canals will be kept in good condition, and that norms regarding the participation expected of individual cultivating households are explicit and well observed. There was a tendency in some of the more formally organized systems to transfer routine maintenance responsibilities to irrigation specialists, as is currently frequently being encouraged through P3A's.

5. Organizational Capacities in Water Distribution

i) Introduction. Many IRS villages studied have had long traditions of instituting water control procedures, while others have not. The need for and the extent to which controls are introduced is linked to a number of factors--including the supply of water available relative to demand, cropping patterns and varieties, inter-dependency with other systems and external regulation, technologies utilized and physical layouts, topography, size, etc.

ii) Water Distribution above the Farm Level. The organizational patterns for controlling water distribution among portions of the canal systems, and the procedures used can take place in a variety of combinations. One approach is to allocate water to different portions of a system at different times (and at differing levels, if needed--primary, secondary, tertiary), as is done through rotation (giliran) or staggered planting (golongan). Another approach is to let water flow continuously, but to regulate the amount entering different portions of the system through emplaced concrete/metal division boxes or through seasonally replaceable locally available materials (wooden logs with etches cut into them, cuts of bamboo, banana palm trunks), or some combination of the two.

The *giliran/golongan* approach frequently requires a more sophisticated type of technological/mechanical capacity to open and shut-off water to different components of the local canal network, and often is associated with external agency involvement and with permanently emplaced but adjustable division gates. However, such associations are not automatic. With a *giliran/golongan* system, one can build in flexibility to alter the frequency and timing of rotation to match relative water availability, which places a premium on on-going decision making capacity to adjust to changing conditions. By contrast the employment of emplaced, generally non-adjustable technologies (whether made from concrete or local perishable materials), divides water proportionally--the adjustment process to reduced or increased levels of water within the system occurring automatically. However, some form of consensus is usually required prior to each season regarding the size of openings which channel water to different portions of the system.

The possibilities for a variety of combinations, both across systems, and by season are obvious. For instance, a rotational approach frequently will be used at higher levels of the system (primary, secondary), while continuous flow of water may be practiced at lower levels during specific rotational turns--water being allocated proportionally among the various turnouts through notched logs. Or the reverse may be the case, depending on available technologies. Balinese *subaks*, with their finely developed and intricately tuned technological/organizational arrangements, primarily use a continuous flow approach to water distribution. <u>It is important to note that in contrast to land, water literally is a 'fluid' resource, the control of which is subject to short-term manipulation and potential social conflict. The importance of institutionalizing norms regarding water user conduct, and the role of technology in facilitating such ends is readily apparent--particularly in water short systems.</u>

A key determinant of the extent to which some form of water control will be practiced at any particular time is that of water availability relative to demand. Most systems studied let water flow continuously during the rainy season (*terus-menerus*) throughout the system. During the dry season, on the other hand, many introduce rotation or staggered planting. This institutional flexibility to adapt to changed water conditions is reflected in an interesting practice found in a number of IRC systems. During the early part of the rainy season, when the level of water available in the system is still insufficient for continuous delivery, water will either be rotated or staggered between physical sub-components. As soon as the amount of water flowing down the streams from the hills is sufficient, the village switches to continuous flow. Many village and externally coordinated systems retain this internal organizational flexibility to switch from one water allocation approach to another-in tune with existing conditions.

iii) Water Sources, Local Irrigation Specialists and Water Distribution. The number and kinds of water sources available and the degree to which they are internal or external to village boundaries are important factors which influence the internal organization of irrigation. Villages with numerous sources (one had 24) often link these sources to specific sawah locations within the canal system, either interdependently (in which suppletion may be practiced), or independently. There is a tendency in such situations for decentralization of management functions to occur. By contrast, where water originates from outside the system, and is shared by a number of communities, gate keepers and lower level irrigation personnel play a critical role in determining the extent to which water allocation procedures at local levels can be standardized. Only 20% of systems reported that overall control of water distribution in the sub-project area prior to IRS was exercised by juru2 pengairan (irrigation service personnel), with another 10% having part or full time weir and gate keepers.

iv) Water Distribution to Sawah Holdings. An ideal to which many systems seemed to aspire was that of providing every cultivator with access to a delivery channel, although the need for such a level of development varied. To the cultivator, direct access to a delivery channel by the lead plot in his sawah holding enables him to regulate his water intake without depending on another cultivator's involvement. The potential for inter-cultivator water distribution inequities is higher where a substantial majority must rely on plot-to-plot water flow, and problems of coordination and water-use efficiency crop up. It is considerably more difficult for villages to enforce sanctions and controls regarding water use in systems with poorly developed delivery systems. In areas with hilly, mountainous and uneven terrain, however, there is probably less need for reaching the 100% ideal; plots tend to be smaller and tailored to topographical contours, with accompanying greater speed and ease of water flow from plot-to-plot.

It appears that at least 40-50% of all IRS systems with existing irrigation, at a minimum, delivered water to cultivators holdings primarily via delivery channels prior to IRS. A substantial majority of IRS locations visited or studied in detail reported that 2/3 or more of their cultivators had direct access to irrigation channels. Some reported above 90%. This tendency to find fairly well developed delivery and drainage channel networks in a substantial portion of systems prior to IRS is linked to interactions between topography, ecology, hill-terracing technologies and organization. Of necessity, Southeast Asian hill-terrace complexes have built-in physical and institutional capacities to channel water in and out of mountain streams so as to avoid flooding of lower lying fields during heavy monsoon downpours. At the same time they retain the capability to channel water from plot to plot, in order to make maximum use of existing supplies when needed.

IRS systems differed substantially in the extent to which water entering individual sawah holdings was subject to regulation, with the kinds of technologies used also varying. In many systems few controls were exercised during the rainy season, while during the dry season some form of regulation would be introduced. In some locations cultivators simply opened and closed earthen-walled dykes on delivery channels. However, informal agreements might specify limits on the depth of standing water permitted in the rice terraces (depending on water availability and the phase in the cultivation process.) A fairly high percentage used short lengths of cut bamboo to channel water out of canals or farm ditches into their fields. The size of the bamboo openings were sometimes roughly proportional to the size of the sawah holdings. A relatively small minority of locations had extremely tight controls, with the emplacement of wooden notched troughs or pieces of bamboo regulated by irrigation specialists according to strict measurements.

The extent to which some communities attempted to use technology to build equity into water distribution is reflected in a 400 hectare IRS mountain system in West Java. The emplaced wooden (cowal) troughs regulating water entry to plots were carefully measured and controlled by village irrigation technicians. Most interesting was the fact that the size of openings in the lower parts of the system were $1\frac{1}{2}$ times larger per unit area of sawah holding served than those in upper reaches. The differing ratios among portions of the system signified an effort to compensate for intra-system variability in the speed and depth of water flow. In short, cutting across most IRS systems studied in detail there was an underlying principle of proportional water delivery and generalized equity. The degree to which this principle was strictly regulated, however, varied widely--often linked to the kinds of technologies used.

6. The Organization of Agricultural Production Prior to IRS

i) Introduction. In most IRS locations the organization of agriculture centered around the household as the primary social unity of production. There was a fairly distinct sexual division of labor in rice cultivation, with women carrying out the more labor-intensive tasks. While the household acted as the primary production unit, the cultivation of rice frequently was subject, in part, to group processes of social control--particularly with reference to the selection of varieties and the timing of planting. Such controls were more apt to be found in locations where villages regulated water distribution, and more frequently in dry than wet season cultivation. Community level decisions on cultivation patterns, where made, usually were taken in conjunction with decisions regarding the planning of irrigation schedules. From the standpoint of the peasant, irrigation and cultivation activities were interrelated, not simply because of the interdependency of their organizational requirements, but also because they were part of the web of cultural perceptions regarding the cosmological ordering of ecological-social processes. According to these views, harmony in social processes (including the management of water) was linked to harmony with ecological rhythms in a reciprocating fashion.

ii) The organization of cultivation after the introduction of HYV's. In most of the villages studied in detail, government agricultural extension programs have had a profound impact on cultivation to the extent that most farmers plant improved rice varieties on a portion of their holdings. Yields achieved are often comparable to those found in more technologically sophisticated irrigation systems. In a number of locations, the introduction of improved rice varieties increased the demand for improved water control. Likewise, cultivation decisions have become more subject to village processes of consensus decision making. Only 26.1% of 448 responding communities reported that rice cultivation was not regulated in some way, and many of these communities undoubtedly were among those which did not yet have functioning irrigation systems.

7. Financial Capacities of Communities in Irrigation

i) Ongoing financing of operation and maintenance. Voluntary labor contributions by cultivators represented the primary input into the ongoing operation and maintenance of local irrigation. In most systems where irrigation specialists were present, and where they were not given special allocations of village land for use while in office, the received payments from cultivators for irrigation services rendered. These payments consisted either of a small portion of the rice yield (ranging from ½% to 1%), or more commonly 25 kg. to 50 kg. per hectare of dried stalk paddy (gabah kering) paid at harvest time on a seasonal basis. When harvest yields were unusually low, the payments were reduced. The willingness of vultivators to make such payments largely stems from the fact that the transactions were internal to the village, sanctioned by custom, flexibly implemented and were for past services rendered.

ii) Financing Construction or Repair. Some communities undertook major construction activities which required local financing--collected on the basis of specially assigned levies to each cultivator (based on land-holding sizes). On occasions communities also called on residents for financial contributions to help repair damaged structures. A few of the more organized irrigation systems kept contingency funds for such activities which represented a portion of the routine O & M payments. For the most part, however, the weak financial base of villages limited technological improvements that could be taken to upgrade the irrigation systems. Most villages with existing systems took advantage of the annual subsidi desa contributions to make incremental improvements to local irrigation structures. These included installation of concrete division boxes and the lining of canals. It seems fairly clear that the existing needs as well as community capacities to upgrade systems are usually considerably greater than the incentive funds available.

D. TECHNOLOGY, PHYSICAL LAYOUT, ORGANIZATION AND IRRIGATION PERFORMANCE: EXISTING IRRIGATION NEEDS AND POSSIBILITIES PRIOR TO IRS

1. Introduction

In Section C an attempt was made to indicate the organizationally diverse ways in which Sederhana communities managed the ongoing operation and maintenance of their relatively small (and primarily community) irrigation systems prior to IRS. It was argued that under the technological, ecological and socio-administrative conditions found in many IRS locales, village organizational capacities in irrigation were considerably higher than those found in major state operated lowland systems. This was in large measure due to the fact that in many of these smaller systems the linkages between inputs and outputs, cultivators and irrigation authorities, environment and technology, and needs and organizational capacities are direct and more easily maintained than in larger, centralized systems.

This distinction between (1) state supervised and centralized systems which cover large areas and numerous villages and (2) relatively decentralized or autonomous systems has been observed elsewhere. Students of irrigation organization have noted that locally managed and technologically simple irrigation schemes are usually more responsive to ecological and organizational requirements and needs. They therefore are usually more stable over time than integrated, elaborate systems which tend to 'over-develop', are less responsive in adjusting to environmental alterations, and periodically undergo phases of organizational dislocation and ecological degradation. While the reality of Sederhana irrigation systems may depart from this idealized contrast, it is important to recognize that the relative autonomy of these systems and the conditions which perpetuate this autonomy are major determinants of organizational performance which should be promoted, not undermined.

The preceding observations, however, should not hide the fact that there undoubtedly was considerable variation among IRS systems in the effectiveness in which irrigation tasks were carried out, just as there were variations within systems. In other words, there were existing needs, both technological and organizational, which if addressed could improve the productivity and equity of irrigation performance. In the remainder of this section, an attempt will be made to consider these needs and constraints as a background for evaluating the impact of IRS in addressing them.

2. Technological Constraints: Diversion Structures and Canal Systems

1) Diversion weirs. As previously indicated, the perishable nature of many community diversion weirs left them vulnerable to damage or destruction during heavy monsoon rains. Damage or destruction to these weirs caused system wide complications in water delivery, sometimes during crucial periods in the rice cultivation cycle. This is to say nothing

about the work required to repair them. Furthermore, these weirs frequently were less efficient in trapping and delivering water than more permanent concrete/masonry structures as a consequence, in lower lying portions of systems water availability was sometimes unreliable during the dry season, if available at all.

ii) Canal Networks. Some irrigation networks needed further elaboration of major canals. Others needed more extensive development of delivery channels. Frequently these needs were potential, that is, they came to the surface following the installation of more permanent diversion works with greater water delivery capacity. The potential payoff from the lining of canals was often high in locations where existing ones were made of porous soil and liable to damage, resulting in conveyance losses which limited water available to the lower portions of the irrigation systems. In some systems where inter-canal rotation was not possible given existing technologies, the emplacement of concrete-mechanical division gates at canal intersections could open up rotational possibilities, and thus improve the effective water delivery capacity of the networks. Finally, a number of existing concrete structures (weirs, division gates) were damaged and poorly functioning, causing water distribution complications. These included both those under Irrigation Service and community jurisdiction.

3. Administrative-Organizational Needs and Constraints

i) Inter-community distribution/maintenance problems. In a number of locations, where outside (usually Irrigation Service) coordination of water distribution and maintenance were required, these tasks were not being carried out effectively. A number of systems studied in detail reported inattention to the upkeep of major works that nominally were outside the jurisdiction of specific villages. Where these structures (usually primary or secondary canals) clearly served a distinctive component (or village) within the larger system, local community initiative was frequently (although not always) forthcoming. But where such demarcations were less clear, or where it was beyond the capacity of the villages concerned to handle the repair required, there were distinct negative outcomes for local irrigation performance.

The difficulties arising from lack of attention to maintenance by external parties are even more apparent when they complicated water allocation among competing villages or sub-systems, as was reported in some locales. In some locations intervillage water distribution was adequately coordinated, but in others, certain sections of the system were favored over others--either inadvertantly or deliberately. The likely result included lack of enforcement of regulations and a rise in illegal actions by cultivators to tap water out of turn--usually at the expense of less favorably situated locations within the canal network. Organizational capacities within villages were much more difficult to maintain under these circumstances, since cultivator adherence to local norms regarding water rights and maintenance responsibilities usually presupposed an expectation of general equity within the system.

ii) Organizational difficulties within villages. It seems clear from the case studies and field visits that where community interests were threatened as a whole, or where maintenance was structured (such as during the 'turun ke sawah'), repair and upkeep activities were effectively implemented, to the extent village technical/financial capacities allowed. The requisite leadership with accompanying community participation usually was forthcoming. But in less formally instituted irrigation activities such as routine upkeep, some systems reported shortcomings.

It is apparent that the interests of cultivators from different sections of systems are not always the same. The negative consequences of inattention to routine maintenance in upper portions of irrigation networks usually are felt more keenly by cultivators in lower lying sections. Several examples were encountered of 'tail end' cultivators taking the initiative to clean sections of canals that were the responsibility of others.

It is a matter of interest, therefore, to consider whether organizing cultivators in smaller units, and around distinct physical components of irrigations systems, improves the performance of routine maintenance and water distribution tasks. This is the approach being pursued by the Department of Agriculture in its P3A organizational activities. It assumes that water user groups organized around distinct sub-components of canal networks are likelier to have common interests that can be more effectively articulated than when they are organized on a community wide basis only. Systems organized in this way usually are likelier to have greater flexibility in adjusting to needs which vary throughout the canal network--the feedback linkages between inputs and outputs are in effect being shortened further. The capacity to disaggregate irrigation tasks organizationally does not preclude the capacity to shift to a more aggregated form when conditions so require.

In smaller more homogeneous systems the need for such decentralized organizational forms may not be as readily apparent, with community pressure and custom sufficing to ensure responsiveness to routine irrigation needs. But in larger, more differentiated systems, there may be fewer incentives for irrigation specialists and leaders to give direct attention to lower lying portions. The physical layouts associated with the technological apparati of many IRS hill systems tend to demarcate natural groups of water users, and in many cases informal patterns of cooperation already exist. There seems to be some logic, therefore, in formalizing such units in accord with the organizational approach outlined above.

It is interesting to note that several IRS systems had made deliberate attempts to balance potentially conflicting interests within systems by taking into account interactions between physical layout and organization. The most illustrative case is that of a transmigrant village in Lampung, which constructed a 100 hectare community system during a four year period in the early 1970's. The physical layout of the system was arranged so that each cultivator had access to a delivery channel, and so that groups of peasant holdings encompassing 10-15 hectares could be formed around specific outtakes. Most noteworthy, the ulu-ulu was deliberately selected from the lower end of the system, or shall we say, put there. In similar fashion, the leaders of the 10-15 hectare sub-units and their assistants also were required to come from the lower ends of their respective sub-systems. By taking cognizance of technology and layout, the village was able to balance the personal interests of persons holding irrigation authority with the interests of the community at large and those of 'tail-end' cultivators.

E. IMPACT OF SEDERHANA ON LOCAL IRRIGATION PERFORMANCE, INSTITUTIONAL CAPACITY, AGRICULTURAL PRODUCTION AND EQUITY

1. Introduction

This analysis so far has concentrated on outlining the parameters which influence irrigation performance in the small irrigation [illegible] which characterize IRS. Its underlying assumption has been that if local institutional capacities to carry out the on-going management of IRS systems can be strengthened, then there is a better chance that productivity and equity goals will be attained over time. It is not possible to consider the impact of the program in the space allotted here in detail--that will be reserved to an annex section. An attempt will be made, however, to highlight the consequences of IRS project implementation upon the capacity of communities to manage their own irrigation affairs in a productive and equitable fashion, considering both the activities undertaken and the manner in which they were implemented. Given this focus and purpose, [illegible] be directed primarily to locations where irrigation systems are currently functioning, leaving the analysis of non-functioning projects to other portions of the evaluation report.

2. Impact of IRS on Construction/Maintenance Capacities

1) Technologies introduced by the government. The kinds of technologies introduced through IRS consisted primarily of some form of more permanent concrete/masonry or gabion weir (80% of all projects), construction of canals and the emplacement of concrete division gates. The [illegible] of previous village works is seen by the fact that where IRS [illegible] diversion weirs were built on existing irrigation systems [illegible] the cases they were built over village weirs. Even more [illegible] canals often followed existing channels, or were constructed [illegible] them.

ii) Impact of Technologies on Maintenance Capacities. The data from the agriculture survey report slight reductions in the frequency with which maintenance and repair was carried out. In the more detailed socio-institutional survey, where structures constructed were in place and functioning, farmers indicated substantial reductions in the frequency and amount of work required to repair weirs first of all, and to clean silt out of canals. This reduction in labor inputs required to keep local portions of the system in working order was felt most strongly in some of the lower portions of systems, where maintenance tasks previously often were more burdensome.

In a number of locations the construction of more permanent works was accompanied by greater Irrigation Service responsibility for maintaining structures. In a substantial majority of the locations surveyed, it was indicated that these responsibilities were not being carried out, and that village initiative was required to ensure that primary and secondary structures were kept in good condition. To the degree that communities were capable of undertaking such tasks, such a state of affairs has its benefits --it perpetuates village autonomy in irrigation and lessens the dependency on external parties. However, where the canals crossed village boundaries, the need for a stronger coordinating role was apparent.

In a minority of cases, critical problems arose in connection with improperly functioning or damaged weirs, which villages did not have the capacity to repair, and which were neglected by the government. Such an example occurred in East Java, where a new weir lessened the water supply available to 25 hectares of lower lying paddies for two seasons. The weir was finally made functional only after repeated efforts on the part of the community involved. In several other locations, imperfectly constructed and incompleted major structures left no impact, one way or the other. It is important to note, however, that the replacement of [illegible] (which can be repaired by community action) by permanent structures [illegible] an element of dependency into the local irrigation [illegible]. If the government is unable to maintain a continuing [illegible] structures are repaired when needed, the irrigation [illegible] may be undermined. The potential seriousness of this problem is seen by the fact that of 435 locations reporting, [illegible] considerable or major damage to headwork structures within a few years, [illegible] reporting substantial damage to the more easily repairable [illegible] works.

3. Impact of [illegible] on Water Distribution Capacities

i) Technologies Introduced by the Government. [illegible] technologies were introduced (division gates, weirs, [illegible]) and [illegible] upgraded (reopening of canals, replacing [illegible] structures with similar technologies) varied considerably. [illegible] can be drawn regarding their impact, [illegible] substantially outweighed negative [illegible].

ii) Impact of technologies on water distribution capacity. There are difficulties in evaluating the agriculture survey data on impact of [illegible] construction activities on water supply conditions. This section differs with the economic section in its interpretation of the percentage of locations benefitting from additional water which come from construction activities--here estimated at between 50% and 55%. (The different estimates in part arise from differing interpretations on how to handle the 'no responses'. Of greater interest is the question of the impact of water availability within the communities already having irrigation systems. Of those reporting improvements during the rainy season, 80% reported modest gains, while 20% reported substantial gains. A substantial proportion reported no change. Similar conclusions apply to the dry season. What is most significant for our purposes is the fact that the distribution of these benefits, where they occurred, tended more than proportionately to benefit the lower more disadvantaged portions of systems than upper ends, thereby increasing equity in the system. These benefits took place either in the form of improved water availability for existing irrigated areas, or the extension of new areas. In part, as we shall discuss later, such benefits occurred in conjunction with improved organizational capacity resulting from extension efforts.

It is significant to note, however, that from 7 [illegible] locations (at a minimum) reported that the availability of water had worsened following the implementation of the subproject--in many cases these [illegible] faulty construction. From conversations with the local consultants and visits to the field this problem appeared to be fairly widespread. A frequent complaint heard was that the replacement canals constructed over existing village channels had been dug too deep. Farmers no longer could draw water directly from the channels, and were forced to rely on more distant turn-out points, switching to field-to-field flows. In some cases the problem was temporary, pending the construction of new delivery channels--in other places, farmers were stuck with a worsened situation, and [illegible]. These water distribution problems again point to the importance of a contingent government capacity to undertake repairs [illegible] where such repairs are the result of the shortcomings of [illegible] or damage by floods and are beyond the capacity of villages to [illegible].

iii) The elaboration of tertiaries. In most of the [illegible] improved technological capacity to distribute water resulted from [illegible] extension efforts, the major initiative to translate these [illegible] into reality seems to have been taken by the communities [illegible] individuals as well as in groups. This included both the [illegible] and the elaboration of tertiaries. In a number of [illegible], the agricultural service appears to have performed a useful [illegible] in conjunction with its activities to assist in the formation of [illegible] (WUA's). The degree to which tertiary delivery systems were further constructed can be seen from the fact that only [illegible] reported receiving water on a field to field basis. [illegible] relied primarily on direct access by cultivators to [illegible] channels, including [illegible] where delivery systems were present prior [illegible] and 28.7% where they were developed or intensified subsequently. The [illegible] locations consisted of 11.4% where tertiary construction was undertaken without guidance, and 17.[illegible]% where guidance was present. These findings, to the degree they are accurate, are consistent with our earlier discussions regarding the irrigation institutional capacities present within IRD communities.

iv) Water allocation procedures. Some systems reported improved capacity to undertake control of water distribution following the installation of new mechanical technologies and the formation of P3A's. For the most part, such controls continued to be managed by the communities involved--although irrigation personnel were involved in 25% to 30% of the cases. Problems emerged in some locations where water allocation, whether through improperly functioning and damaged technologies, or lack of attention or bias on the part of external personnel, was not allocated effectively between sub-systems.

v) Water supply situations. Approximately 70% of IRD locations with functioning irrigation systems reported that their water supply during the rainy season was reliable and adequate. Only 15% reported intermittent and unreliable supplies. Of the reduced number of systems getting water during the dry season, however, only 15% reported reliable and adequate supplies, 55% reported reliable but less than adequate supplies, and [illegible] reported intermittent and unreliable supplies. The problems of water shortage during the dry season help to explain why most locations introduced some form of water control. Over two-thirds employed [illegible] giliran (rotational) methods of water allocation, although staggered planting (golongan) was also practiced.

4. Impact of IRD Implementation procedures on local institutional capacities, including the formation of water users [illegible] (P3A's).

i) Introduction. A major goal of IRD as expressed [illegible] senior irrigation official responsible, is to encourage target [illegible] to have a sense of 'participation, belonging and responsibility' for the ongoing development of their irrigation systems. As has been demonstrated, existing and potential capacities for reaching this objective are [illegible]. How projects are implemented, including the formation of viable water users associations where needed, will be important factors determining the [illegible] to which these ideals can be attained.

ii) Water Users Associations. To date, the [illegible] the Department of Agriculture, working under the guidance [illegible] have been the key [illegible] in assisting communities to form P3A's. [illegible] [illegible] has been mixed--although when placed in the context [illegible] [illegible], fairly good. P3A's have [illegible] been formed in [illegible] [illegible], with [illegible] reporting actively [illegible] [illegible]. This is not to suggest that in locations where [illegible] operating effectively, O & M is not being carried on adequately. The need for P3A's, just as the need for formal organizations in irrigation, varies among the IRS systems. <u>The goal, therefore, should not be to form a specific type of water users organization, but rather to strengthen the capacity of communities to carry-out the ongoing management of their own systems.</u>

There have been a number of impediments which have delayed progress in forming P3A's, chief of which is the fact that in approximately 45% of the projects water is yet to be received. The process of organizational formation is a slow and tedious one, with no instant guarantees of success. The flexible approach being pursued by the Department of Agriculture in attempting to adapt to local conditions is an appropriate one. Its field level personnel demonstrated considerably deeper understanding of the dynamics of peasant irrigation systems than Irrigation Service *kabupaten* level personnel--which is to be expected, given the more intensive involvement of the former with peasants on a regular basis. There still are a number of issues that need to be worked out. Doing so will take time and experience.

The approach of the P3A's, as outlined in an earlier sub-section, is one of supporting the formation of water user groups organized around distinct sub-components (such as quaternary canals) of irrigation systems. <u>If these organizations are to continue to expand and be viable in the future, however, it is critical that they be formed prior to construction at the tertiary level, and that they have a major input in determining the degree to which further elaboration of field level delivery networks are needed, and where they will actually be emplaced.</u> Given the close link between physical layout and organizational possibilities this early role is critical.

iii) <u>Government implementation procedures</u>. In the past, a number of problems emerged from IRS implementation procedures that did not allow for participation by intended beneficiaries. For instance, in the early stages projects were often dropped on communities without preliminary consultation of plans--some 55% of project reported no plans were discussed, and in another 22%, beneficiaries were not permitted to interject regarding the plans. The major implementing agency has changed its approach and taken a number of positive steps to ensure that projects will in fact be desired by communities, and allow for greater participation. As a number provincial officials noted, the manner in which communities are approached from the start will go a long way in determining the degree to which they subsequently will be willing to take on management responsibilities, and the degree to which they will tend to rely on the government. The direct ties between these implementation procedures and the potential for P3A formation are obvious.

The previous observations call for a very flexible approach on the part of implementing agencies--one in which accommodations are made for local capacities. Such an approach is more demanding in the short run, but with considerably higher payoffs in the long run regarding IRS institutional, productivity and equity objectives. By helping to perpetuate conditions which encourage local initiative and responsibility, the government's provision of selective technological and organizational inputs should strengthen the institutional resiliency that many of these systems already have.

5. <u>Beneficiaries</u>

i) <u>Introduction</u>. The 517 Sederhana projects from the first three years of IRS (1974/75-1976/77) are geographically dispersed throughout the Indonesian archipelago, spanning 24 of 27 provinces, and with 80% of the locations situated outside of the island of Java. The primary beneficiaries of the projects are the rural agricultural communities (or groups of communities) involved in rudimentary or prospective irrigation systems that underwent technical/organizational upgrading or construction. For the most part these communities fall in the government of Indonesia's target group for rural development activities. If we use measurement criteria established by the Ministry of Interior to classify villages in terms of their stages of development, 41% of IRS locations fell in the least developed category, 55% in the beginning to develop category, and only 4% in the comparatively well developed category.

From the standpoint of social and economic amenities, educational facilities and accessibility, these communities also were priority areas for government development activities. Average rice holdings, while larger than in some of the very densely populated regions of Java, were still comparatively low at 0.3 to 1.0 hectares per cultivating household. While precise estimates are not available, it is reasonable to assume that 80% to 90% of the households fall below an annual per capita income figure of $150. From sample villages studied in the socio-institutional survey, less than 2% of the households had electricity.

The geographical dispersion of project locations means that IRS encompasses a diversity of cultures, local languages and ethnic groups. It is not possible to treat such diversity in detail here.

ii) <u>Distribution of benefits</u>. The question of how benefits are distributed within the local community (or within the specific irrigation systems) is an important one. In many of the major state operated lowland systems rehabilitated under World Bank funding, beneficiaries tend to come from the rural elite. In the Sederhana projects studied in detail, it was noted earlier, those most directly benefitting tended to come from the lower portions of systems which previously were more difficult to irrigate. This observation is not meant to suggest that improvements initiated under IRS eliminated locational inequities within systems, but they often tended to narrow gaps. In locations receiving irrigation for the first time, the provision of outside technologies sometimes permits the delivery [illegible] to more distant holdings that indigenously constructed works cannot reach. Clearly there are exceptions to these generalizations--what is being emphasized here are the overall trends.

In this evaluation it has been emphasized that the parameters associated with small irrigation systems, such as characterize IRS, are such to encourage greater responsiveness to water user interests than often found in larger systems. There were, however, shortcomings and needs, which the upgrading of technologies and the promotion of organizational modifications emphasizing participation in smaller water user groups attempted to address. Sederhana activities, accordingly, were geared t ensuring that intra-system feedback linkages between inputs and outputs continued to be maintained.

In looking further into the question of who benefits (whether from extension of irrigated land or increased intensity of cultivation on existing land), it is important to note that the percentage of landless households in the more isolated villages which characterize IRS is considerably less than in some of the heavily populated lowland regions of Java. Eighty percent of the IRS communities reported having few if any landless laborers. In only 15% of the villages did landless households exceed the number of cultivating families.

Given comparatively low levels of landlessness, one can assume that the provision of benefits to cultivating households for the most part did not exclude any major sectors of the village populace. Where landless households were present, they probably benefitted from (1) direct employment in the construction activities initiated through IRS and (2) increased employment in land preparation, transplanting and harvesting activities--all group activities, in which landless laborers tend to participate.

Estimates of the economic benefits from the Sederhana program have been presented in Section IV.

iii) Role of women. Women have been and will continue to be major beneficiaries of IRS projects, both through additional employment opportunities created in rice production as well as by their role as managers of the domestic household economy. Allowances must of course be made for the differences which arise out of the diversity of cultural regions represented by Sederhana locations, including parts of Sumatra where matriarchal social forms are present.

In general social relations of production in rice specify major roles for women in the most labor intensive rice production activities--transplanting and harvesting--for which wages in cash or kind are usually forthcoming. There is a tendency for women to manage food crop production and for men to manage cash crops according to informants. Data from the IRS projects, however, indicate fairly substantial participation by women in non-rice production/income earning activities participated in by men. These include upland cash crops, tree crops and fishing. More exact breakdowns of employment activities for both men and women are not available from current data. Women do not exercise a major role in irrigation and cultivation decision making processes, but they do hold considerable influence in determining how benefits will be used.

iv) Conclusion. In sum, for the most part the socio-economic and cultural characteristics of communities involved in the Sederhana program are such to ensure that benefits will be broadly shared, or at least not structurally excluded from specific sectors of the local populace. This is in part a result of the technological and organizational characteristics associated with the primarily community oriented systems. Improvements introduced by IRS construction and organizational activities (in communities studied in detail) tended to benefit more than proportionately those locations which previously had greater difficulty in getting water. Local institutional capacities to manage irrigation systems productively and equitably were usually promoted, not undermined.

SECTION VI. ENGINEERING EVALUATION OF THE SEDERHANA PROGRAM

I. APPROPRIATE CHOICES OF TECHNOLOGY, DESIGN AND CONSTRUCTION

This section of the evaluation deals with the civil engineering aspects of the program including construction of major works, on-farm development and operation and maintenance.

A. DIVERSION STRUCTURES

Gabion, masonry and concrete weirs

Of the twenty-five Sederhana subprojects visited by the team, only two or three of them had masonry or concrete weirs. These generally appeared to be sound structures with no problems. However, one of the structures had low strength concrete that will deteriorate rapidly.

The diversion structure with the few exceptions mentioned above, consisted of masonry abutments and headgate walls with gabion weirs. Seepage under, through, and around the weirs was noticeable on every gabion structure visited and often it was a serious problem. The SUNGKAI subproject in South Kalimantan is a good example of what can happen with gabion weirs on streams having small flows. This is a 1974/75 subproject with a target area of 108 hectares and a cost of Rp. 7.9 million for the major works. According to local officials, little or no water delivery has been made to the farmers since the major works were built because most of the stream flow is being lost to leakage through the gabion weir. The weir is 10 meters wide and over 3 meters high, which is higher than the maximum recommended height given in the Design Manual prepared by the consultant.

Because seepage is such a prevalent and serious problem with gabion weirs, every precaution should be taken to reduce it to a tolerable minimum. The prevention of seepage should begin at the design stage and be followed on through construction, operation, and maintenance. This is especially true where the stream flows are small or where there is a shortage of water supply. Excessive seepage through gabion structures can be caused by the placement of oversized stones, especially in bottom layers, of the gabion cages. Sometimes the cages are filled with stones which are smaller than the cage openings and they are subsequently washed out by the force of the water. If the cages are not filled completely, the sides and top collapse or bulge and the designed shape and size of the weir is not maintained. This may also cause excessive or uneven settlement of the gabions. Finally, it is important to tie all the gabion cages together in order to have a sound structure which is essentially one unit.

All the gabion weirs observed had been in place for the relatively short time of two to four years. Already several were in need of minor repairs and a few needed major repairs. The defects could be caused by several things including: (1) inadequate field investigations and survey data resulting in poor design, (2) poor construction methods and materials, and (3) lack of timely maintenance. It is imperative that more emphasis be placed upon providing for better supervision of construction and closer adherance to the specifications.

Gabion structures are not a long-lived type of structure for use in diverting water for irrigation systems. Since Sederhana funds are limited, the opting for a least cost structure such as a gabion weir, may, in the long run, be the most expensive and unsatisfactory approach that can be used. Such an approach may result in structural failures, expensive replacements, excessive maintenance problems, and the possible abandonment of the subproject.

Piping and foundation failures

Piping and foundation failures are likely to occur on diversion structures constructed on permeable foundations particularity if seepage control is not provided. An example of this problem is seen in the AEK SIMARE subproject in North Sumatra which cost Rp. 15,000,000 to construct. The diversion structure abutments on this subproject failed only one month after their completion because of piping under the abutments. Assistance was then requested from the consultants to redesign the weir. After making foundation investigations of the area a new weir will be built upstream at a location having better foundation characteristics.

Sluiceways

The sluiceways on some subprojects were not effective. This was especially true on streams which transport large amounts of gravel and large stones during floods. In some cases there was insufficient head on the sluiceway to remove the gravel and the large stones had a tendency to wedge in the sluiceway opening. In other cases the sluiceway was located so that there was insufficient flow to flush out the debris. Regular maintenance is required to keep the sluiceway free of obstructions, expecially during flood flows. This may require daily maintenance for short periods.

It is recommended that as soon as the Design Manual for Diversion Dams, Canals and Drainage Structures being prepared by the Consultant is available, the design criteria in that manual should be followed in the design of diversion dams and sluiceways.

Site preparation, backfilling, and compaction

On a number of subprojects there were cracks, some quite large, in the masonry abutments and wing walls of the diversion structure. This was particularly noticeable where the masonry wing walls were placed on a sloping subgrade that was backfilled. Several things must be considered in order to avoid excessive settlement around and under the structure including: site preparation; clearing; stripping, based on foundation investigations; backfilling; and, most important of all, proper supervision and inspection of the construction by Provincial or Section Public Works inspectors. Site preparation is often neglected or unsatisfactorily and where the ground surface is not suitable for foundations or embankment, it should be removed. Foundation investigations may be needed to determine how much should be removed. Only selected material, free of vegetation and rocks, should be used in making the backfill.

Proper compaction is the most important factor in backfilling around structures and in constructing embankments and dikes. However, compaction appears to be deficient in much of the construction work on the Sederhana subprojects, especially around structures. An inspector should be on the job at all times when fill work is in progress in order to control the quality of the work. In order to ensure optimum compaction, the approved material should be placed in horizontal layers not more than 15 cm in thickness.

B. CANALS, MAIN AND SECONDARY

Canal Alignment and Grade

Canal alignment is not a serious problem on most Sederhana subprojects. However, field survey methods are often inadequate and of questionable accuracy, causing design changes and subsequent delays in construction. Not enough centerline elevations and corresponding cross-sections are taken in the field surveys to show all the slope breaks and changes. This results in a plan of the system of canals and structures that does not fit the topography of the existing land and which has to be corrected in the field by those making the construction surveys.

In discussions with Public Works personnel, it was learned that they find inaccuracies of a meter or more in the survey work on many occasions. Not only does this cause problems in construction staking, but cost estimates are also based on those poorly made surveys.

Steps should be taken to ensure that survey and design contractors produce a reasonably accurate survey, especially for topographical mapping and that the Provincial Public Works offices have qualified survey personnel to field check the Contractor's surveys.

Also, it is important to see that the contractors are qualified to furnish acceptable designs for an irrigation system. On the Kekelae subproject in Central Sulawesi, the design contractor developed a plan which called for 193 two-meter masonry drop structures. A far more practical and cheaper approach would be to use masonry canals or long chutes on the steep slopes with energy dissapators at the lower end. The Section Chief was in the process of redesigning the system to use masonry lining.

Canal Structures

The most commonly used structures on the Sederhana subprojects are masonry vertical drops, division boxes and turn outs. Other structures used are checks, culverts, chutes and inclined drops. Generally speaking, the canal structures have not been a problem on the Sederhana subprojects except that often they are larger and more complicated than they need to be.

The biggest problem with canal structures is where field surveys are inadequate and some of the structures have to be relocated. Documentation needs to be stressed. Without some sort of documentation there is no way to prepare and submit "As Built" plans for certifying quantities for payment or reimbursement.

The Masonry workmanship appeared to be reasonably good, but some of the structures have cracks in the wing walls which are laid on inclined slopes because of the backfill being improperly compacted. Lack of proper compaction is another prevalent problem with the structures. Often the backfilling is done with poor materials and is not compacted according to specifications. Then a few weeks after the work is completed, especially after heavy rains, backfill begins to settle and the structure cracks. Constant supervision and inspection by qualified personnel is one of the most important factors in obtaining good construction results.

It is recommended that the design criteria in the Design Manual for Canal Structures as prepared by the Consultant should be used in designing and writing specifications for structures. Further a set of drawings and specifications should be provided to construction inspectors in order to upgrade quality control and standards.

Canal Construction

Excavation work on canals is not always done according to the plans. In some cases the excavation only approximately follows the surveyed lines and sometimes no grade stakes are set. The canal grades are checked by use of a plastic pipe full of water which is not practical for long distances or for setting grade stakes. More surveying equipment is needed, including simple hand levels. Qualified survey personnel in the Public Works provincial and section offices are needed for checking the work done by contractors and for construction staking.

C. ON-FARM WORKS

Tertiary Canal Systems

Tertiary systems can be considered as a planned terminal system. Traditionally in Indonesia the irrigation water on the farm is distributed paddy to paddy or farm to farm. Generally, the irrigated subproject is divided into tertiary blocks of from 100 to 150 hectares. A further subdivision of the tertiary blocks are the quarternary blocks of 10 to 15 hectares. It is at this level where the traditional methods seem to be most prevalent, especially in the steeper areas. Almost/subproject distributes water in this manner which demonstrates that tertiary systems are not necessarily a must, especially on the steeper sloping lands. Equitable distribution of water is being accomplished by paddy to paddy distribution. Tertiaries should be added only where and when they are needed with the periods of water shortage being considered to determine whether or not a tertiary system may be needed.

Work accomplishments to date on tertiaries is of poor quality for the most part and is far behind schedule. One of the difficulties facing officials is that the farmers do not want to give up their land for tertiary canals, particularly when they do not receive any cash compensation. Where clearing, leveling and paddy forming has been done by the farmer it is understandable why they do not want to give up any portion of their land. However, the construction of tertiary systems to achieve greater command of the tertiary blocks has commenced on a few of the subprojects. The Rural Irrigation Service (RIS) at The provincial Agricultural offices have not been able to expedite the tertiary canal programs because of budget porblems and shortages of manpower. The technical staff needs more of certain types of equipment in order to perform the farm-level implementation of Sederhana subprojects. They should be provided basic, light equipment such as surveying equipment, drawing equipment and planimeters. Although they have a quantity of inspection jeeps and motor bikes, additional vehicles will also be needed in order to expand the implementation of subprojects.

Procedures are needed to regulate use of irrigation water prior to completion of the on-farm systems. Unauthorized cutting of the canal embankments and use of bamboo piping through the embankments should be discouraged. However, the emphasis should be on getting water to the farmer as soon as possible.

D. OPERATION AND MAINTENANCE OF THE IRRIGATION SYSTEMS

The objective of operation and maintenance (O & M) on Sederhana subprojects is to ensure the equitable distribution and optimum use of irrigation water by properly operating, maintaining, and constructing improvements to the system and its facilities.

The large majority of Sederhana irrigation subprojects cover an area of between 100 and 2000 hectares. Almost all of these subprojects include irrigation, but a few involve swamp reclamation. The major works constructed for each subproject generally include a small diversion weir, a sluiceway, canal headgates, unlined primary and secondary canals, control or check structures, turnout structures and division boxes. Also there are waste or drainage ditches and related structures where needed.

The diversion weir is usually either gabion type or river stone masonry. Such structures, especially the gabion type, are expected to have a relatively short life (5-10 years). However, it is Public Works' intention to convert these semi-permanent structures to more permanent ones by additional improvements when the irrigation area served is more developed.

Efficient operation of the systems can be expedited by the following: (1) Construction of control structures for water delivery such as checks and gated turnouts at designated delivery points and the ultimate closing of all other breaches in canal embankments including farmer-made turnouts and diversion structures; (2) Construction of farm ditches leading from these designated turnouts; (3) Installation of water measuring devices; and (4) Construction of drainage facilities.

Some of the maintenance problems observed on the subprojects are slides, erosion, siltation and flood damages. Slide areas may be found where there are deep cuts or high slopes on either or both sides of the canal. Steep slopes may need to be flattened. In some situations a series of benches may be required to relieve the condition or ven a diversion dike or ditch. In extreme cases it may be necessary to install culvert pipe for carrying water through the danger area. Eroding or sliding areas within the canal periphery may require that the canal be lined in order to correct the situation. As a result of the siltation taking place under some of the existing conditions, many canals will need maintenance on a regular basis, especially where they are constructed through light, sandy soils.

There have been some instances where damages have occurred to the upper reaches of canal systems because the canal intake gates were left open during periods of flooding. The intake gates should be kept closed all during the threat of flooding unless there are full time gate operators on duty.

It is difficult to obtain data on maintenance costs and what is available had little supporting evidence. There are no completed and functioning Sederhana subprojects on which a concerted maintenance program is being carried out, and there is virtually no data available on maintenance costs.

Reports indicate that only Rp. 2000 per hectare were budgeted for operation and maintenance. However, studies several years ago by the World Bank and the Ministry of Public Works show that Rp. 3500 to Rp. 3800 per hectare are required for proper maintenance. In recent joint meetings of the consultants, Agriculture and Public Works field personnel it was strongly suggested that operation and maintenance budgets should be increased. The suggested figure was in the range of Rp. 5000 to Rp. 10,000 per hectare.

The best approach to funding operation and maintenance costs may be a temporary subsidy until such time as the responsibility can be taken over by the farmers or water users associations.

E. EXISTING CAPACITY AND PROCEDURES USED FOR IMPLEMENTATION ACTIVITIES

Planning, designing, and drafting

More careful planning and designing is needed to avoid major design modifications. Upgrading of drafting standards and improving techniques of the Provincial Public Works designers and draftsmen should be stressed to strengthen their capabilities.

Drawings which are common to all subprojects should be used as much as possible, especially on canals where turnouts, drops, chutes and masonry lining are called for in the plans. Structural drawings and plans sent out to the field to be used for staking and construction purposes must be checked for drafting errors. All drafting work should be checked. Sometimes dimensions are left off of drawings causing people in the field to try to get the dimensions by scaling when the drawings are not drawn to scale. Some Public Works offices do not mark all revised drawings. This sometimes results in un-revised drawings being sent to the field. Further method of dating drawings and revisions should be adapted.

Supervision

Provincial Public Works inspectors should be required to be at the job site while construction work is going on. They should see that the contractor adheres to the construction specifications and standards. On-the-job training of personnel in construction inspection techniques is needed in additional to formal training at the training centers. Competence of inspectors should be carefully evaluated and guidance given those who need it. Supervisors should visit construction sites frequently, especially to projects where they thinks the inspectors are in need of further training. One complete set of drawings, technical specifications and standards should be provided for each of the construction inspectors.

Selection of Contractors

Some local contractors lack the experience and manpower to do acceptable work on contracted items. Consequently, they have tended to do poor work and are always behind schedule. The TELO subproject in Riau consists of a small diversion weir, three small water control structures, 1900 meters of irrigation canal, and 2,500 meters of river channel rehabilitation. The construction of the subproject was considerably behind schedule due to the contractor's lack of experience in irrigation construction work. This problem was also reported in Aceh on the KOTA ATAS subproject where the contractor had virtually no experience in construction gabion structures.

It is thus, recommended that pre-qualification of contractors be done prior to the awarding of contracts.

Guarantee Period of Construction Work

As far as can be determined, the present guarantee period of construction work for Sederhana Projects is only one month. This is accomplished by the withholding of five percent of the contract amount by DGWRD for one month after completion of the subproject. During this period, the contractor must make repairs or make good any shortcomings. Previously, this withholding or guarantee period was much longer, but the contractors complained that at today's interest rates, they could not afford it, so the period was shortened.

This causes a problem since construction work is usually completed during the dry season and the subproject cannot be tested by flooding. In order to promote construction quality and to check the diversion structure during flood periods, an extension of the guarantee period should be considered by DGWRD.

Section VII.

Evaluation of the Training Phase of the Sederhana Program

C. FINDINGS, NEEDS AND RECOMMENDATIONS

General

The in-country training of technical and administrative personnel working on Sederhana subprojects is a very important element for building provincial, section and district staffs for the implementation of Sederhana subprojects.

Surveying and construction supervision and inspection have been problem areas on many Sederhana subprojects. This is especially true of surveying as it relates to the staking and layout of the main and secondary canals and the related structures such as checks and turnouts.

The training can be done at the existing training centers with greater use being made of some centers and the facilities of others being expanded. Primary training emphasis should be placed on surveying.

Levels of Training

The training to date has been directed toward the following personnel: (1) Provincial level Public Works offices, (2) Wilayah or regional level Public Works offices on Java only, (3) Section level Public Works offices, (4) Agriculturists at Provincial and Section levels, (5) Key farm leaders of Water Users Associations, and (6) Some training of Indonesian private engineering firms who are doing survey and design work for Sederhana subprojects. Exhibit 1 gives a detailed listing of the courses.

Personnel Working of the Sederhana Program and Their Training Needs

From the personnel lists and in discussions with Public Works, consultants and agricultural officials, it was determined that the potential staffing might be as follows (the actual numbers depending upon the personnel available in each of the provinces):

(1) Provincial Level Public Works Offices. A graduate engineer (BIE) would be in charge and have a staff of 2-4 graduates from a technical high school (STM's) with 10 to 15 years experience. They would supervise and assist the BIE's and STM's at the Section and District levels with the more complex problems and implementation of the work. All new graduate engineers and those with little or no irrigation experience as well as the STM's should have thorough training in all the subjects which relate to Sederhana Irrigation. Since there are 24 provinces involved with the Sederhana program, this could mean training would be needed for 24 graduate engineers and 50-100 STMs at this level.

(2) Wilayah or Regional Level Public Works Offices on Java only. There are four provinces on Java having Sederhana subprojects with an average of 3 regions per province. Thus there could be training required for 12 BIEs and 50 STMs at the regional level.

(3) Section Level Public Works Offices. A Bachelor of Irrigation Engineer (BIE) is usually in charge with a staff of 2-5 STMs depending upon the work load of the section. However not all personnel are assigned to work on Sederhana irrigation. STM's and others receive a higher incentive pay while working on the Sederhana Program. When there is a reduction in the amount of work on Sederhana subprojects or no work at all they are retained on Public Works payrolls at the regular pay scale.

With 24 provinces and an average of 5 sections per province, there are approximately 120 sections to be staffed. This would require about 120 Bachelor of Irrigation Engineers and 360 to 500 STMs. Where staffing is short of personnel, there may be only one or two regularly assigned STMs for the supervision of construction work. Others can be brought in from other sections on a temporary basis.

(4) Agriculturists at Provincial and Section Levels. Since there are 24 provinces there is a need for at least 24 extension agricultural specialists (PPS's) at the Provincial level and they could all be involved in Sederhana Irrigation subprojects. According to the existing personnel lists from Agriculture there are 160 Kabupatens to service and 678 subprojects. If there were 2 to 3 extension agents assigned to each Kabupaten there would be need for between 300 to 500 PPLs.

It is evident that there is a shortage of agricultural personnel and that the field offices are under-staffed. Also some of the personnel assigned to the Sederhana program have other assigned responsibilities.

(5) Key Farm Leader of Water-Users Associations. These are local farmers who need to be trained in water management practices, tertiary canal construction and on-farm irrigation practices, as well as in the basic organization and development aspects of water-users associations. The Department of Agriculture has the responsibility of training and assisting them in the operation and maintenance of tertiary and on-farm irrigation systems.

Since there are 678 Sederhana subprojects, there is a sizeable number of farm leaders who need training. The records show that, during the past two years, an average of 40 leaders per province or approximately 960 leaders per year have been trained.

(6) Private Engineering Firms. In addition, training should continue to be provided to improve the capability of Indonesian private engineering firms which are doing contract work including the surveying, planning and designing of Sederhana systems.

Training Centers

At the Yogyakarta training center there is a roster of approximately 75 people on whom the center can call as instructors. This includes over 25 instructors on the staff, many of whom are retired experts in various field. The others are from other institutions in the area such as the technical high school which furnishes instructors to teach the mathematics courses to the surveyors. A handbook of the course materials has been prepared for the trainees to use in their training sessions and also to take with them when they finish the course. The same approach is used at the Bandung training center and the same quality of instructors is available there.

Training Costs

The Following cost estimates were obtained from the Head of Irrigation Diklat Section at Public Works.

1. The average cost per person for the 3-months courses is about $1930/person.

2. The average cost per person for the 1½-2 months courses is about $1485/person.

3. The average cost per person for the 3 week courses is about $915/person.

Recommendations

Emphasis should be placed upon in-country training course, especially in surveying, construction inspection, operation, and maintenance

Manuals have been prepared for soils and foundation investigations, technical specifications, hydrology, design of irrigation structures, and operation and maintenance irrigation systems. These should be translated and reproduced in sufficient quantity so they can be distributed to trainees during their training sessions. More field problems and exercises which can be used as case studies in the class room and out in the field in conjunction with lessons should be introduced.

It is recommended that a short course be given to constiuction contractors to appraise them about contract responsibilities, policies requirements. Also a review of construction specifications would be desirable in order to upgrade the contractors' staff in their work as it relates to irrigation systems.

Everyone who is involved with the training programs, should study and review the "Training Program Evaluation Report" December 1977, prepared by Mr. C.G. Burress, Training Program Coordinator with the Consultants.

Further, it has been suggested that some of the courses should be extended in duration as follows:

STM's construction supervision and inspection from 3-3½ months.
STM's drafting and cost estimation from 3-3½ to 6 months.
BIE's, Ir's project planning and design from 1½ to 3 or 3½ months

Extension of time may require USAID approval. Where it is determined that the courses should be extended, consideration should be given to dividing some of them into two parts. For instance:

Basic Course in Surveying & Mapping	3 months
Advanced Course in Surveying & Mapping	3 months
Total	6 months

This would permit the newer and less experienced employee to get some basic training early in his career and to go back to a field to gain experience in the basic principles before coming back for the mo advanced principles of the course.

Consultants may be needed in order to assist and implement the Sederhana training program and assist instructors in develcping neede material for the various training courses. They could also assist in the collection and development of appropriate visual aids.

In-Country Training

DGWRD Course Title	Level	Length (Months)	No. Trained 1976-77	No. Trained Goal for 1977-78
Project Planning and Design	Ir., BIE	1½-2	21	24
Construction Management and Monitoring	Ir., BIE	1½-2	0	48
Irrigation Project Operation and Maintenance and Water Management	Ir., BIE	1½-2	23	24
Surveying and Mapping	STM	3-3½	19	24
Principles and Practices of Operation and Maintenance	STM	3-3½	22	24
Construction Supervision and Inspection	STM	3-3½	21	24
Drafting and Cost Estimation	STM	3-3½	0	48

MOA Course Title	Level	Length (Months)	No. Trained 1976-77	No. Trained Goal for 1977-78
Construction of Tertiary and Irrigation and Drainage Systems	PPS Ag. Grad.	3	29	22
Principles and Practices of Irrigation and Operation and Maintenance of Tertiary Systems and On-Farm Irrigation	PPS Ag. Grad.	3	29	21
Irrigation Water Management	PPL Ext. Worker	½	199	176
Water-User Associations and Water Management	PPL Ext. Worker	1	89	98
Water-User Association Leader Training	Prov. & Kabupaten Offices	½	1000	2025

IRS Projects Visited by Gray and Gembala

Province	Name of Subject	No. of Subject
North Sumatra	Purbaganda	1207401
	Timbang Deli	1210402
	Lao Simeme	1210406
	Keraksaan	1207501
	Kuala Janji	1207606
	Bukit Cermin	1210607
	Sihail-hail	1204608
	Aek Simare	1204609
	Lumban Gaol	1204610
	Aek Mandosi	1204611
Riau	Sirah	1404502
	Tampan II	1404610
Bengkulu	Air Durian	1702503
	Air Dau	1702604
	Air Sengak	1703611
	Air Kelingi	1702616
West Java	Ciaria	3201402
	Cidahu Girang	3201601
	Cumanggala	3205603
South Kalimantan	Sungkai	630540
	Rawa Taras	630750[illegible]
	Rawa Palam	63[illegible]50[illegible]
	Pampaia	630560[illegible]
South Sulawesi	Panaikang I	7303407
	Calendu III	730352[illegible]
	Kariu I	[illegible]
	Panaikang II	[illegible]
	Kariu II	7303[illegible]
	Kajenjeng	7303507

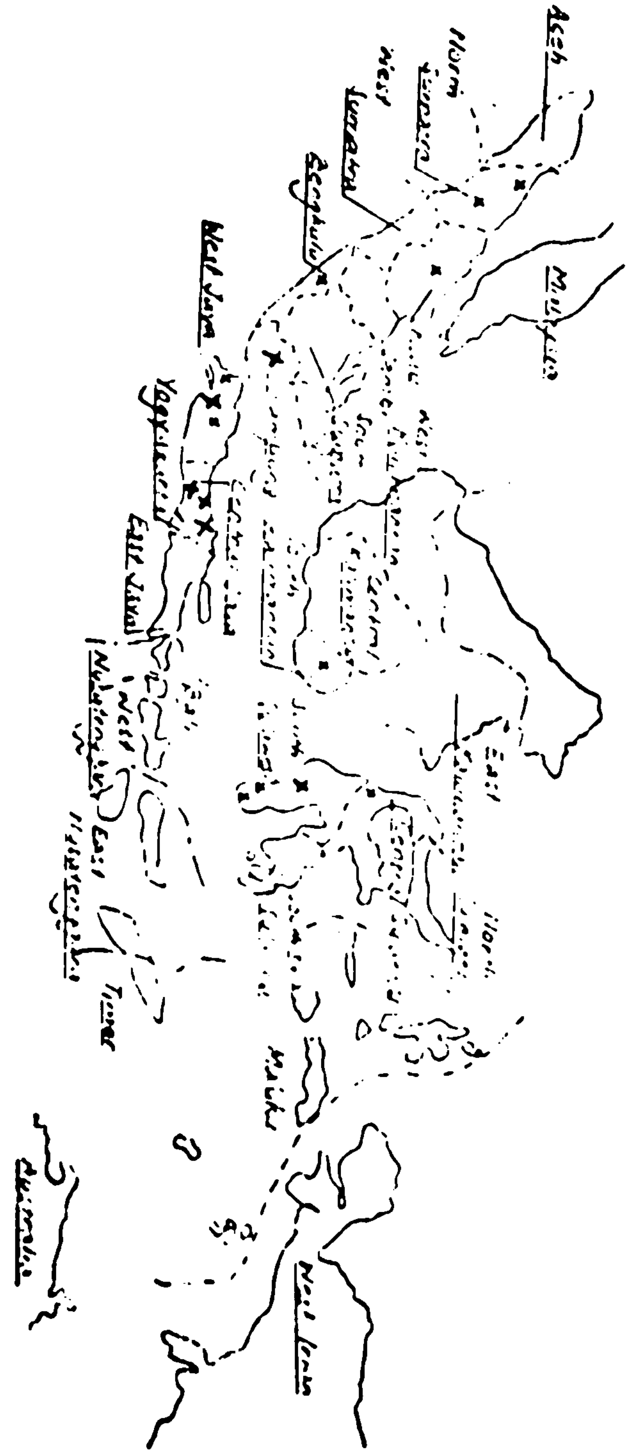
1977/78 Projects

Central Sulawesi	Kekeloe
South Kalimantan	Rawa Negara

Additional project visited by Gembala

South Sulawesi	Bilangloe

Annex 1(a)


Aceh
Maluku
West Java
Yogyakarta
East Java
Timor
West Irian

SEDERHANA (SIMPLE) IRRIGATION AND LAND DEVELOPMENT

INDONESIA

DISTRIBUTION:

ASIA/ISPA:BEDupuis
DSB/AGR:GCorey
ASIA/DP:RHalligan
ASIA/DP:VElliott
ASIA/CM/ROD:PHowley
USDA:JHammond
AID Reference Center

Draft
Ellison

Act PS 4 - verify hypothesis

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Supplement to Section V of the Irigasi/Reklamasi Sederhana Evaluation Report: Socio-Institutional Section

John Duewel
December 1978

Table of Contents

Table of Contents (Contd.)

Table of Contents (Contd.)

Table of Contents (To be Contd.)

SUPPLEMENT TO SECTION V OF THE IRS EVALUATION REPORT WHICH CONSISTED OF THE "SOCIO-INSTITUTIONAL EVALUATION OF THE SEDERHANA PROGRAM (IRS)"

by John Duewel

I. INTRODUCTION.

A. Preliminary Comments.

This additional follow-up section to the Sederhana Evaluation Report is a supplement to Section V which consisted of a socio-institutional evaluation of the IRS Program. It therefore does not stand on its own, but rather should be read in conjunction with Section V.

The major purpose of this supplement is to provide more detail on the institutional/organizational components of Sederhana irrigation systems--both in terms of description and analysis. While mention will be made of policy implications of the research findings, the major focus will be on the actual workings of Sederhana systems both prior and subsequent to project implementation. This approach is consistent with the approach taken in Section V.

The format of this supplement will also follow that of Section V. This should facilitate reference to the earlier report. The supplement will be less concisely focussed, given its attention to detail, and will involve some repetition from Section V as well as between chapters. I decided to follow the format in Section V, which separated analysis of the institutional dynamics of Sederhana systems prior to IRS project intervention from that which followed. Doing so facilitates analysis of the impact of the program. It should not suggest, however, that IRS necessarily involves a decisive break from the past, particularly where existing systems have been well-developed, although in need of technological upgrading. While IRS intervention has often led to varying degrees of adaptation or elaboration of existing patterns of technology and organization, in some systems there have been major changes.

The underlying assumption of the approach taken in the earlier report and this supplement is the utility in specifying the parameters which influence irrigation modes at the local, village level, and in historical context. (See also discussions in 1.B and 1.C. of this supplement). While such an approach helps permit more systematic analysis of inter-system variations in irrigation processes, it does not alaways do full justice to the actual operation of specific systems as presented in case studies. Citations from case studies to illustrate specific points or variations will be an important and necessary component of this analysis. The preceeding qualification, however, should be kept in mind.

In order to compensate for this latter deficiency, therefore, I think that it would be useful to write up illustrative case studies from selected IRS locations. In preparing this supplement, I initially transcribed detailed notes from the 20 Sedernana irrigation monographs which were written up as a part of the socio-institutional research component of the evaluation. Some of these could be used as case studies, although there is still need for follow-up inquiry on selected points. The Sub-Directorate of Land and Water Conservation (heretofore referred to as SDLWC) of the Department of Agriculture, under whose auspices the research was conducted, has tentative plans for such an undertaking.

B. Research Objectives and Sources Used.

In the appendix which follows this supplement, the sources of information on which the socio-institutional part of the IRS evaluation was based-including strenghs and weakenesses--will be reviewed in greater detail than was done in Section V. In this sub-section I would like to focus more on the objectives of the specialized research study undertaken under the auspices of the SDLWC, specifically as they relate to the problem of measuring the impact of the program and the distribution of beneficiaries.

The major objective of the special study was to analyze the institutional and organizational workings of the local irrigation systems, both prior and subsequent to IRS government intervention. This tied directly in with onw of the three major IRS objectives--to enhance the institutional capacities of the various parties concerned to implement the program. It was also related to a second objective--improving the well-being of the rural populace, the majority of whom have low incomes. As argued in Section V the two objectives are interelated. Given the kinds of technological, ecological and administrative parameters under which most Sederhana systems function, there are direct links between the local organizational capacities and the ability to achieve welfare and productivity objectives for the rural populace over time.

It will be useful to look further into the question of how we attempted to measure beneficiaries, the distribution of income and local participation in the context of the IRS program. These are all components of 'social soundness' analysis. The existing data base and other surveys running concurrent with and as a part of the IRS evaluations (see Appendix I) were inadequate for performing such an analysis. Moreover, there were additional difficulties in measuring the socio-economic impact of the program linked to the limited amount of time available to carry-out the research, and the timing or sequencing of IRS project benefits.

It is clear that in a number of project locations there have been direct and fairly immediate benefits. These benefits have been attested to in the Economic Section of the report, They include the extension of irrigated land, increases in cropping intensity, and increases in yields. These data, however, do not tell us about the impact of the program on the level and distribution of income at the micro, household level. Measuring income changes is not an easy task when adequate base-line data are available, much more so when they are not. Furthermore, the achievement of benefits in the IRS case frequently is a long-term process involving technological and institutional change. Since the program was only begun in 1974/75, and USAID's involvement in 1976/77, an attempt to measure its socio-economic impact to date (as relfected in the measurement and distribution of income) would not have done justice to the achievement of benefits over time.

Given the preceding considerations (including the constraints imposed by the amount of time available to carry out the research) we attempted a different approach. Rather than focus merely on outcomes as reflected in estimates of aggregate income changes or numbers of persons affected (beneficiaries), we attempted to look at the institutional and technological trends which in significant measure determine the distribution of such outcomes. This is valid to the degree these trends influence community and household decision-making processes in irrigation. In the Sederhana context, this approach involved considering changes in patterns of irrigation organization and performance, in the elaboration of appropriate village level irrigation technologies which improve organizational capacity, in the levels of improvement in water management and cultivation techniques, and in patterns of access to land and water resources.

The level of access to water resources on the part of individual (and groups of) cultivators as reflected in capacity to irrigate sawahs (rice paddies), and to improve cultivation and water management techniques is an important consideration. In water short systems, upstream cultivators are often favored over downstream water users. I would argue that to the extent that technological and institutional changes promoted under IRS improve the relative position of downstream cultivators who are disadvantaged, the program is achieving one of its major objectives.

One of the major goals of the research study, therefore, was to use a 'dynamic' institutional mode of analysis in order to facilitate understanding about irrigation causal processes. Such an approach can be contrasted to the kinds of beneficiary analysis currently in vogue among international agencies. The latter tend to over concentrate on outcome at the expense of causality. The forms that such beneficiary analysis usually take, despite well-intended objectives, tend to be 'static', relying primarily on inferences drawn from aggregate data. They thereby sometimes divert attention from the socio-institutional context in which change is taking place.

C. Analytical Perspective and Policy Concerns.

A major concern of current Indonesian government policy in the broad area or irrigation development policy is that of improving the capacity of communities to cooperate in the management of irrigation affairs at the local level. This is also an objective of the Sederhana Program. The government's recent decision to become more directly involved in constructing and rehabilitating the tertiary components of irrigation systems, including its crash tertiary development program, can in part be seen as an effort to make these systems more productive and efficient.

The government's attention to the tertiary components of irrigation systems represents a modification of past policies which left the operation and maintenance of the terminal structures in the hands of village communities.[1] The new approach emerged in response to the perceived inability of communities to undertake rehabilitation, repair and development of tertiary systems on their own. A number of explanations have been offered for this apparent lack of collective capacity to act by cultivators. These explanations range from technological and ecological constraints to bureaucratic inefficiencies and irregularities, from demographic trends to evolving patterns of access to land resources, from a lack of community level leadership and initiative to a decline in traditional village cooperation (*gotong-royong*).[2] Underlying this search for causes is the assumption that Javanese communities performed local maintenance and distribution tasks more effectively in the past than the present.

It is important to note that many of the assumptions of of scholars and policy makers (regarding the nature of village level problems and organizational capacities) are in significant measure derived from research and experience in the larger, primarily lowland and state operated systems. By contrast, there has been comparatively little detailed, research in the smaller, technologically simple systems. It is important, therefore, that attempts be made to provide information on the parameters which influence irrigation processes in the smaller systems. In this way decision makers and administrators will be better able to assess the conditions under which local operational capacities can be perpetuated or stimulated, and those under which they may be undermined.

It will be useful at the outset, therefore, to distinguish between Sederhana (primarily community) irrigation systems and larger state operated systems--where such distinctions are valid. In large measure these distinctions are built around the differing irrigation parameters which influence organizational performance in these systems. These include the surrounding ecology, technologies and physical layouts associated with the system, relative water availability in relation to demand, indigenous traditions and cultural patterns, the degree of autonomy vs. interdependency within the system, size and scope, agricultural cropping patterns, and irrigation tasks and functions.

The analytical distinction between (1) state supervised and centralized systems which cover large areas and numerous villages and (2) relatively decentralized autonomous community systems has drawn the attention of several scholars who have studied irrigation societies. They have observed that locally managed and technologically simple irrigation schemes often are more stable over time than integrated elaborate systems.[3] The latter tend to 'over-develop ', may be less responsive in adjusting to micro-environmental changes, and periodically undergo phases of organizational dislocation and ecological degradation. Similar problems occurred in many of Java's larger systems during the 1940's to 1960's. Decentralized and loosely coordinated schemes, by contrast, often are more responsive to ecological and organizational requirements and needs. This may occur by virtue of their smaller size, their more direct feedback linkages between inputs and outputs[4], and by the more compartmentalized and easily manageable nature of their technological 'apparati'.[5]

In separate articles both Coward and Spencer have commented on Southeast Asian irrigation systems. They observe that community level organizational possibilities in irrigation are directly tied to such concrete considerations as topography, technology, ecological setting and physical layout. Coward notes that in Southeast Asia "there are few examples of irrigators acting in an organized manner to contribute to effective operation and management of agency-supervised systems." In this regard he points to technology and organization, concluding that the physical layout of state irrigation systems usually "demarcate collections of water users that are excessively large" for effective local level "corporate actions".[6] Central Java's efforts to propagate irrigation organizations (*Dharma Tirta*) which are built around sub-village units organized around distinct and more easily managed physical components (ie. sub-tertiary out-take channels), represents an attempt to compensate for these difficulties.

Spencer gives a favorable view of local organizational possibilities inherent in the communal irrigation systems typically found in the hill and mountainous areas of Southeast Asia.[7] Many of the IRS project locations would appear to fit his typology. Spencer notes that the organizational and technological requirements of hill-terracing in Southeast Asia are such that small cohesive communities and groups traditionally have developed, maintained and extended terraces on their own initiative with minimum, if any, outside involvement. He observes further that once constructed there is often an underlying stability and flexibility in a well-maintained terrace group which contributes to 'economic stability' and to 'local autonomy'. His ideas appear to be directly applicable to historical patterns of irrigated agriculture throughout Indonesia (and particularly Java) prior to and up into the late colonial era. By that time massive state construction of large lowland irrigation networks substantially had transformed the irrigation sector.[8] Bali's subak irrigation systems, in like fashion are an example of watershed coordinated but primarily locally run irrigation systems employing hill-terracing technologies, and organized around generally small, distinct physical units.

II. General Characteristics/Description of Sederhana Communities.

A. Preliminary Comments.

In the discussions of IRS systems which follow throughout this supplement, I will draw primarily from information provided in the special socio-institutional survey of 20 Sederhana projects. This will be supplemented by data from field visits, and on occasion from other sources. However, where relevant data is available from the Department of Agriculture and DGWRD complementary surveys of all IRS locations, these also will be referred to.

B. Size, Administrative Structure and Location of IRS Communities.

1. The 'desa' as an Administrative Unit.

There is considerable variation in the size of Sederhana communities as defined by the administrative category 'desa' (the official administrative unit as recognized by the government). One reason for this variation is the fact that many village units are really what Geertz has called "village complexes", which were formed as a result of Dutch efforts to amalgamate contiguous hamlets/villages during the early 20th century. As a consequence, many village complexes historically have not been natural social units but exhibit considerable diversity. Some sub-sections (hamlets) have had closer ties (economic, agricultural) with neighboring desa.

Having said this, it is important to note that the recent historical trend has been one of consolidating administrative authority (rather than autonomy) in the hands of the official village leadership--as it involves interaction with the bureaucratic administrative structure of the state. These linkages between the village and the state have proliferated and grown in importance as rural development and other programs have expanded. In most villages, the desa headman plays a key role in irrigation affairs, although how this role functions in practice varies considerably--as will be discussed later.

2. Population Size/Demographic Structure.

In Java the population size of 11 sample IRS villages studied in detail averaged approximately 4,700 residents and 1,100 households, ranging from 400 to 2,300 households. This was approximately double the size of 9 IRS village units from the islands of Bali, Sulawesi and Sumatra, which averaged 2,600 residents with 500 households, ranging from 100 to 1,000 households. Our own sample probably overstates the size of IRS villages as a whole, since it under-represents the more remote locations as well as villages where irrigation is being introduced for the first time, which tend to be smaller in size. (For further details on population sizes and the demographic structure of IRS sample villages, see Appendix II).

The following table gives a breakdown of the variation in the population size of IRS sample villages as measured in terms of number of households.

Table 1: Frequency Breakdown of IRS Sample Villages in terms of Number of Households.

Range (# Households)	No. of IRS Village
100-250	2
400-500	7
600-800	5
900-1,000	3
1,600	1
1,900-2,300	3
Total	21

In looking at the implications of population size for the organization of irrigation, one of course must consider the number of cultivating households actually involved in irrigation, the physical structures of the system(s), etc. At this stage, it is important to note that many villages are sufficiently large in size to suggest that irrigation organizational sub-units below the desa level are needed for affective irrigation performance.

3. Administrative Sub-Units.

All of the desa except 1 (the 100 household bandjar from Bali) had administrative sub-units variously called kampong (parts of Sumatra, West Java), dukuh (Central and East Java), jaga (North Sulawesi), lingkungan (South Sulawesi), jorong/kampongs (West Sumatra), etc. For our purposes we will call these hamlets. While the number of such sub-units varied, they were closely related to the population size of the desa. The number of such units in Java ranged from 3 to 27 per desa, while outside of Java they ranged from 3 to 8. In 70% of the desa, the size of the administrative sub-units (hamlets) averaged 100 households or less, with a median size of 70. In the remaining 30% for which data are available, the median size was 300. There are additional and smaller administrative sub-categories within villages, although for the most part these are less important than the hamlet as an administrative/social unit.

What is important to note at this stage is that the hamlet often has served as the unit for mobilizing cooperative labor for the maintenance of irrigation structures. These degree to which the hamlet corresponds to distint portions of the physical layout of irrigation systems is a matter of interest, and will be discussed later.

4. Location.

It is difficult to draw many conclusions regarding the implications of locations of IRS systems, given the considerable diversity involved. Many of the systems, particularly in parts of Sumatra and Sulawesi are located at some distance from the lowest administrative level of the provincial government--the subdistrict (kecamatan). Data from the complete enumeration of the 500+ IRS projects indicate that 44% were within 5 km. of the kecamatan h.q. (which is often a desa in its own right), 26% were from 6-10 km. from kecamatan, and 30% were more than 10 km. away. Some of the systems did not have access by motorized transportation.

If we look at the sample IRS projects studied in detail, 70% were within 5 km. of their kecamatan headquarters, while 33% were within 10 km. of their district (kabupaten) centers, 33% were from 11 to 20 km. away, and 33% were more than 35 km. from their kabupaten centers. All but one could be reached by motorized transportation.

In general IRS systems tend to be more remotely located from district headquarters than some of the major lowland state operated systems. Possibly more important for our analysis, and as will be discussed in greater detail shortly, they tended to be located near the ends of roads on mountain slopes or bordering less accessible hillier regions.

C. Economic Livelihood, Agricultural Cultivation and Land Use Patterns, Social Structure and Levels of Income.

1. Economic Livelihood.

If we take the total universe of the IRS systems, the by far dominant form of economic activity centers around agricultural cultivation. Within the 21 sample IRS villages, in only 1 did more than 20% of households derive their income from non-agricultural pursuits, with non-agricultural households per desa averaging 11%. Those not involved in agricultural production worked primarily as government officials, traders, estate workers or non-agricultural laborers.

2. Agricultural Cultivation and Land-Use Patterns.

The land-use patterns of the 500+ IRS locations (1974/75-1976/77) prior to project implementation were as follows. 16% of IRS locations were categorized as undeveloped, 8% as mostly upland crops, 25% as a combination of wet rice and upland crops and/or undeveloped, and 51% as primarily wet rice areas. Approximately 76% of locations had some form of wet rice cultivation prior to IRS, with 60% having rudimentary irrigation systems. Of the potential irrigated acreage, 59% was devoted to wet rice cultivation prior to IRS, of which 55% was irrigated and 45% rainfed.

With one exception (a swamp-land, rainfed drainage project in South Kalimantan), the IRS sample projects were selected from locations with existing irrigation systems prior to IRS. In these desa, 39% of agricultural land was irrigated, 3% rainfed and 58% devoted tp upland crops--most of the latter not potentially irrigable.[9] In the Javanese sample villages, the irrigated land was about equal to upland crop areas, while outside of Java the dry land crop areas represented 2/3 of total cultivated land. Table 2 which follows gives a frequency breakdown of villages according to the percentage of land under irrigation, indicating the variation among villages in the role played by irrigation.

Table 2: Distribution of IRS Sample Villages in Terms of the Percentage of Cultivated Land under Irrigation.

% of land irrigated/village	Number of Villages		
	Java	Non-Java	Total
0-20			
21-40			
41-60			
61-80			
81-100			
Total			

3. Agricultural Production Patterns and Social Structure.

A more detailed discussion of agricultural cultivation will follow later in the report. At this point, an attempt will be made to explore briefly some of the socio-organizational characteristics of Sederhana locations which derive from patterns of production and access to land, and which have implications for irrigation organizational/institutional processes.

Before beginning the discussion, it will be useful to present a Table that I have put together from data from the 21 IRS locations, and from which additional tables and discussion will follow. Table 3 provides information on the percentage of households within each of the sample villages categorized as to types of agricultural cultivation, tenancy status and the average size of irrigated land per cultivating household.

Table 3: Breakdown of Cultivation Patterns, Tenancy Status and Average Irrigated Land Holding Sizes by IRS Sample Village.

Kabupaten/ Province	% of Total Households: Irrig. Rice. Cult.	Upland Cult. only	Total Ag. Cult.	Agric. Labor	Total Agr.	% of Agric. Cult. Households: owner own/ten	tenant only	Avg. Size. Irrig. Holding
W. Java:								
1. Pandeglang	50	30	80	-	80	60	40	0.5 ha
2. Serang	70	29	99	-	99	50	50	0.5
3. Kuningan	65	-	65	25	90	63	37	0.4
4. Ciamis	80	5	85	-	85	85	15	0.25
C. Java:								
5. Sleman (Dj)	60	25	85	-	85	80	20	0.3
6. Magelang	80	5	85	-	85	95	5	0.4
7. Wonogiri	33	50	83	10	93	93	7	0.5
8. Jepara	50	5	55	15	70	80	20	0.4
E. Java:								
9. Lumadjang	50	30	80	15	95	90	10	0.3
10. Send--Lum.	33	22	55	33	88	70	30	0.7
11. Jember	40	14	54	38	92	72	28	0.5
12. Bali	76	18	94	-	94	100	-	0.3
13. N. Sumatra	96	-	96	2	98	100	-	1.0
14. W. Sumatra	80	-	80	-	80	77	23	0.5
S. Sulawesi:								
15. Bantaeng	89	8	97	-	97	99	1	0.5
16. Siderap	30	65*	95	-	95	5	95**	0.5
N. Sulawesi:								
17. Minahasa	79	12	91	-	91	95	5	0.7
18. Gorontalo	53	33	86	-	36	90	10	0.7
Lampung, Sum:								
19. Cent. Lamp.	80	5	85	-	85	98	2	0.2
20. Sth. Lamp.	33	60	93	-	93	100	-	0.8
S. Kalimantan:								
21. Bandjar	-	95*	95	-	95	100	-	2.0*

* Includes households with rainfed sawah cultivation.

** Most of the land in this village is nominally owned by a single landlord family under pre-existing semi-feudal rights, which entitle them to a 1/3 share of the yield (at the most).

First, as noted earlier, an average of 89% of the households in the 21 sample desa derive their primary souce of livelihood from agriculture. Significantly, the bulk of these households are cultivators (either owner operator or tenant), as the following simplified table indicates. What is noteworthy is that in 17 of the 21 villages peasant cultivators account for 80% of the households. All of the 4 villages where they account for 55% to 65% of the households come from Java, while even in Java 2/3 of the IRS sample villages are predominantly composed of cultivating households. None of the non-Java locations reported fewer than 80% cultivating households, and since 80% of IRS locations come from outside of Java--this pattern is probably the norm.

Table 4: Frequency Distribution of Desa according to the Percentage of Households which are Ag. Cultivators

% of Households as Ag. Cultivators	Number of Desa		
	Java	Non-Java	Total
0-49	-	-	-
50-59	3	-	3
60-69	1	-	1
70-79	-	-	-
80-89	6	3	0
90-99	1	7	8
Total	11	10	21
Average	75%	91%	83%

In like fashion, there were no significant numbers of landless agricultural labor households outside of Java. In Java, 6 of the 11 locations reported landless agricultural laboring households--3 from 10%-15% of village households, and 3 from 25%-30%. The data from the complete census of the 500+ IRS projects carried out by the Department of Agriculture corrobarate data from the IRS sample desa. They indicate that in only 8.6% of the desa (mostly from

Java) did the number of landless labor households exceed that of cultivating households, while 79% of the desa reported few if any landless labor households. With allowances for some of the desa from Java, these data suggest that the internal structural characteristics of IRS desa are such that for the most part a substantial proportion hoseholds have access to land as a source of livelihood.

A second point of interest concerns the proportion of households within the sample villages that are directly involved in irrigation cultivation activities. The following simplified table indicates that while there is considerable inter-desa variation, improvements in the local organization and technology of irrigation systems, to the degree needed, can potentially benefit a substantial proportion of households. In 75% of the sample desa, over 50% of households cultivate crops on irrigated land, with a per-desa average of 61% overall (55% for Java and 68% outside of Java).

Table 5: Frequency Distribution of Desa According to the Percentage of Households with Irrigated Cultivation*

% of Households in Irrigated Cult.	Number of Desa: Java	Non-Java	Total
0-29	-	--	--
30-49	3	2	5
50-59	3	1	4
60-69	2	-	2
70-79	1	2	3
80-89	2	3	5
90-99	-	1	1
Total	11	9	20
Average	55%	68%	61%

* (Excluded South Kalimantan, drainage project, with no 'irrigation' as such).

It is appropriate to look at the distribution of landownership and tenancy among cultivating households, as indicated in the following table on tenancy status among sample IRS desa.[11]

Table 6: Frequency Distribution of Desa According to Percentage of Cultivating Households Who Are Owner Cultivators or Part-owner Cultivators.*

% Households Who Are Owner Cultivators or Part-Owner Cult.	Number of Desa Java	Non-Java	Total
0-29	-	1**	1
30-49	-	---	-
50-59	1	-	1
60-69	2	-	2
70-79	2	1	3
80-89	3	-	3
90-100	3	8	11
Total	11	10	21
Average	76%	95%***	85%***

* The figures here refer to cultivators who are owner operators, or part owner/part tenant operators--as contrasted to cultivators who are tenant operators only, Thus, if a desa has 85% of its cultivators categorized as owner or part owner cultivators, only 15% fall in the tenant only category.

** In one desa in South Sulawesi, 95% of land rice land was owned by a single family--descendant of the village founder.

*** Percentages exclude the desa from South Sulawesi just mentioned.

The data indicate that a fairly high average of 85% of cultivating households are at least part owners of land cultivated, with the locations outside of Java (at 95%) having few landless peasants. Overall, only 15% of the sample desa had more than 30% of cultivators who were landless tenants. Tenancy levels are actually higher than these data suggest, since a number of households combine cultivation on their own land with land rented from others, although classified in the land-owning category.

Unfortunately, data are not available from the 500+ desa census regarding tenancy levels. What is more important than merely looking at tenancy levels is to study the conditions of tenancy, as reflected in sharecropping and rental agreements.

Since I do not for the most part have access at this state to the data from the households surveyed, my comments on tenancy are derived from field visits and from those reports in which data are available. What is particularly of interest is the extent to which gains from irrigation improvements are likely to be transferred to tenant cultivators, as reflected in the proportion of yields retained and in the costs of cultivation.

For the most part the data indicate that where tenancy relationships exist, they are built around sharecropping opposed to rental, pawning and other forms of land exchange,[12] although combinations are possible. In two locations from the extreme western part of Java, where tenants constituted 50% to 60% of all cultivators, the tenancy 'terms-of'exchange' are not overly unbalanced in favor of the landowners. The crop is divided on a 50/50 basis, with the tenant assuming the costs of cultivation, the landowner paying the land tax, and the village irrigation assessment divided on a 50/50 basis. In the one location from Central Java where data is available (Yogyakarta), the harvest is shared on a 50/50 basis, the cultivator assumes input costs, and the landowners takes responsibility for the land tax. These findings are similar to other smaller village systems with which I am familiar in Java. They are a distinct contrast to tenancy terms found in many of the larger heavily populated, lowland systems of Central and East Java, where tenants often get only 1/3 to 1/4 share of the crop. They suggest that in IRS locations in Java, there has been less erosion of the position of tenants and a greater retention of traditional social organizational forms than in the major systems. (One must be careful to recognize that within any one desa there are probably inter-household variations in tenancy terms).

The terms of tenancy in the non-Javanese locations, where for the most part population density is less than that found in Java, probably either proximate (or are more favorable to the tenant than) the terms found in the Javanese locations just mentioned. Levels of tenancy, also are generally lower than those in Java. The one exception, the IRS location in the Kabupaten of Siderap in South Sulawesi where 95% of the rice land was owned by one family, is interesting. Under the generally favorable share-cropping terms there, the tenant retained 2/3 of the harvest yield, while 1/3 went to the landlord, with input costs being split. Where land was difficult to cultivate, 75% went to the cultivator, with 25% to the landowner. Such terms were sanctioned by custom, and had not undergone recent change. In part the more favorable situation outside of Java reflects the fact that the supply-demand situation vis-a-vis land is less of a problem.

The preceding conclusions, however, must be taken with caution, given the lack of sufficient data. They should be viewed as suggestive, not definitive. A very critical factor regarding tenancy conditions is the extent to which land is owned and subject to control by the community and its residents according to custom, as opposed to being alienated to outsiders. It has been reported that in some IRS projects outside of Java which were located in close proximity to district and semi-urban complexes, there have been attempts by outsiders to purchase land following successful implementation of the project. Thus, although it would appear that the tenancy patterns found in IRS systems generally provide incentives for improved cultivation/water management practices by peasants, such conditions may change. The Irrigation Service, for instance, has turned down requests from a number of locations in South Sulawesi where land ownership was concentrated in the hands of a single or few families according to hereditary, 'semi-feudal' rights.

4. Levels of Income and Amenities.

In section V of the main report, using criteria developed by the Ministry of the Interior, it was noted that 41% of IRS locations fell in the least developed category, 55% in the beginning to develop category, and only 4% in the well developed category. While accurate estimates of per capita income are not available, levels ranged from $75 to $200 in those sample villages where such data was provided. One can assumed that from 80% to 90% of the households fall below a $150 income per capita figure.

A key determinant of income on the part of households centers around access to land. Tables 3 and 4 gave an indication of the substantial proportion of households (75% for Java, 91% outside of Java - averaged among sample desa) who cultivated land. A majority of these households, particularly outside of Java, have a combination of irrigated and non-irrigated land with whibh to work. Unfortunately, we do not have a breakdown within villages of households according to amounts of land owned and operated by type. The following Table, however, does give an indication of the amount of irrigation land operated per household with access, to irrigation, and should be interpreted in conjunction with Table 5. The average irrigated holding of o.5 hectares per water user household, while low according to international standards, is higher than that found many of the more densely settled lowland regions of Java. When considered in conjunction with non-irrigated holdings, these data suggest that IRS irrigation system for the most part are composed of viable agricultural units. This does not deny the fact that such averages hide distributional inequities, and that some systems may have substantial numbers of economically marginal peasants.

Table 7: Frequency Distribution of Sample IRS Desa According to Amount of Irrigated Land Operated per Household Involved in Cultivation on Irrigated Land.

Size of Average Irrigation Holding Per Desa in Hectares	Number of Desa		
	Java	Non-Java	Total
0.2	1	1	2
0.3	2	1	3
0.4	3	-	3
0.5	4	3	7
0.6	-	-	--
0.7	1	2	3
0.8	-	1	1
0.9-1.0	-	1	1
Total	11	9	20
Average*	0.4	0.6	0.5

* Averages here are averages among desa averages, not weighted to size of desa. This approach also has been followed in average figures in other tables.

From the standpoint of social and economic amenities, including educational facilities, a high proportion of IRS villages are priority locations for Indonesian government development activities. Table 8 indicates the distribution of selected goods and services among households from IRS sample desa. These include transport goods (bicycles, motorcycles), communication goods (radios), and household facilities (electricity, sewing machines). One must exercise caution in interpreting the data and in drawing conclusions about welfare implications. For instance, low levels of bicycle ownership do not necessarily imply lack of mobility but often are associated with more remote locations where alternative forms of transportation (busses, or the ubiquitous 'colts') are available and preferred. The listing here is meant to be illustrative.

Table 8: Frequency Distribution of IRS Sample Desa According to Possession of Selected Goods/Services Among Households.

% of Households Owning Good/Service	Number of Desa				
	Type of Good or Service				
	Bicycles	Motor-cy.	Radio	Elec.	Sewing m
0	-	2	-	14*	-
1-2	3	14	1	3	9
3-4	4	3	2	-	2
5-9	3	1	9	2	4
10-19	3	1	3	1	1
20-29	3	-	4	1	2
30-49	3	-	2	-	2
50+	2	-	-	-	-
Total	21	21	21	21	21
Highest %	72%	12%	37%	25%	45%
Average %	22%	2%	13%	2%	9%

* Includes 4 desa where only 1 household had electricity.

Bicycles are the most broadly distributed of the items listed above, averaging 22% of households per desa--18% for Java and 27% for locations outside of Java. Motorcycles, by contrast, averaged only 2% per desa, with only 4 desa having more than 3% of households owning motorcycles. Radios are the next most widely distributed good/service, averaging 13%--10% for Java and 16% outside of Java. Almost all desa had a minimum of 1 or two television sets, some of which were used in desa meeting houses. In no desa did even 1% of households own television sets. An average of 9% of households had sewing machines, around which the Java/non-Java differences were most pronounced (an average of 3% per Javanese village and 17% per village outside of Java). Finally, in only 4 locations did more than 1% of households have electricity. Two-third of sample locations had none (or at a maximum one household with electricity).

D. Summary of the Section.

The preceding discussion gives some indication of the variations among IRS communities in size, social structure, and agricultural and economic livelihood. Having said that, there are also noticeable patterns which a substantial proportion of these communities share, and which have a bearing on the conduct of irrigation affairs at the local level.

The substantial majority of households in these communities consist of peasant cultivators (average--83%). Irrigated agriculture plays a central and frequently primary role in the perpective village economies, with an average of 61% of households involved in irrigation as cultivators. The majority of these cultivating households (average of 85%) own at least part of the land they cultivate. While substantial numbers of households in some desa are involved in tenancy agreements (particularly in Java), what data there is suggests that the conditions of tenancy do not block incentives for improved water managemenr and cultivation practices. Sharecropping on a 50/50 basis appears to be the dominant mode in those desa from which data are available. Average irrigated holding sizes, while low (0.5 hectares), often are supplemented by upland hectarage.

In sum, the land-use and socio-organizational conditions of agricultural production in sample IRS desa would in general appear to be conducive potentially to fairly high levels of local participation in operating irrigation--including the sharing of benefits from improved technologies and organizational performance. These generalizations, however, should not downplay the fact that each IRS system has itw own unique set of problems (frequently including mounting land pressure). The systems, therefore, must be studied in a local context.

III. Description of Sederhana irrigation systems.

A. Introduction.

In this section I will attempt to give a broad overview of Sederhana Irrigation systems as they existed prior to major goverment intervention under IRS. The major focus here will be on topography, technologies, size and relative autonomy of the systems, including related needs and problems. Later sections will focus on organizational capacities of these systems prior to IRS--including construction/development activities, maintenance and repair, and water distribution. The data that I will use in this section will be drawn both from the census surveys conducted by the Department of Agriculture and Irrigation Service as well as the more detailed socio-institutional survey. The emphasis here, in addition, will primarily (although not exclusively) be on those locations where existing systems were present prior to IRS.

As indicated earlier, 59% of the 174,000 hectares of realizable potential irrigated hectarage was already under wet rice cultivation prior to IRS. Irrigated land, at 55,980 hectares represented 32% of the total project area and was found in 55% of IRS systems. A major factor to consider, therefore, is the fact that 55% of project locations had existing, primarily communal systems prior to IRS.

B. Size and Scope.

While the 520 to 530 IRS projects encompass a diversity of situations (viewed from the standpoint of size, technologies, water sources and water availability, topography, etc.), there are some generalizations that can be made.

A major distinguishing characteristic of the IRS systems is their generally small size (and relatedly, use of simple technologies). If we look at all of the 530 projects in terms of the potential irrigible land area, than the average size of IRS systems is around 330 hectares. Unfortunately, I do not have with me a breakdown of data on the estimated size distribution IRS projects, both potential and then existing. If we take the approximately 55% of locations that had existing systems, and divide them into the existing irrigated land area (prior to IRS), then the average size of the systems at the outset was approximately 190 hectares.

It will be useful to look at the sample IRS systems to illustrate the kinds of units and size variations found overall. This is not to say that the sample IRS locations are representative of the IRS universe, but that they provide interesting examples of inter-community diversity. The data here are based on the systems as they existed prior to IRS project activities.[13]

The IRS sample systems in their pre-projects stages averaged 235 hectares apiece (which is 8% less than their current average of 254 hectares) ranging in size from 0 hectares (for Bali) to 660 hectares (for the system in Serang, West Java). Table 9 gives a breakdown of these systems (or rather community locations) according to the amount of pre-project irrigated hectarage present. As can be seen from the table, 35% originally had less, than 100 hectares, 25% between 100 and 299 hectares, and 40% above 300 hectares.

The preceeding figures are probably misleading for they give an over-inflated view of the actual size of irrigation systems present within IRS communities. This is because the data are based on village (desa) totals. A substantial proportion of IRS 'village irrigation systems' actually consist of several systems (or sub-systems) which may or may not share the same water source (i.e. stream or river). Even if they share the same source, such as a stream, they may have separate weirs and be operated independently (other than overall coordination provided by desa officials). Some of these systems, or sub-systems may be shared with other desa, although such an arrangement is less frequent. Further descriptions and data on the variations among IRS sample desa in the number, size and technologies of their irrigation systems will be presented later in this section under the sub-heading, 'Physical layout, technology and size'.

Table 9: Frequency Distribution of Sample IRS Location According to the Amount of Irrigated Land Prior to IRS.

Amount of Irrigated Land Per Location (In Hectares)	Number of Desa		
	Java	Non-Java	Total
0-49	1	1	2
50-99	2	3	5
100-149	2	-	2
150-199	1	-	1
200-299	2	-	2
300-399	1	3	4
400-499	1	2	3
500+	1	-	1
Total	11	9	20
Average	233	237	235
Lowest	4	0	0
Higest	660	461	660

C. Topography.

The data from the Agriculture Department and Irrigation census surveys are generally consistent with regards to the topography of IRS systems. They indicate that 24.1% of IRS project locations are situated in terrain that is flat (less than 2% slope), 34% have a 2-5% gradient, 17.1% have a 5-10% gradient, and 23.4%

have more than a 10% gradient. Many of the areas that are flat, it should be noted are either situated in valley bottoms or have their water sources in adjacent hilly terrain. A substantial majority of IRS systems, therefore, appear to come under Spencer's hill-terracing typology discussed earlier. Such systems can be characterized by their simple technologies and by the fact that they can be managed by autonomous communities. It is probably no accident that the existing community systems present in large part emerged under these kinds of topographical conditions.

The sample IRS desa are generally consistent with this overall pattern. Of the 11 locations from Java, 10 or located in hilly-mountainous terrain, and 6 or 9 for which data are available are located aboue 1,000 feet in altitude. For the locations outside of Java, only 2 of 9 are located in flat or lowland areas, 5 are located (at least in part) in hilly terrain, and 2 are in mountainous terrain above 1,500 feet in altitude. Portions of these systems (i.e. valley bottoms, small plateaus) may be relatively flat, but other portions are hilly with substantial slopes. The one location from Bali, for instance, is situated at an altitude of 900 meters (2,800+ feet), where a subak is being formed from a former tree crop (cloves, coffee) area.

D. Degree of Autonomy--Interdependency.

Related to the question of topography is the fact that many of the existing (and new) IRS irrigation systems were relatively self-contained and/or situated in the upper reaches or headquarters of streams and rivers. Of the 415 locations on which data are available, 65% reported no irrigation systems upstream, 15% reported only 1 system, 10% reported 2-3 systems and only 10% reported more than three upstream systems. Likewise, 71% of 400 reporting locations stated that there were no downstream systems. In the upper reaches of water sheds and in numerous hill areas, cultivators from small irrigation systems are able to tap into and out of streams. Often there is less need for inter-desa (or inter-system) irrigation coordination in these areas in comparison to that required in major lowland networks. It is important to recognize, however, that a minority of systems which share a common intake structure (i.e. diversion weir), or on occasion a common water source (river), may require such coordination during dry season water short periods.

Among the IRS sample desa the level of interdependency among communities is probably higher than that for IRS systems as a whole. Prior to IRS, 6 locations shared irrigation facilities with other desa. As a result of IRS construction, 3 additional desa have begun share common facilities with other desa, while 2 further desa are slated to do so if and when IRS initiated construction becomes operable. The sample desa do, however, provide a range of situations which differ substantially regarding the levels and impact of such interdependency. These variations deserve closer attention.

First, in two desa (West Java, South Sulawesi), water is received via secondary canals of larger systems operated by the state (the Irrigation Service) and is shared among several desa. For instance, the 125 hectares in the mountainous area of Kuningan, West Java are serviced by 4 tertiaries from 2 secondaries which have a 530 hectare command area and provide water for 8 desa. The level of interdependency in such locations which are totally incorporated into state operated systems is high.

A second kind of situation arises where several desa share a common intake structure and a primary canal, but where distinctive tertiary portions of such systems are not shared, but contained within single desa. The degree of effectiveness and the level of involvement of lower echelon Irrigation Service employees in operating these facilities, and in co-ordinating inter-desa water distribution varies widely. In general the desa concerned act fairly autonomously in running their own portions of the shared systems. For a variety of reasons, including lack of sufficient attention by Irrigation Service personnel charged with manning intake structures and major division gates, downstream desa often are in a relatively disadvantaged position.

This second typology includes diverse situations. In some IRS locations, the level of inter-dependency is potentially high during dry seasons, where a major portion of a community's water comes from intake facilities shared with another desa upstream. In desa Gunungdatar, Pandeglang, West Java, for example, two of the desa's three major water sources (technologically simple 'bronjong' weirs which irrigate 50 and 126 hectares respectively) are shared with a community upstream. The third source (a spring within desa confines) irrigated 66 hectares (or only 25% of the desa's irrigated land). During water deficit periods in the dry season, two of the desa's three systems were liable to water shortage (particularly in downstream portions) when the upstream desa diverted more than its share of water.

In other IRS locations, the proportion of village land obtaining water via diversion structures shared with other desa represented a minor component of total irrigated land. In these cases, the potential impact of inter-dependency was less consequential, although still capable of generating problems. In the village of Ulu-Galung near the southern tip of South Sulawesi, only one of three weirs was shared. The 72 hectares serviced by the shared facility constituted less than 15% of the desa's irrigated land.

Desa Jambak situated in mountainous terrain in West Sumatra is a good example of inter-dependency introduced by IRS construction activities which substantially expanded irrigated land. Prior to IRS, the desa's irrigation consisted of 8 small systems, each with its own intake structures ranging from 4 to 15 hectares in size, the majority of which had sufficient water for two rice crops a year. An eighth small system within the desa had a simple weir which tapped water from the river (and its tributary streams), the major irrigation source for the desa. This weir, however, had limited intake capacity. Under IRS, this simple weir was repaced with a permanent weir capable or irrigating 75 heatares within the desa of formerly primarily rainfed sawahs, and 60 hectares in an adjacent desa. Two newly installed Irrigation Service personnel played a useful role in managing water distribution from the major turnouts of the larger shared system, with the village continuing to maintain total responsibility for the 50 hectares encompassed by the 7 smaller systems. Although the internal composition of the desa's irrigation networks had changed, with the construction of one large system, in practice the management of irrigation continued to be primarily a desa affair.

In short, in this outline I have attempted to illustrate the diverse kinds of conditions under which intake or canal facilities are shared among desa. Only 2 of the sample IRS desa have irrigation sub-systems completely integrated/contained within larger state operated networks. In other locations, where irrigation interdependency among desa is present, its actual impact and meaning for the community of interest depends on a variety of factors. These include the proportion of community facilities so affected (and at what level), its relative location within shared systems (upstream or downstream), the kinds of physical structures/technologies used and the manner in which inter-community contacts in irrigation are articulated, the amount of water in the system available relative to demand, the season and phase of the cultivation sequence, etc. Most IRS systems visited or studied in detail had sufficient water during the rainy season. Where inter-community interactions (or lack of them) became more important was during dry season periods of water shortage, or where repair of shared facilities was required.

For the most part, however, where shared systems were present, there was comparatively little inter-desa interaction on a formal level. The operation and maintenance of respective portions of such facilities was primarily a single community affair--although the need for cooperation was sometimes apparent. If we take the IRS universe as a whole, the relative autonomy of most of the systems (or sets of systems) is a distinguishing characteristic in comparison with large state operated and primarily lowland systems. The organizational implications of this feature will be probed later.

E. Physical Layout, Technologies and Size.

For the most part the kinds of technologies present in systems prior to IRS consisted of simple structures made of locally available materials. These included (1) diversion weirs and free intake structures made of stone, earth, brush, bamboo, and banana and coconut trees trunks, (2) division gates and smaller channel weirs constructed from similar materials, (3) earth lined canals and farm ditches, and (4) simple mud or bamboo openings into fields. (Additional description of these simple technologies will be presented in later sections dealing with maintenance and water distribution activities).

An important characteristic of such structures was their vulnerability to damage or destruction by periodic banjirs (sudden flood torrents of water) which cascaded down mountain streams and rivers during heavy monsoon downpours. Related to this vulnerability was the existence of a community capacity to undertake repairs to damaged irrigation facilities at short notice. While some of these indigenous technologies were highly efficient, others had limited intake capacities.

The simple type of bronjong weirs described above were probably characteristic of existing community systems taking the Sederhana universe as a whole. However, in the sampe desa studied as well as systems visited on the field, it is clear that a number of desa had constructed semi-permanent gabion weirs (with or without governmant assistance), and in some cases permanent masonry weirs. The latter tended to be associated (although not exclusively) with construction intiated by the government during the colonial era. The construction of more permanent structures has been on the uptake following the village subsidy program and other development incentives provided in recent years. The point to be emphasized again is that while traditional, fairly impermanent structures predominated, the sample desa studied varied considerably in the levels and spphistication of their technologies prior to IRS.

It should be emphasized that a majority of the sample systems had comparatively well developed canal netwerks, although many have benefitted from (and have need for) further elaboration of tertiary and sub-tertiary systems, and technological upgrading (such as canal lining) of existing structures. Before citing some examples, however, it will be useful to return to the discussion initiated earlier regarding the size and number of systems encompassed within individual desa irrigation networks.

As indicated previously, the average size of 230 hectares of irrigated land per IRS desa location substantially overstates the size of actual systems. Most sample desa with more than 100 hectares under irrigation had multiple systems within their boundaries. The following table illustrates the inter-desa variations in the composition of irrigation networks and the size of their component systems. The 74 systems (units) averaged 61 hectares in size, with larger systems (more than 50 hectares) averaging 100 hectares, and smaller systems averaging 14 hectares. Most of the larger systems were broken down into smaller tertiary units.

Additional elements of diversity in these systems center around the configuration of water sources that are tapped for the various systems. To illustrate this diversity, it will be useful to describe a few of the desa irrigation networks (Network, as used in this context, refers to the configuration of systems/sub-systems within a particular desa. It is not meant to suggest that all or any systems are inter-connected).

First, there are irrigation networks which consist entirely (or partially) of sets of diversion weirs that tap a single water source. Desa Sukorambi which is located in mountainous terrain in Jember, East Java, is a good example. Three systems, starting from upstream on down have been developed and extended over the last 40 years, culminating in IRS replacement of the lowest-lying systems bronjong dam with a more permanent structure. All 3 systems (consisting now of 152, 106 and 147 hectares respectively) get their primary source of water from a single stream/river. Several are supplemented by springs, but there systems are not interconnected.

Table 10: Distribution of Sample IRS locations According to the Composition of Desa Irrigation Networks Prior to IRS*

Type of Desa Irrigation Network	Number of Desa	Avg.Irrig. Ha./Desa	Avg.Ha./ System/Unit
1. Tertiary portions of larger systems operated by the state.	2	190	65
2. Small, single, <u>desa</u> run systems (less than 100 lbs.)	3	60	63
3. Large, complete desa run single system with 3 tertiary units	1	367	122
4. 2 systems shared with 3-4 other <u>desa</u>	2	100	50
5. 3 to 4 substantial systems (more than 50 hectares each).	6	397	120
6. 3 to 8 small systems (less than 30 hectares each).	2	60	11
7. Mixed irrigation networks--with 1-2 substantial systems (over 50 ha) and from 4-12 mini systems.	4	246	33
a) Larger systems (6)		136	87
b) Mini systems (24)		115	19
Total	20	235	61
Average per small system/unit (below 50 hectares)		Number-- 36	14
Average per substantial system (50 ha. or above)		Number-- 41	100

* Includes current situation of 2 systems (Bali, East Java) which were basically formed after IRS. Data from 18 other systems refers to the pre-IRS situation.

By contrast, desa Kalegen which is situated at the upper reaches of a mountain river/stream (900 meters altitude) in Magelang, Central Java has inter-connected systems serviced by 5 dams. All are drawn from the same stream, irrigating a total of 140 heatares.

A second variant is found in desa networks which have more than one source of water. The 660 hectares of irrigated land in Desa Citasuk, Serang, West Java, get water from 4 independent and separate sources, diverted by 4 weirs. Three of these sources are rivers/streams which irrigate 560+ hectares, while one source is a spring which irrigates 93 hectares. In similar fashion, desa Senduro which is located in mountainous terrain (altitude 345 meters) in Lumadjang, East Java, gets one half of its water (94 hectares) from a single dam on a river. The remaining 100 hectares is irrigated by channels leading from 4 springs.

In still other variants, desa may have several water sources, one of which may be diverted in two or more locations. I will defer more detailed discussion of the types of structures (including lengths and numbers of irrigation channels) found in sample IRS systems to a later section in the report.

It is not clear to what extent the sample IRS desa are representative of the pre-existing IRS systems with respect to physical layouts and technologies. Possibly they may be weighted to the more complex, technologically developed side. What is important for our understanding here is the fact that these variations in the physical layout and composition of desa irrigation networks often correspond to organizational variations in the operation and maintenance of systems. A common feature of most of these systems, however,--their small size as defined by physical layout and their comparative autonomy--facilitates organizational capacities at the community and sub-community level.

IV. IRRIGATION ORGANIZATIONAL ARRANGEMENTS PRIOR TO IRS--OVERVIEW.

A. Introduction.

In the Sederhana context, a major policy concern of the Indonesian government centers around the appropriate role and direction of government policies in encouraging improved local management of irrigation systems. Formulating policies is a difficult process requiring initial assessment of existing organizational dynamics and needs. The latter, rather than the former will be the focus of this supplemental analysis. The objective is (1) to describe in greater detail the diverse ways and conditions in which communities develop, operate and maintain their irrigation systems over time, and concurrently (2) to aasess organizational capacities, performance and needs--both prior and subsequent to IRS project intervention.

It is clear from the case studies and field visits that organizational needs vary among systems and over time, just as they vary within differing portions of systems, and during differing seasons of the year. These needs are often linked to specific tasks and functions dictated by the local irrigation environment, and the degree to which group coordination and mobilization versus individual activity is required. For instance, in many of the IRS locations organizational arrangements are introduced during dry season periods of water shortage so as to allocate scarce supplies of water more efficiently and equitably, which in turn are relaxed (or dropped) during the rainy season when water is available in greater quantities. Some systems switch from a rationed to continuous flow situation intermittently, making appropriate organizational modifications in accordance with demand-supply relationships.

Just as there is considerable variability in the organisational tasks and functions associated with specific irrigation systems at differing times, there is also variability in the capacity of communities to carry out these tasks and in the specific organizational modes they use. For instance, the organizational capacities (and needs) within communities undertaking irrigation for the first time are often different from those with extensive experience in irrigation. While the focus of this rpport is on systems which existed prior to IRS, the insights so derived have implications for the newly formed systems.

The purpose of this section is to give an overview af the kinds of organizational arrangements and personnel involved in managing irrigation prior ro IRS. Later sections will deal more specifically with organizational variations as they apply to construction, maintenance, repair and water distribution activities.

B. The Role of Village Administrative Officials.

1. The Village headman.

In most IRS systems studied (or visited), it is clear that village officials with administrative responsibilities (villag headmen, hamlet heads) play a major role in supervising and managing systems. In large measure this role derives from the authority and responsibility vested in the office of the headman regarding village affairs as a whole. It includes (1) resolving issues that cannot be settled by specially designated irrigation officials and techicians, and (2) presiding over the planning and implementation of major irrigation/agricultural activities.

In practice there is considerable variation among systems in the manner in which the headman's authority is implemented and concerning the irrigation/cultivation activities to which it extends. Such variation is linked to a variety of conditions. These include leadership qualities, custom, the size and complexity of systems, the degree to which irrigation management functions have become specialized, the level of conflict within the system, the relative availability of water, the tasks and functions within the system, the level of interdependency with other communities and/or agencies, the extent to which group or community mobilization is required, etc. The list could go on. An attempt will be made to illustrate patterns, to the degree the data and case studies permit. Given the diversity of conditions which influence irrigation roles of village leaders, systematic analysis is difficult.

Initially it might be useful to outline what I would call a modal type of irrigation role that village headman in IRS systems play. This 'modal' role is associated with a reasonable level of complexity within the irrigation system, including the imposition of some form of water control during the dry season. It also assumes the presence of irrigation specialists who are charged with the responsibility of implementing irrigation maintenance and water distribution tasks.

In the kind of situation just outlined, the desa headman will be responsible typically for calling together and presiding over meetings attended by other desa level officials, hamlet heads, village irrigation technicians or specialists ('the village irrigations' or ulu-ulu as they are most commonly known), contact farmers, village notables, possibly agricultural extension agents and/or irrigation officials, and even cultivators themselves. These meetings usually are held once or twice a year prior to each cultivation season. Decisions are taken regarding cultivation schedules, water distribution procedures, and work responsibilities for maintenance and repair of the system(s)--including cleaning canals of silt and weeds, repairing damaged weirs and division structures, etc. The headman's irrigation role here centers around his responsibility to help build a consensus for the planning and implementation of village wide irrigation activities that require coordination, supervision and frequently the mobilization of labor (*kerja bakti*).

Second, throughout the cultivation sequence(s) the headman is kept informed of progress in carrying out irrigation and agricultural cultivation tasks which are often delegated to the village irrigation and/or agricultural specialist(s). Where problems arise that require his attention or intervention, or which necessitate the convening of a *rapat* (group meeting) to make additional desa level decisions, the headman will be asked to step in and take a more active role.

The kinds of problems addressed obviously vary among systems, depending on a variety of factors. The headman is often asked to adjudicate disputes and implement sanctions regarding conflicts and/or infractions related to water distribution (typically during stress period in the dry season), which cannot be resolved at a lower level. For example, in an IRC system near the western tip of Java, conflict over water between upstream and downstream users, and between *desa* is frequent during dry seasons. It is reported that the *ulu-ulu* usually refer approximately 20% of the cases that they cannot settle themselves to the headman. These involve either serious or persistent infractions, or ones that cut accross irrigation jurisdictional lines, including sub-sustems within the community as well as inter-<u>desa</u> conflicts or dealings over water allocation and/or maintenance responsibilities.

The headman also may required to coordinate decision making and consultation on an ongoing basis with reference to the implementation of water distribution schedules. Changes in water distribution procedures may be necessary or useful where more or less is available than expected.

Frequently situations arise where major repair to damaged weirs or canals must be undertaken, often on an emergency basis following floods, and requiring substantial amounts of labor. The <u>desa</u> headman usually (although not invariably) will be responsible for initiating whatever steps are necessary to see that manpower and supervision are forthcoming.

The preceding outline of a 'modal' irrigation role, obviously, does not do justice to the diversity and permutations that exist in practice. <u>The important point to remember, however, is that the headman's irrigation duties center around meeting demands that cannot be addressed at lower administrative levels within the community or irrigation system(s), including carrying-out functions that require cooperation, coordination and supervision across unit lines</u>. Usually, the day-to-day responsibility for implementing local irrigation tasks is delegated to village irrigation specialists, individual cultivators, irrigator groups and hamlet officials.

<u>Most IRS communities with existing systems have attempted (with varying degrees of success) to build-in an institutional flexibility to adjust organizational units to meet changing tasks and needs</u>. In some communities this capacity to aggregate or dis-

aggregate organizationally in irrigation is based on well-developed institutions, with specialized functions and clearly laid-out areas of responsibility. In others, tasks and responsibilities are less sharply defined organizationally--being highly dependent on the leadership qualities and initiative shown by village leaders, chief of which is the desa headman.

The point to emphasize here is that the personal qualities of the village headman as a leader of the community were constantly cited as a key factor influencing the operation of local irrigation systems. This is not to suggest that such qualities alone make for successful irrigation, or that without a dynamic or skillfull leader, the organizational capacities of IRS communities in irrigation inherently were limited. The skills and authority of the village ulu-ulu (irrigation specialists), the needs and demands within the system for leadership, and the level of development of intervening irrigation institutions all have to be taken into account. A lot also depended on the personal style of the leader. Some, by personal choice remained actively involved in daily irrigation details despite the presence of well developed institutions. Others preferred to remain more aloof and delegate responsibilities, stepping in only when needed. It is clear, however, that in making adjustments to changing ecological, demographic, administrative and economic contingencies, and in developing institutions and extending systems, the personal leadership qualities of the village headmen were usually key determinants of successful adaptation and performance.

A major concern of policy makers centers around the degree to which village leaders have an interest in and capacity to discharge village wide irrigation responsibilities in a reasonably equitable and effective fashion. Experience in many of the large state operated lowland systems indicates that village officials often neglect irrigation responsibilities, and are more concerned about personal gain. In part this problem reflects the changing roles and functions of village leaders as communities become increasingly integrated into national political, economic and administrative grids. Often the personal land holdings of village leaders (or else plots assigned to officials as compensation for services performed) are favorably situated within the irrigation system. That is, they may be located near the heads of tertiary outtakes and adjacent to feeder canals, thereby having best access to whatever water is available. Outside of community pressure or custom, there may be few incentives to ensure that lower lying plots get water or that the lower portions of canal systems are well-maintained.

The economic, administrative and technological parameters of the smaller IRS systems often differ from those found in the larger state operated, primarily lowland irrigation networks--as suggested earlier. In particular, their small size, relative autonomy and relatively perishable technologies generate pressures for active irrigation leadership on the part of village officials. Clearly one must exercise caution in generalizing from field visits, discussions and research of short duration--given the diversity of conditions found in existing IRS systems. It appears, however, that IRS village officials for the most part are more responsible, active and effective in discharging irrigation tasks.

The preceding observation is not to argue that IRS communities could not benefit from technological upgrading and organizational modifications, nor that these existing leadership roles are unlikely to change. What it does suggest, however, is that attention must be given to the dynamics of the processes of institutionalizing leadership in irrigation tasks at differing organizational levels within local systems. In this regard, it is important to consider 'traditional' expectations associated with the headman's responsibilities to the community, including irrigation.

In many IRS communities, the headman's role in irrigation and other desa affairs, and the manner in which he works, is influenced significantly by the fact that his office is vested with a 'traditional' moral authority. (At least, the moral connotations of the office frequently were cited by informants, and persisting irrigation practices and customs give evidence of the same). The headman often is viewed as the '*bapak*', or father, of the community--the upholder of custom and tradition. He is expected to act in the interests of the community, and to work towards preserving outward harmony and consensus in village interactions.

In part peasant perceptions of this traditional role and its functions are included within a wider cosmological perspective of the inter-relationships between the ecological/natural order and social processes. We will discuss the impact of such beliefs when considering the headman's role in performing rituals and perpetuating customs associated with irrigation. In part this attempt to preserve a modicum of outward harmony, and to keep conflict situations under control, has been designed historically to limit pretexts or chances for outside intervention in village affairs.

It is clear, however, that in some existing IRS systems this 'traditional' role may never have evolved, or else may have changed. For instance, in parts of Banten, where village officials historically have been held in lower esteem than elsewhere in Java, the prestige associated with the headman's position often has been low. In other locations where village officials are identified with specific factions, regard for their authority may be low among portions of the community. As will be indicated shortly, in some Indonesian cultural settings, the headman may be responsible to culturally legitimated groups of adat elders (traditional upholders of customary law). In Bali, where authority over irrigation is not coterminous with village administrative authority, the klian subak (irrigation society leaders) are often held in higher respect than bandar ('village' administrative unit) leaders. In most systems visited or surveyed, however, the 'traditional' authority associated with the headman's office continues to be maintained, although sometimes in attenuated form. As such, it has implications for the manner and effectiveness in which irrigation functions are discharged.

Two kinds of situations found in IRS communities serve to illustrate how this traditional role of the village headman has evolved and how it functions in the irrigation sphere.

First, in several systems studied in West Sumatra and North Sulawesi, it was noted that special groups of village or adat elders advise the headman in irrigation matters. The formal interactions between the headman and these groups in irrigation is an extension of institutionalized patterns handed down by custom, woven into the moral fabric of the community--which cover a wide body of activities of concern to the village as a whole. In the Balinese subaks, such customs are written down in the awig-awig, or the religiously and culturally legitimated by-laws of the irrigation associations handed down over time, which form the basis of consultation in irrigation decision making.

Such formal patterns of interaction often are less evident in many IRS systems, at least to the casual observer. However, informal consultation between the headman, irrigation officials and persons of respect and influence is often necessary in irrigation--as is frequently the case in Atjeh, South Sulawesi and elsewhere, where local religious figures cannot be ignored. Consultation between the headman and such notables (and the community at large) is part of the ongoing process of molding consensus on issues of concern to the village, on which the capacity of the headman to perpetuate and exercise his authority often depends. The major pre-seasonal *rapat* and *musyawarah* (group discussions), which are held in a majority of systems studied in detail, are an integral component of the processes of molding consensus in decision making.

Second, in many of the IRS communities visited or studied in detail, the headman had either been a founder or major developer of the irrigation system. His stature and authority in such locations in significant measure was linked to his role in taking the initiative to develop or extend the irrigation system. Often his personal reputation and leadership skills have helped to continue to underwrite the smooth functioning of irrigation.

For example, in an IRS system south of the provincial capital of South Sulawesi, the *desa* headman left a then fairly lucrative position in the civil service to take office in the village in 1947. He personally took the initiative to form a communal irrigation system soon after assuming office after the failure of the rainfed rice crop (*tadah hujan*) had happened one too many times. The village built the system through its own *gotong royong* (cooperative labor) efforts--expanding it over time to 400 hectares. In the early 1970's government aid was used to construct a more permanent weir, thereby further doubling the capacity of the system. Our visit to the desa was brief and unscheduled, and since other members of the party had to return to the provincial capital, we were only able to meet with one of the hamlet (kampong) heads as we walked along and briefly inspected the village works. Significantly, the elderly desa headman was out helping supervise the routine cleaning of the canals, and working in his nearby fields.

A final example from a fairly large (400 hectares) mountain system near Sukabumi, West Java, illustrates the leadership role that the village headman can take in introducing improved water management practices. In this location, the village headman had been active in adding 100 hectares to the irrigation network by converting former tea estate land to irrigated sawahs. In the 5 hectares of irrigated land that he owned personally, the headman employed sharecroppers and laborers from various locations within the village irrigation network on a rotating basis. The persons so employed gained experience in working with improved water management and cultivation practices on the headman's land, and then were able to introduce these new skills into their own locations. This approach was the headman's own way of personally introducing and extending knowledge and experience of improved agricultural techniques to the community at large--a responsibility he took seriously given his role as village leader.

To recapitulate, the preceding fairly extensive discussion is designed to illustrate the important role in irrigation played by village officials, and in particular the headman. The headman's influence is important not only within locations where village administrative bounds coincide with the physical layout of irrigation systems, but also where they do not. This includes locations where irrigation organizations or systems have an identity distinct from the village unit of government and administration.

Most of the IRS communities, as noted earlier, are more autonomous in running their own irrigation affairs than villages incorporated into large state pperated irrigation networks. It should not be forgotten, however, that these villages are not static entities. Given 'development' trends, these communities are moving in the direction of broader integration into the wider political-economy. Village officials (including the headman in particular) are increasingly being saddled with administrative 'development' chores imposed from above. Their orientation to external bureaucratic demands is likely to increase, not decline, with potential implications for the amount of time and attention that can be directed to supervising local irrigation. As a consequence, organizational problems may arise in those systems which depend heavily on personal leadership qualities and intervention by the village headman without accompanying development of intervening village irrigation institutions.

Since the village headman do not manage irrigation in isolation, it is necessary also to consider the irrigation roles played by hamlet leaders, village irrigation specialists, Irrigation Service personnel peasant group leaders, and the cultivators themselves. These roles must be considered not only in the context of the distribution of responsibilities for specific irrigation tasks, but also in terms of changing patterns of internal and external exchange within the rural economy.

2. Hamlet Officials. In most IRS locations, hamlet heads, who preside over sub-desa administrative units (hamlets, kampongs or villages), exercise important functions in irrigation affairs. While their irrigation roles vary considerably among and even within communities, these roles center around the fact that the hamlet is the primary administrative unit used to mobilize labor for co-operative tasks (gotong royong). Hamlet heads, as a consequence, frequently are responsible for mobilizing and supervising house-holds in cleaning canals and undertaking repairs to damaged structures. Their role in water distribution is usually, although not invariably, less important.

The importance of the hamlet as a unit for cooperative action derives from the fact that it is often the most solidary unit of social interaction and group mobilization--given close kinship, residential and cooperative labor-sharing modes. This characterization is particularly valid in the larger village complexes (desa) found in Java and parts of Sumatra dnd Sulawesi which frequently have more than 1,000 households. We will discuss the role of hamlet leaders in greater detail when discussing variations among communities in patterns of maintaining and repairing village canals and weirs. It is important to note, however, that without the active cooperation of hamlet heads, it is often difficult to carry-out cooperative irrigation tasks requiring labor mobilization.

An important consideration that bears upon the role of hamlet leaders is the extent to which there is overlap between the hamlet as a social-administrative unit on the one hand and the physical outlines of the irrigation canal network on the other. For example, in those locations where hamlet members have their sawah holdings in a generally contiguous area one could postulate that cooperation in irrigation maintenance tasks can be more effectively managed by hamlet heads than in locations where there is inter-mixing from a variety of hamlets.

There clearly are a variety of permutations which cannot be fully explored here. For instance, there is sometimes a direct matching between a hamlet as an administrative unit and a distinct portion of an irrigation system. Or, several hamlets may share a tertiary irrigation canal, for example, with members from specific hamlets being in the upper, mid or lower oprtions of the unit, or on one side of the canal. Then there are situations which seem to be quite prevalent in IRS systems, in which from 50% to 75% of the cultivators in distinct locations come from a single hamlet, with the remainder coming from other hamlets. In such cases, hamlet leaders may have distinct portions of the system which come under their jurisdiction with regards to maintenance responsibilities, and where it is comparatively easy to mobilize cultivators. Finally, there are irrigation locations where cultivators come from a variety of hamlets, with no one residential locale dominating.

When one takes the desa irrigation network as a whole, or specific systems (or sub-systems) which make-up such networks, there is also considerable room for variation. Some irrigation locations within the systems are attributed to specific hamlets, and therefore are fairly homogeneous in terms of their hamlet composition. Others are intermixed. In attempting to assess the impact of the relative homogeneity/heterogeneity of irrigation sub-locations with respect to the performance of irrigation tasks, there are a variety of considerations that must be taken into account. One therefore must exercise caution in making generalizations. <u>The evidence from the</u>

sample IRS communities, however, suggests that in a majority there is a substantial correspondence between physical components of the canal layout and hamlet of domicile. Such patterns, no doubt, help facilitate the performance of maintenance tasks--in particular the periodically organized cleaning of canals and emergency repair.

In some irrigation communities outside of Java that are small in size, and comparatively autonomous, there are no irrigation specialists found within the village. Rather, the headman or hamlet heads assume responsibility for managing irrigation as a part of their regular duties. Most IRS communities with existing systems, however, had distinct irrigation specialists (commonly called ulu-ulu) with responsibility for irrigation. In such communities, the role of hamlet heads in irrigation must be considered in the context of the division of responsibilities with such specialists. As suggested earlier, hamlet heads functioned primarily as mobilizers of cultivators for maintenance tasks involving group action. There was, however, considerable variation in the manner in which such tasks were implemented.

An important consideration that affected the responsibilities of hamlet heads was the degree to which irrigation tasks had become specialized, and carried out by a corps of irrigation specialists. In about a fifth of the sample IRS communities, there were multiple irrigation specialists or assistants who discharged irrigation tasks, including maintenance. Hamlet officials would be called in only in those situations requiring major maintenance beyond the capacity of the specialists.

A more typical pattern, however, was one where there was either a single ulu-ulu (village irrigator) or several village irrigation specialists responsible for distinct systems (or sub-systems) within the _desa_. Their role was one of coordinating and supervising irrigation activities, with the actual maintenance work being conducted primarily by cultivators. In these cases, hamlet heads usually were active in supervising and mobilizing labor for regularly scheduled maintenance, with distinct physical locations of responsibility. Usually there would be at least several hamlet heads falling under the jurisdiction of a single village irrigation specialist. Further illustration of the irrigation roles of hamlet heads will follow in sub-section C.

C. The Role of Village Irrigation Specialists or Irrigators.

Most IRS village systems visited or studied in detail had at least one, if not several village members assigned specifically to implement irrigation management tasks. Usually where there were several village irrigation specialists, they had responsibilities for distinct components (ie. tertiary canals) of the canal network, or for individual systems. (Some communities had multiple full or part time assistants in addition to the specialists.)

The specific composition of duties assigned to the village irrigation specialists varied. Frequently they involved (1) supervising the distribution of water, particularly during the dry season when controls are often introduced, (2) operating weirs, outtake structures and division gates where needed (and where such tasks were not being performed by Irrigation Service Personnel), (3) carrying out routine maintenance activities (either directly or through coordination), and (4) co-ordinating the implication of regularly scheduled major maintenance activities. A more detailed discussion of the pattern of responsibilities will be reserved for later sections dealing with specific irrigation tasks.

The most well known term used for such irrigation specialists is ulu-ulu, from Central/East Java, although the term is loosely used elsewhere. Other terms used include ili-ili, jogo-tirto, ladhu, and kepala bagian kemakmuran from Central Java, ili-ili and ulu-ulu in Javanese transmigrant areas of Lampung, ulu-ulu, Raksa-Bumi, mayor, kekolot, and jonggol from differing areas of West Java, Itu-wowo and ulu-ulu in East Java, Mandor Air, Mandor Wae and Momondo Air in South Sulawesi, Mantri Air in Minahasa Kabupaten of North Sulawesi, Mayor Lololopo in Gornotalo of North Sulawesi, Kepala Padang in South Kalimantan, Raja Bandar in North Sumatra, Tuo Banda in West Sumatra, Keujeruen Blang or Keujeruen Syik in Atjeh and Pekaseh or Klian Tempek in Bali. This list is not exhaustive, but rather suggestive of differences in local traditions and terms used to describe such village specialists.

In 79% of the systems sdudied in detail, there was a single individual appointed (or elected) to co-ordinate the village wide implementation of irrigation tasks--what we might call the chief irrigation specialist. He either operated on his own, or was assisted by other specialists. In the remaining 21% of systems, there were typically 3 to 4 ulu-ulu (in one case 8), with equal status in theory, each responsible for a distinct system within the overall irrigation network.

In general, where a single specialist was recognized as having overall responsibility for irrigation, such an individual was considered to be a major member of the village officialdom. In some cases such specialists functioned as the dominant force and authority in irrigation, with the village headman playing a secondary role. The more typical situation, as indicated earlier, was one in which the village headman was the chief authority in irrigation, and recognized as so by the village populace. The degree to which responsibility for implementing day-to-day irrigation tasks was delegated to the specialists in the later situations varied. Generally the headmen preferred to limit their responsibilities to tackling problems and initiating activities that otherwise could not be handled by the specialists.

In Table 11, which follows, an attempt has been made to divide the 19 sample villages with existing, functioning irrigation systems prior to IRS according to the manner in which irrigation specialists were organized. Three typologies with sub-variations are listed.

Table 11: Distribution of Sample IRS Communities According to the Types of Irrigation Specialists and Assistants present.

Category		No. of Desa	%
I.	Average of 4 Irrigation Specialists per village with distinct areas of responsibility.	8	42%
	a. 1 senior specialist with village wide responsibility, and several specialists with responsibility for distinct systems or sub-systems.	(4)	(21%)
	b. Several Irrigation Specialists (3 to 8) with responsibility for distinct systems/sub-systems.	(4)	(21%)
II.	One Irrigation Specialis or Village Irrigator.	6	32%
III.	One Irrigation Specialist or Village Irrigator with multiple assistants.	5	26%
	T o t a l	19	100%

In the most prevalent type constituting 42% of the sample communities, there were from 3-4 (in one case 8) ulu-ulu (or irrigation specialists) with responsibility for different components of the village irrigation network. In the second most common type (32%), there was a single village irrigation specialist responsible for irrigation affairs--although in most cases such specialists were actively assisted by hamlet heads. In the third type, representing 26% of the sample communities, a single irrigation specialist with overall responsibilities received help from full or part time assistants. Such assistants had less stature or less direct responsibility and authority than did the specialists listed in the first category. To give a better idea of the variations among the commmnities, it will be useful to discuss these categorizations in greater detail, and to provide illustrative examples both from the sample desa as well as from those visited during field trips.

The first general category can be broken down into two subcategories as was done in Table 11. Sub-category a represents those communities which have a village irrigator with community wide irrigation responsibilities, assisted by irrigation specialists with management responsibilities for distinct systems (or sub-systems) within the village irrigation network.

To illustrate, in an IRS location studied in North Sumatra, one ulu-ulu functioned as the overall irrigation co-ordinator responsible for water allocation among three tertiary blocks, and for maintenance of the weir and the 6 kilometer long primary canal. Three additional ulu-ulu were each individually responsible for distributing water within 150 hectare tertiary blocks, and for coordinating and/or carrying out maintenance. If necessary maintenance or repair could not be completed by the ulu-ulu within several days, then as many of the 8 hamlet heads involved in locations needing repair would be called in to mobilize cultivators.

A second illustration comes from the mountain system run by the community of Kalegeh, in Magelang Kabupaten, Central Java. Kalegeh's irrigation network consisted of 5 weirs diverting water from a single mountain stream. One ulu-ulu held overall responsibility for the irrigation network and its five sub-systems, several of which were inter-connected. He was assisted by three ili-ili, each of which was responsible for a specific area (1 or 2 sub-systems) and assigned to one of the 3 kelompoks (or water user groups) formed around these areas. Kalegeh is interesting because in addition to the village government and the irrigation specialists who managed irrigation, there were also distinct cultivator groups linked to specific portions of the irrigation network (with elected leaders) prior to IRS or government intervention. A water users association, formed around these water user groups, was started in the 1960's. Since such associations (P3A's) are being promoted by the government, Kalegeh is probably more representative of the post IRS situations, which in formal terms often are more organizationally complex.

Sub-category b under Type 1 represents those communities which have several irrigation specialists (or ulu-ulu) with responsibilities for distinct systems or sub-systems, but with no single specialist responsible for the irrigation network as a whole.

In desa Citasuk of the Bantenese area located in the western tip of Java, there were four ulu-ulus--each assigned to a separate system. These systems ranged from 50 hectares to 250 hectares in size, and were serviced by four different weirs--3 tapping 3 different rivers and one tapping a spring.

In desa Isimu Sela in the Kabupaten of Gorontalo in North Sulawesi, the irrigation network consisted of three distinct systems, with 115, 165 and 25 hectare command areas. These normally were operated independently, although on occasion when one of the systems broke down, it was possible to practice suppletion from another. Each system had an irrigation specialist called a '<u>mayor lolopo</u>', and each <u>mayor lolopo</u> had an assistant.

If we consider the communities falling under Category 1, it becomes apparent that they had clearly demarcated physical systems around which their irrigation networks were structured. In six of the communities, these were based on separate dam sources for diverting water per each internal system, while in the remaining two the sub-systems consisted of distinct tertiary blocks. The organizational implications of the physical layouts are evident. This is not to suggest that all locations with distinct multiple physical systems correspondingly had separate irrigation specialists assigned to individual systems. In a substantial majority of the cases, however, they did.

An intersting observation that can be made is that in those locations in which the component systems were relatively autonomous, there was no overall irrigation supervisor. By contrast, in those locations which had an <u>ulu-ulu</u> with overall responsibility in addition to system (or sub-system) <u>ulu-ulu</u>, the systems tended to be more interdependent.

<u>Category 2 consists of those IRS communities which from the reports appeared to have one village irrigator or ulu-ulu only, and no assistants</u>. <u>These represented 32% of the sample villages</u>. (It may be that several of these locations are incorrectly categorized, with incomplete information.) In several of these systems it appears that lower ranking Irrigation Service personnel (weir or gate keepers)

were present, thereby in part relieving the _ulu-ulu_ of some duties. In several other of these systems it was reported that the hamlet or _kampong_ heads played a very active role in assisting the village irrigation specialist to manage irrigation activities.

In the desa of Manjung in the Wonogiri area of Central Java, for instance, there are three small systems totalling 60 hectares that have been developed over the last 3 decades. There is one _ulu-ulu_ or _jogotirto_, who is actively assisted by hamlet heads (_kebayan_) not only in maintenance but also in water distribution activities. In part this high level of involvement by hamlet heads is a matter of self-interest. At the pre-IRS stage in the fledging systems, 1/3 of the land was in _tanah-bengkok_--in which all hamlet heads as well as _desa_ level officials had shares.

While not included within the sample survey, reports on some IRS systems from the province of Atjeh which were presented at the national P3A conference in Bali are interesting. They suggest that in the Atjehnese communities concerned, there is a single irrigation specialist called the _Keujereun Blang_. Interestingly, the duties of _Keujereun Blang_ are primarily limited to managing water distribution. Maintenance and repair of canals and weirs, by contrast, is the responsibility of the village headmen and other village officials--who have authority for mobilizing labor. (See also earlier discussion on the irrigation roles of headmen and hamlet leaders.)

The third category consists of communities where there is a single village irrigator with village wide responsibilities, but who is aided by a few to as many as 30 to 40 irrigation assistants--either part or full time. _There are several types of patterns._ _In one, the irrigation specialist may use the assistants for special_ duties--wherever needs arise--directing them closely in their work. In a system in West Java, for instance, part time assistants work only during water short periods during the dry season, so as to help the ulu-ulu keep conflict under control, by patrolling the canals while water is being distributed. In a second version, assistants may be assigned to distinct systems or sub-systems on a more or less permanent basis. However, they are carefully controlled by the village irrigator--in whose hands the real day to day responsibility for implementing decisions and exercising authority lies. In a third variant, such assistants have small but distinct command areas of responsibility--including the right to make decisions.

Communities from both East and West Java, and North and South Sulawesi are found in this third category. Several from West Java are indicative of the diverse kinds of adaptations to local situations, and deserve mention.

One of the sample desa is located in mountainous terrain in the Kabupaten of Kuningan, West Java, not far from the border with Central Java. The village receives its irrigation from 4 tertiary canals which branch off of two secondary canals operated by the Irrigation Service. There is one overall village irrigator called the Raksa Bumi. He, in turn, coordinates 25 irrrigation assistants (or mayor), which are assigned in groups of five to each of five irrigation blocks. There are five kampongs within the desa, and each kampong is closely identified with a block--the five mayor in each block thus appear to come from a single hamlet (or kampong). The importance of the hamlet as a unit with direct implications for irrigation organization are evident in this example.

Another system in the Kabupaten of Ciamis in West Java, also located in mountainous terrain, demonstrates the importance of the hamlet as a unit of irrigation organization. The 400 hectares of irrigated sawah prior to IRS received water from 3 rivers and one spring, coming to the village via 18 channels. There were 9 semi-permanent weirs prior to IRS, two dating back to the late 18th century. The one ulu-ulu worked in close cooperation with 13 kampong heads under a system called korps kerja bakti. The kampong heads were directly involved both in water distribution as well as in supervising maintenance, with each hamlet having a minimum of one irrigation assistant (petugas) assigned to be a member of the work corps. The responsibilities of the petugas (or work staff) were primarily in the area of maintenance and repair.

A third IRS community from West Java, the uppermost desa on a mountain slope near Sukabumi, was not part of the sample, but was studied in the pretest of the questionaires. The desa had 23 major channels--4 primary and 19 others, which came from 5 rivers and streams, plus numerous springs as supplements. The desa had 4 kemandoran (or hamlets) and around 1700 households, and one ulu-ulu who was in overall control of irrigation, and very busy with his job. He was assisted by 40 pembantu (assistants) called janggol, who were assigned to one of the major 23 channels. Some channels had one janggol, others 2 to 3, and a few up to 4, based on need. These janggol were paid full time irrigation assistants, responsible for dividing water as well as carrying out maintenance. Only when there were major repairs beyond their control, or on special days set aside for major seasonal maintenance, would the hamlet heads become involved (along with the ulu-ulu and headman) in mobilizing cultivators for cooperative labor. The desa switched to this system of irrigation organization, which transfers irrigation responsibilities significantly to a core ofspecialists, only after the earlier system of relying on cultivators became 'kurang tertib'--not well arranged.

In sum, even from the small sample of villages studied or visited, it is clear that there was a considerable amount of diversity in the way communities allocated irrigation management responsibilities among headmen, hamlet heads, village irrigation specialists, irrigation assistants, cultivators and water user groups prior to IRS. Most communities delegated major responsibility for co-ordinating irrigation activities to either a single irrigator or several specialists, with fairly high levels of involvement by hamlet leaders and village officials. As we shall see in the discussion on water distribution and maintenance tasks, cultivator participation was also fairly high. Some of the more organizationally sophisticated communities had begun to move in the direction of transferring responsibilities for day-to-day tasks to a corps of irrigation assistants with special duties. Most of these, however, expected water users to participate on major repair jobs, and on regularly scheduled community wide cleaning of the canals. Others, by contrast, were moving in the direction of greater organized involvement by peasant cultivators through the formation of water user groups--either formal or informal. Finally, the physical layout of systems, including the technologies used, often had a direct impact on the types of organizational formats that evolved.

D. The Role of Formal Organizations.

In general the Sederhana communities did not have formal organizations prior to changes introduced by the government--at least as defined by a constitution, membership and written procedures (as found in Bali). The lack of a formal organizational structure, however, should not imply that existing organizational modes were ineffective. What is striking about a substantial number of IRS communities is that there were fairly well defined informal norms and sanctions which helped to regulate irrigation behaviour and to promote corporate action, where needed. Many communities, however, reported that there was room for improvement through more detailed specification of duties, rules and contributions expected of cultivators. For such improvement to take place, many systems required further development of existing and/or new technologies, including a more elaborate network of field level delivery and drainage channels. The potential role of formal organizational structures in promoting such developments will be discussed later in the report.

It is interesting to observe, however, that in several of the detailed case studies formal irrigation organizations had been created prior to involvement by the government.

In the IRS community of Kalegeh, located 900 meters up in mountainous terrain in Central Java, a village irrigation association called '*Tirta Martani*' was formed in 1967 under the leadership of the *desa* head. In 1971 the existing organization was converted to the *Dharma Tirta* format, and informal cultivator groups became formally organized sawah *kelompoks*--water user groups organized around the physical layout of the irrigation network. As was noted in sub-section C of this Chapter, and Chapter III, Kalegeh had 5 partially interconnected systems, using 5 weirs--and organized in to three major *kelompoks*--each with its own *ili-ili*. The *desa* was comparatively small (415 households), with an irrigated network of 139.5 hectares. The *ulu-ulu* continued to retain his traditional role as implementer and co-ordinator of irrigation under the Dharma Tirta format. Interestingly enough, in terms of its technologies, topography, size and general autonomy, Kalegeh clearly fits the Spencer typology outlined in Chapter I of this report.

In an IRS community in North Sumatra, a formal organization was formed in the early 1960's at the time that its irrigation system was being developed by 8 hamlets. The construction of a diversion dam, 6 kilometer long major canal and secondary and tertiary canals, thus, occurred in concert with organizational formation. The Irrigation organization was known as the Panitia Irigasi Persawahan Kelahun Pinang ('Sawah Irrigation Committee of Kelahun Pinang'), with the hamlet heads (coming from two kecamatan) as joint sponsors. The organization collected fees, carried out construction activities, and employed 4 ulu-ulu as discussed in sub-Section C. In 1975, with the assistance of an Agricultural Extension Official (PPL), it underwent modification, and a water users association (P3A) was formed. (The irrigation associations-or Perkumpulan Petani Pemakai Air, which is translated literally as Grouping of Cultivators Using Water- will hereafter be referred to as P3A's.)

In addition to these formal types of organization, which covered the whole irrigation network and all cultivators, there were special groups or committees formed in several sample desa to manage irrigation. In the last sub-section we discussed the way in which a desa in Ciamis, West Java, operating through its hamlet heads, village officials and ulu-ulu, set up a Korps Kerja Bakti to implement day-to-day tasks. A sample desa in Serang, West Java, was reported to have a 15 man committee with decision making-authority in irrigation, and an identity separate from the village administration. Its composition and duties, however, were not spelled out.

Finally, the sample desa from West Sumatra, as reported earlier, had an irrigation advisory committee called Panitia Pengairan Desa. It consisted of the Wali Negeri (the desa head), the three wali jorong (3 administrative sub-unit leaders), the Ninik Mamak Pemangku Adat (customary adat elders) and the 8 Tuo Banda (the respective ulu-ulu). The desa head was the key person at the community wide level (there was no single irrigation specialist with overall responsibility), while the 3 Wali Jorong (which encompassed 5 hamlets) played a traditionally sanctioned role at lower levels. While the Tuo-Banda (irrigation specialists) were responsible for the day-to-day implementation of irrigation tasks, the Wali Negeri and Wali Jorong held major responsibility for initiating non-routine tasks which required the mobilization of cultivators--such as the annual cleaning of canals and emergency repair. Finally, the adat elders played a critical role in settling disputes and in assigning and mobilizing funds. This role was of particular importance, since land was often held substantially in the name of the clan (kaum), in which the adat elders held authority as clan representatives.

E. Inter-Village Interaction and Coordination: The Role of Hierarchical Leaders and Irrigation Service Personnel.

Up to this point we have been discussing organizational forms and personnel which were internal to the communities prior to IRS. In a number (although not all) locations, where several communities (or more) shared a single water source, persons external to the villages also were involved in co-ordinating irrigation.

In parts of North and West Sumatra, and in South Sulawesi, there are locations where a number of villages copperated in irrigation, with coordination functions sometimes exercised by locally recognized hierarchical (or patrimonial) leaders. None of these situations turned up in the sample survey. However, reports from agricultural assistants indicate their presence in selected IRS community areas.

A report by a Canadian regional development team in South Sulawesi, for instance, argues that local patrimonial rulers whose authority is still recognized, sometimes perform useful functions in co-ordinating (and arbitrating between) communities sharing common irrigation facilities. In the Simalunggun region of North Sumatra one finds an inter-community organizational format called the Panriahan Pamokkahan still functioning. Groups of villages which share a primary canal consult each other periodically, and alternate leadership annually among one of the village headman. The headmen, as a group, remain responsible for co-ordinating irrigation among communities. Their decisions are considered binding. Finally, in Bali the Sedahan Agung coordinate irrigation in specific watersheds. Their authority is recognized by all subaks (irrigation communities) concerned, and is legitimated through historical as well as cultural tradition.

For the most part, external (or inter-village) coordination of water distribution in Sederhana communities--where it exists--is conducted by lower-ranking Irrigation Service personnel. These personnel man diversion weirs and turnout gates on primary and secondary canals. Of 370 IRS locations reporting, 20% stated that overall coordination of water distribution in the project area in theory was in the hands of a juru-pengairan (or sub-subsection irrigation official). Often, however, such co-ordination was limited to periodic visits. Another 10% of IRS communities reported the presence of gate and weir-keepers. (These figures apply to post-IRS situations.)

In some of the sample locations studied in detail or else visited, it appeared that the construction of IRS facilities became the justification for installing an Irrigation Service technician into the project area. It is important to note that where inter-desa competition for water is keen during the dry season, such personnel potentially may exercise critical functions in determining the degree to which water can be distributed efficiently and equitably. Frequently, however, this function was not being discharged adequately--either prior or subsequent to IRS. The presence of outside personnel often is more essential in situations where several *desa* share common intake facilities or canals (see discussion in Chapter III of this report), and less so where they have their own weirs diverting water from a common source (river). As was noted, the level of interdependency in the sample desa is probably higher than in the IRS universe as a whole. (We will discuss the role of outside agencies in greater detail later in this report, including examples.)

It is worthwhile noting again that within 70% of the IRS systems, outside officials do not influence the management of irrigation. As noted earlier, only 35% of IRS communities have additional systems upstream, while 30% have downstream systems. The relative autonomy of most of these systems remains a distinguishing characteristic, with interesting implications for organizational performance.

V. ORGANIZATIONAL CAPACITIEIS TO CARRY-OUT CONSTRUCTION AND LAND DEVELOPMENT ACTIVITIES PRIOR TO IRS.

A. Introduction.

As has been indicated earlier in this report, the capacity of communities to carry-out irrigation construction and land development activities is a major concern of government policy--particularly with regards to tertiary canal development. In this Chapter, therefore, an attempt will be made to look at major construction activities implemented by selected IRS communities (both those in the sample survey and those visited) prior to government intervention through the Sederhana Program. Construction activities concerning repair or replacement of damaged community weirs, canals, and terraces will be deferred to a later chapter of the report, as will discussion of land development activities in areas acquiring irrigation for the first time through IRS.

B. Examples of Major Construction and Land Development Activities Prior to IRS.

In a number of the systems studied or visited, government sponsored construction represented only a step (although sometimes a major one) in a series of improvements and extension of irrigation infrastructure initiated by the communities concerned. Usually, although not invariably, the expansion and elaboration of systems was carried out with little if any outside technical assistance.

For the most part, these locations already had existing, functioning irrigation systems during the late colonialera--either the product of village efforts or else construction by the colonial government. Several, however, built systems from scratch during the 1950's through the early 1970's, one covering up to 400 hectares.

Since the circumstances associated with such activities were diverse, it will be useful to briefly summarize a number of the case studies, before looking for common patterns.

First it will be useful to look at several systems formed during the last few decades, before looking at communities which undertook major modifications or extensions of existing systems.

In the Kabupaten of Wonogiri in the southern portion of Central Java, three small systems which totaled 60 hectares were formed by a desa in the early 1950's in hilly terrain devoted primarily to dry land cultivation. Each system had its own weir, and two shared a single water source--a river. The weirs for these systems were all constructed in a period of two years. They were permanent structures made out of stone. In two, the desa sought and received some technical advice from the Irrigation Service. The initiative and decision to carry out the construction however came from the desa, which provided all the labor through gotong-royong activities as well as funds from desa sources. In particular, the desa headman, using musyawarah consensus, played a key role in launching these activities. Currently the condition of the dams is poor as a result of deterioration, but the desa lacks the funds to purchase the necessary materials to undertake repair. The canals undergo major repair two to three times a year. Interestingly, where 25 years ago the desa was able to harness funds to launch the systems and purchase requisite materials, they now no longer appear to have the financial capacity to undertake major rehabilitation of the permanent structures.

In Lampung, South Sumatra, Javanese transmigrants who settled in the area in the early 1960's, initially primarily cultivated dry land crops for a period of 10 years. In 1971, under the initiative of the dynamic desa leader and after extensive discussions, they began construction of an irrigation system. By the end of 1974 the system had expanded to 110 hectares. In undertaking construction of the system, and in the extensive discussions about the manner in which the community would organize operation and maintenance, the desa relied heavily on the advice of cultivators with experience in wet rice production in Wonogiri--the primary place of origin. Their ulu-ulu, who had received training in water management and irrigation during the late 1940's and early 1950's, was a key person in decision-making. Under the Sederhana project, an additional masonry weir is being constructed further upstream from the present weir at the suggestion and partially under the guidance of the desa. It is expected to add 70 hectares of irrigated rice paddies, once all the tertiaries are in place and the rice fields formed and terraced.

In previously discussed Keluhan Pinang in North Sumatra, community action and active leadership by kampong headmen led to the formation of an irrigation system in the 1960's. Over 400 hectares of dry-land cultivation were transformed into irrigated rice (150 hectares with two crops a year). The village, through its own efforts built its own weir, 6 kilometers of major canals and additional kilometers of tertiary canals. Approximately 50% of the land was located on a relatively flat plateau, while the tail-end of the system was terraced along steeply sloping land.

A substantial proportion of the remaining communities undertook major extensions or modifications to their systems during the last several decades. Several illustrative examples follow.

In the West Javanese village near Sukabumi discussed earlier, 100 hectares of new sawahs were added to the existing 300 hectares over a 10 year period from the late 1950's into the 1960's. These *sawahs* were situated primarily on a fairly steep ridge and its mountainside which previously had been part of a coffee estate. The formation of these *sawahs*, including the leveling of land and the dyking of fields, was the responsibility of individual cultivators. In practice, however, such cultivators relied heavily on the labor and advice of village technicians with experience in these matters. During this period and earlier, 4 additional dams and 4 major canals were added to the existing 19 weirs and canals. In all of these activities, the *desa* headman played a key role--as outlined earlier.

In the Central Javanese mountain village of Kalegeh, which we have discussed previously, 4 major irrigation construction efforts were undertaken between 1960 to 1969. These included building an additional weir and extension of rice paddies. In only one case did the projects benefit from government subsidies.

Between the 1930's and the 1940's, a mountain village in Jember, East Java built three diversion weirs along a single watershed to irrigate 165 hectares. In 1969, the *desa* headman took the initiative to add 50 hectares of land which could be irrigated by making one of the weirs permanent, using *desa* funds and technical skills.

In the Kabupaten of Minahasa in North Sulawesi, during the late colonial period, a 200 hectare irrigation system was built by the *desa* Tatelu. The funds were collected from the villagers. The required labor inputs also represented *gotong-royong* contributions. Later, step by step, the system was extended--including lengthening of canals, opening up of land for *sawahs* and installation of more permanent technologies. The *desa* headman, along with the village irrigator (mantri air) played major roles in securing the participation of the cultivators at large. While canal construction and modification of the physical infrastructure was conducted on a gotong-royong basis formation of sawahs was carried out in small groups.

In our final example, a village located on the lower foot-slopes of Mt. Merapi, not far from Jogjakarta, one of the desa's irrigation systems was first constructed during the late colonial era by the Dutch government for use by sugar plantations. The weir was a fairly simple construction, and the main canal at that time was only 175 meters long. In 1970, the desa (1) rehabilitated the dam and made it more permanent, (2) extended the length of its primary canal to 500 meters, and (3) elaborated its tertiaries to a length of 10,000 meters. These improvements enabled 95% of the systems cultivators to get water directly from delivery channels.

Most of the sample IRS villages had modified and develop their irrigation systems in the recent past. It is clear, however, that not all communities have such a capacity, particularly in the new systems found in some of the less densely populated islands. It is also evident that the circumstances just described for the most part differ from those found in many of the large, state operated lowland irrigation networks. It will be useful, therefore, to summarize some of the conditions associated with village capacities to undertake development of irrigation largely on their own.

C. Conditions Associated with Irrigation Construction and Land Development Activities Prior to IRS.

At the risk of oversimplification, we can outline several major determinants of village irrigation development capacities.

First, almost without exception, all of the villages had active leaders who took major responsibility and initiative in encouraging construction activities. Official leadership applied in particular to repair or construction of weirs, canals, and other irrigation infrastructure requiring group action. Second, in most of these cases the villages concerned were largely responsible for managing their own irrigation. They operated fairly autonomous systems.

Third, in most villages studied, communal norms and sanctions regarding obligations expected in gotong-royong activities were well observed and respected. In part this reflected the approach of leaders and dictates of tradition. Headmen, usually secured the partiaipation of cultivators via village wide discussions and eventually consensus, before any major construction activities were launched.

Fourth, many of these systems were situated in hilly or mountainous areas where the types of construction required were within the technical reach of the villages. Likewise, most of the systems were relatively small in size, although several were as large as 400 hectares.

Fifth, many of the desa had the requisite technical skills needed to build weirs and canal networks, and to open up sawahs. For the most part constructions were not made of cement or masonry, although in recent years there has been a shift in this direction. Significantly, the pace of irrigation construction seems to have accelerated in a number of locations following the provision of annual subsidy incentives by the government--particularly through the subsidy desa program. Since a major constraint present in most villages was inadequate finances, government funds were often used to help defray the costs of purchased construction materials. The value of labor inputs provided free through unpaid but expected gotong-royong contributions appears to have substantially exceeded the value of purchased inputs.

Sixth, there was variation among villages concerning the manner in which the opening up of paddy fields--including terracing, levelling, and bunding--was organized and financed. As indicated earlier, group activity organized and directed by village leaders was used to construct public irrigation infrastructure. By contrast, forming sawahs was primarily left to individual cultivators or groups of cultivators, and carried out in stages.

There were, however, variations. In a minority pattern, gotong-royong labor, directed by village officials, was used to form sawahs, involving heavy concentrations of manpower upon selected portions of the system, in a sequencing process. Some cultivators, thus, would be favored over others--particularly when such construction stretched over a period of years. In Wonogiri, for instance, the formation of sawahs in the three small systems stretched over a period of 5 years--with approximately one/third of the 60 hectares being opened during the initial year. In Bali, where a new subak is being formed under IRC about 1,000 meters up on a mountain in land formerly devoted to dryland cash and food crops,,there is an interesting approach. The village appears to have used a gotong-royong approach in forming the initial 30 hectares of irrigated terraces. In the interests of equity, however, it appears that 96% of the 100 households in the village have some land in that first 30 hectares. By the end of the third year, the irrigated sawahs are expected to reach the full potential of 100 hectares.

Under a second appraach, the opening of sawahs is left to individual cultivators and their families. In the irrigation system formed by Javanese transmigrants in Lampung (which was discussed earlier), the initial irrigated area of 30 hectares during the first year was expanded to 100 hectares after 4 years. Prior to forming the system, there was extensive discussion about the approach to be used. It was agreed that *gotong-royong* labor by all potential cultivators would first be employed to lay out the basic physical infrastructure of the system, including delivery channels. It was not possible, however, to achieve a consensus regarding a *gotong-royong* approach to forming *sawahs*, since some cultivators would be favored over others. Instead, each cultivating household remained responsible for opening its own land and shaping its terraces and bunds. Everyone wanted a piece of the action from the start. The preceding approach was feasible, since the canals and teritaries had been laid out in conjunction with land allocation in such a way that every household had access to a channel. Accordingly, during the first year, households shaped sawahs on their land that was immediately adjacent to delivery channels--each succeeding year adding new terraces below those already constructed. Such work was concentrated heavily in the two month period prior to the onset of the rainy season, during the most slack period in the agricultural cycle.

A variant of this second approach, which leaves responsibility for laying out rice fields to individual households, was employed in a mountain village near Sukabumi, West Java. Here, as we noted earlier, a whole ridge (amounting to 100 hectares) and its surrounding mountain-side were added to the existing irrigation network. The forming of terraces and bunds appears to have taken place over a ten year period. While individual cultivators took responsibility for the lands allocated to them, they relied fairly substantially on a group of village technicians with experience in such matters. The latter were hired to provide technical guidance and some of the labor needed. Since the supply of such technicians was limited, the terracing process took place over time on a phased basis. It also appears that the elaboration of field delivery channels, which were very intricately developed throughout the village network, in large measure accompanied the formation of sawahs, rather than being laid out in advance.

In sum, the examples presented in this chapter give some idea of the diverse kinds of situations in which communities have comparatively recently made major modifications to their systems. There are, however, some common elements--including patterns of leadership and participation, types of technologies and physical structures, organizational approaches, and technical knowhow. It is important that the government retain enough flexibility in its technical and organizational assistance programs so as to capitalize on such village capacities and knowhow where possible, while at the same time addressing constraints faced by individual communities. Many village systems can benefit from and desire technological upgrading of irrigation infrastructures as well as assistance in water management, agricultural cultivation and organizational techniques. Financial inadequacies at the village level are a major constraint which slow the pace of technological upgrading requiring purchase of materials.

VI. ORGANIZATIONAL CAPACITIES TO CARRY-OUT MAINTENANCE, REPAIR AND INCREMENTAL CONSTRUCTION PRIOR TO IRS.

A. Introduction.

A major concern of government policy centers around the capacity of villages to conduct ongoing maintenance and repair of the physical infrastructure of their irrigation systems. In considering this matter, we will first look at irrigation maintenance capacities prior to IRS, before turning to look at the situation after government intervention and introduction of improved technologies. (The latter post IRS situation will be addressed later in this report). The two situations may differ somewhat, since the post-project phase may involve technologies (gabion or permanent masonry weirs) which are quite different from the types of diversion structures present within systems originally. Likewise, the post-IRS organization of maintenance/repair activities may also differ from preexisting modes as a result of organizational modifications introduced by field level agricultural extension staff.

Throughout this chapter an attempt will be made to evaluate the capacity of and the conditions under which IRS communities carried out maintenance effectively prior to project intervention, and the circumstances under which difficulties were encountered. Where appropriate, contrasts will be made with conditions found in state operated lowland systems, where irrigation structures at the local level are often (although not invariably) poorly maintained and in a relative state of disrepair. An additional consideration of relevance concerns the effectiveness of Irrigation Service personnel in either facilitating or hampering maintenance and water distribution at the village level--based on their degree of effectiveness in discharging duties.

In the discussions which follow, distinctions will be drawn between major maintenance activities typically carried out prior to the onset of a cultivating season (turun ke sawah), and routine on-going maintenance where needed on a periodic or irregular basis. The organizational procedures associated with these two activities often vary. An attempt also will be made to consider the frequency with which emergency repair due to flooding or other damage is required on irrigation works, and the manner in which communities organize to undertake repair. Finally, the need for and capacity of communities to undertake incremental construction will be probed--such as the lining of canals and the installation of concrete division boxes.

It should be noted at the outset that the need for and tasks involved in maintaining irrigation structures will vary considerably by locale. The physical-ecology of the micro and macro-irrigation environments and the technologies involved in the physical layout of the systems are important determinants of the frequency and nature of local irrigation maintenance tasks. In the Seoerhana context, the simple village weirs and earthen canals are frequently vulnerable to damage, particularly in many of the highland locations which are prone to the sudden flood torrents (banjir) which come sweeping down the mountains during monsoon storms. This situation of vulnerability requires an active organizational capacity to tackle problems immediately as they arise.

A fairly high level of community labor at certain times of the year therefore, is required to keep village irrigation structures in good working order. This is because of (1) the perishable nature of the diversion weirs which are vulnerable to damage during the monsoon storms, as indicated above, (2) the high silt content of many of the mountain streams and rivers and (3) natural vegetative processes which lead to the growth of weeds in unlined earthen canals. The fact that terraced rice cultivation in many of the IRS locales has resulted in stable relationships with the surrounding ecology must in significant measure be attributed to the capacity of communities to perform irrigation organizational tasks effectively over time. This observation is in part consistent with the findings of an FAO team as well as the Canadian regional development team in Sulawesi, which noted that small community systems are often better maintained and more effectively run than large state systems.

The following table is drawn from the 55% IRS locations which reported functioning irrigation systems prior to project implementation. It indicates the frequency with which upkeep and repair activities were uddertaken prior to IRS. Unfortunately these data do not distinguish betwean major and routine maintenance activities, although they appear to refer to major activities. The data indicate differences among *desa* in the amount of time devoted to major maintenance and repair, with higher volumes of work during the wet season.

Table 12: Frequency of Irrigation Maintenance and Repair Prior to IRS in the 55% Locations Reporting then Functioning Systems.

Number of Times Activity Performed Per Season	Percentage of Households			
	Maintenance Activities		Repair Activities	
	Rainy Seas.	Dry Season	Rainy Seas.	Dry Seas.
0	20.8	32.2	21.1	44.7
1	20.0	24.7	37.4	27.0
2	29.9	19.2	20.8	10.9
3	12.0	5.4	7.9	5.7
4-6	10.6	12.6	8.3	9.3
7+	6.7	5.9	4.5	2.4
Total	100.0	100.0	100.0	100.0

It will be useful, therefore, to focus on the specific kinds of activities undertaken.

B. Major Seasonal Maintenance and Repair Activities.

1. Pre-Cultivation Community Meetings.

Most locations reported annual or semi-annual periods when the community would act together to repair irrigation structures and to clean canals. The commencement of such activities took place prior to the 'descent into the fields' (turun ke sawah) to undertake preparation of the soil, and usually followed a major meeting to decide on work schedules, the timing of cultivation and other issues related both to irrigation and agricultural cultivation activities.

The format that these meetings took, the kinds of participants, and the topics discussed varied from community to community. For the most part, however, these meetings (or rapat) followed traditions of long standing, in which major issues that involve the livelihood of the village populace are discussed in advance through a process of group consensus. In a majority of cases the meetings were chaired by the headman, with participation by the ulu-ulu (irrigation specialists), desa officials, hamlet heads, leading farmers and other notables. In places such as West Sumatra, North Sulawesi and Atjeh, adat and religious elders played key roles. The junior agricultural assistance (PPL) were frequent participants or observers, and in systems where Irrigation Service personnel played leading roles--they also were sometimes in attendance.

The topics discussed during these meetings included plans for carrying out irrigation maintenance and repair activities prior to cultivation, as well as on an on-going basis. Assignments would be gimen out to respective groups regarding the areas they would be expected to clean, and regarding on-going maintenance schedules. Also, decision regarding water distribution, to the degree control was being exercised, were a topic of primary concern--particularly prior to the dry season. Finally, there was considerable variation in the degree to which agricultural cultivation activities--including types of crops, timing of planting, etc.,--were subject to village control. Agricultural cultivation and cropping patterns were, however, a topic frequently discussed in fairly graat detail.

In some cases, the ulu-ulu would play a key role in setting out the agenda of the meeting and in laying out plans--based on his assessment of existing repair needs and water availability. Fairly extensive discussion among small groups of cultivators often took place prior to such meetings. In other cases, the rapat meetings themselves became the forum in which views were aired, and decisions made. In a Minahassan desa in North Sulawesi, for instance, the village irrigation specialist (mantri air) made suggestions to the desa head at the meeting, who in turn had the authority to hand out assignments.

In one case in Jember, East Java, where the desa in question received its water in one system via a weir operated by the Irrigation Service, the initiative for the desa meeting came from the juru pengairan (or sub-kecamatan level Irrigation Service specialist). In this case the timing of maintenance and water distribution activities was contingent upon government action. The juru pengairan would inform the desa (usually in September and March) that during a 15 day period the drying of primary canal from which the village got water would take place. The village would be expected to dry its own three canal sub-systems at this time, and undertake whatever cleaning and repair was necessary.

Usually, however, where the Irrigation Service was involved in maintaining some of the structures, it would be either a participant at the meeting, or would be given the results. Sometimes informal discussions with government officials took place prior to the meetings. Usually the desa would be expected to contribute to the cleaning and repair of canals and structures which nominally were the responsibility of the Irrigation Service. Hence the need for interaction, so that in making assignments, plans also could be made for work on the Irrigation Service operated facilities.

Where formal irrigation committees or advisory groups existed, these were expected to play key roles in the irrigation decision making process. It is interesting to note that in at least 25% of the sample desa, a village rembug, or full convening of all cultivators took place at the time that irrigation and cultivation decisions were to be decided. All of the communities where this variant of full participation took place were comparatively remote hill/mountain villages.

2. Organizational Variations in Implementing Seasonal Maintenance Tasks.

Once decisions were made regarding the timing and schedules for cleaning canals, these decisions were conveyed to cultivators via hamlet heads primarily, but also by the irrigation specialists, their assistants, and farmer leaders--or some combination of these persons. The ulu-ulu or other village irrigation technicians usually were responsible for coordinating the cleaning of canals and the repair of weirs. Direct mobilization and supervision of working groups of cultivators in gotong-royong cooperative fashion usually was conducted by hamlet heads.

There was considerable organizational variation in the manner in which the major cleaning of canals and repair of structures was carried out.

In one minor variation, the whole village would start at the head of the system and work its way downward, day-to-day, until finished. Usually, however, specific assignments would be handed out to working groups. These assignments could relate both to primary and secondary canals shared by the whole village, or to individual systems used by separate hamlets or cultivator groups. In addition to work at the primary or secondary level, work also was carried out at tertiary sections.

In locations where the whole desa shared common facilities, such as a primary and secondary canal, an attempt would be made to divide up the major canals in sections based on an assessment of a fair apportioning of work responsibilities to differing working units. Usually assignments would be made to hamlet (or kampong) heads, with their working groups consisting of hamlet residents. This principle also frequently applied to Irrigation Service managed facilities which were commonly shared by the desa, and on which the desa would be expected to help conduct repairs. In both of these kinds of situations, hamlets were assigned responsibility for specific sections of the canal network at the primary and secondary level. These and subsequent organizational arrangements to be discussed took cognizance of the fact that the hamlet was probably the most natural social unit for mobilizing effective corporate action. (See also discussion in Chapter 4 of this supplemental report.)

A good example of the preceding approach to maintenance on primary/secondary structures is the system in North Sumatra discussed earlier. Here, the 6 kilometer long primary canal would be divided up among the 8 kampong heads--with cultivators working where there kampongs were assigned. Different principles of organization, by contrast, applied to the tertiary blocks.

In other locations the desa's irrigation network would consist of more than one irrigation system or sub-system. There were several organizational approaches for carrying out major maintenance on the primary and secondary structures of such systems, which also frequently extended to tertiary components. Usually anywhere from one to several hamlets would be recognized as falling within the physical layout of specific systems or sub-systems. Where distinctive patterns of overlap between specific hamlets and specific cultivation locations were present, hamlet heads usually would be assigned responsibility for such locations within the specific system. Thus, several hamlets might be encompassed within and work on one system, while other hamlets would be linked to different systems or components of the irrigation network.

It was common, therefore, for a hamlet head to be assigned responsibility for specific portions of a command area--either at the primary/secondary level, the tertiary level, or both. Under one variant, hamlet cultivating households would be assigned to work in the same location as their hamlet head, irrespective of the location of their own sawah plots. Systems in the southern and northern portions of South Sulawesi, and in the Kabupatens of Minahasa and Gorontalo in North Sulawesi, all followed this pattern with reference to the major seasonal clearing of canals and repair of weirs. In all four cases, there was a close correspondence between hamlet (or administrative unit) of domicile and specific cultivation locations in the irrigation system. In three of four cases, likewise, a different organizational format was activated with reference to routine maintenance--with cultivators working in locations where there plots were. In the Minahasa location in North Sulawesi, the four jaga (kampong heads) would have an informal competition to see which kampong could complete repair and cleaning of its section of the irrigation system in the shortest possible time.

Under a second variant, which was more common, cultivating households would work in the locations where their plots were located, under the hamlet head assigned to that location. Since there frequently was a close correspondence between the hamlet and the irrigation unit, most cultivators under a particular hamlet head would be from that hamlet. There were, however, differences between locations within specific desa regarding the homogeneity of working groups--as reflected in hamlet of domicile. (See also Chapter 4). This pattern was found, for instance, in the desa from Jogjakarta, where five dukuh were served by the IRS rehabilitated weir and system, which was one of several systems in the village. A similar pattern was found in Wonogiri, Central Java, where the kebayan (dukuh head) supervised cultivators within specific locations within the three systems in the desa.

A third, less common variant in some ways represented a combination of the first two. Here the composition of working groups assigned to specific hamlet heads would differ--depending on the level within the irrigation system primary/secondary, or tertiary. We can refer again to the example from North Sumatra. On the commonly shared primary canal, all cultivators from a specific kampong would work in the sections assigned to their respective kampong heads. On the other hand, within the three tertiary blocks, each of which was managed by a different ulu-ulu, cultivators would work where there plots were situated, under the supervision of the kampong head assigned to that location.

In some communities, where there was a close correspondence between hamlets and specific sections of irrigation systems located within desa confines, hamlet heads played a much less active role from that already outlined. In a mountain village in Lumajang in East Java, for instance, the ulu-ulu and his assistants co-ordinated and supervised cultivators in major maintenance activities. Cultivators would work in the general location of their plots, and were recruited to work on major structures by the ulu-ulu, when required. In Jember, in East Java, a similar pattern holds--with the ulu-ulu and the pembantu ulu-ulu mobilizing households for seasonal maintenance and repair. Here the three fairly sizable hamlets correspond to the three irrigation systems. The desa and hamlet officials however, leave responsibility for implementing the maintenance tasks to the irrigation specialists. In similar fashion, in Kuningan, West Java, the five irrigation blocks within the desa irrigation network correspond to 5 kampongs. The kampong heads, however, do not play that active role in managing seasonal repair and upkeep. Rather, the desa ulu-ulu (Raksa Bumi) and his 25 assistants (mayor), assigned 5 to a block, carry-out and supervise maintenance in specific locales, with participation also by cultivators.

The previous example in interesting, because it represents a case where multiple irrigation assistants have taken over the responsibility for managing the seasonal repair and cleaning of canals. Hamlet heads play a relatively minor role. Three additional examples from West Java, where multiple irrigation assistants are present, have diverse local organizational modifications to specific tasks. In all three cases, the hamlet continues to be an important administrative unit of organization, although the functions of the hamlet leaders vary.

In the desa near Sukabumi situated in the mountains, where there were 40 irrigation assistants (jonggol) assigned to 23 major channels, the desa administrative structure is called in on the major cleaning of canals. All desa households participate in locations assigned to their hamlets (or kemandoran). In another desa near Sukabumi, in a less mountainous location, a different variation is followed. Major annual maintenance in 3 tertiary blocks was carried out by (1) approximately 20 irrigation assistants assigned to the different blocks and (2) representatives from 60 RT (sub-hamlet neighborhood groups). Each RT sent one representative per day for as long as the maintenance was being conducted. Finally, under the Korps Kerja Bakti format of Ciamis, West Java, the primary responsibility for seasonal cleaning and repair of canals is left in the hands of special irrigation assistants. They are appointed from each kampong--and paid for their work--and are supervised by the ulu-ulu, the desa headman and the hamlet heads. However, prior to the dry season, when major repair to primary and secondary canals is sometimes necessary, all cultivators may be mobilized to assist the paid specialists.

A still different organizational approach is found in the Kabupaten Serang, in the Bantenese area of West Java. While the ulu-ulu cooperated with the kampong heads in supervising the major seasonal repair, an important intermediary role was played by informal working groups. These groups consisted of up to 30 generally contiguous cultivators, and were led by a contact farmer or other person internally selected. These informal associations of water users which pre-dated IRS are in some ways forerunners of the Mitra Cai (P3A) approach currently being pushed by the provincial government in West Java.

The final example to be cited differs from others in that there is a lack of correspondence between the hamlet and specific irrigation units. In the sample desa from West Sumatra, where there were 8 small systems, the irrigation specialists (Tuo Banda) from these systems supervised cultivators in cleaning the canals and repairing the simple diversion weirs. Overall guidance was provided by the desa irrigation committee, including the 3 wali jorong. The 5 kampong leaders, however, did not take an active part in carrying out these tasks--other than asparticipants in systems where they had holdings.

The preceding discussion gives a glimpes of the considerable diversity in organizational formats associated with the major seasonal cleaning of canals and repair of irrigation facilities. This diversity is linked to differences among communities in their modes of adaptation to their respective ecologies, technologies, tasks and cultural traditions. We have argued that given the relative autonomy of these systems, the nature of their technologies, their patterns of leadership and the direct linkages between inputs and outputs, they demonstrate a fairly high capacity to meet irrigation organizational needs. This in particular is true regarding the institutionalized, seasonal upkeep that almost all systems have traditionally undertaken. Such conclusions, however, should not imply that these communities could not benefit from improvements. Many reported improved performance of maintenance tasks following organizational modifications introduced from outside. For the most part, however, these alterations were grafted on or adapted to existing procedures--hence the utility in studying pre-existing institutional modes.

There were, however, several overall patterns that it may be useful to summarize again. First, in most communities there was a fairly close correspondence between residential units and irrigation cultivation units. While there was clearly inter and intra-community variation in this regard, in a substantial majority of locations it appears that at least 2/3 of the cultivators would come from similar hamlet units. In some cases this correspondence was almost 100%. While the ulu-ulu on the whole remained responsible for co-ordinating the major seasonal irrigation maintenance undertaken, hamlet heads frequently had direct responsibility for mobilizing cultivators. In some cases cultivators worked as a group with their hamlet leaders, irrespective of their sawah locations. In other situations, they would work under the hamlet head where there plots were located. Some communities mixed these two approaches, with one principle (the hamlet unit as a working group) applying to primary and secondary structures, and the other (the sawah unit) applying at the tertiary level. In some communities, hamlet heads played minor roles in mobilizing cultivators--such tasks being left to the irrigation specialists and their assistants.

For the most part, however, cultivators were expected to participate in the major annual or semi-annual organized maintenance activities. Even in the communities where attempts were being made to delegate such tasks to a core of specialists, should the difficulty and scope of the repair work needed be beyond the capacity of the irrigation assistants, the community would mobilize cultivators to assist. Given the importance to communities of restoring their irrigation networks to good working order, organizational flexibility was more important than institutional rigidity.

3. Types of Participation.

There were several variations in the expected (or communally sanctioned and mandated) participation expected of individual households in the major seasonal irrigation tasks.

The dominant pattern found in 70% of the sample survey desa (and the desa visited during field trips) was one in which those responsible for assisting in major seasonal maintenance were cultivating households--either owner operators or tenants. Under the second most common pattern, found in 20% of communities--including IRS locations from North and South Sulawesi, Central and West Java, and Lampung, full participation was required from all desa households. With one exception these were community systems, where full participation was primarily a legacy from the past, and a recognition that the irrigation system was important to all residents--whether cultivators or not. In Kalegeh, the mountain village in Central Java, the gotong-royong labor (or kerja bakti) required of all households was called 'Gugur Gunung' (litterally 'falling mountain'?). Where village wide participation was expected during the semi=annual cleaning of canals, almost invariably routine maintenance was the responsibility of cultivators only.

The third variant, covering 10% of communities, is a miscellaneous category. It includes a desa near Sukabumi where each neighborhood group (RT) furnished a single cultivator per day until maintenance tasks were completed. It also includes locations where paid irrigation assistants normally conducted seasonal repair--unless tasks were too complex. Finally, it includes an IRS community in DIY where cultivators (owner operators and tenants) as well as non-cultivating landlords were expected to participate--while landless labor households were not.

Where households were expected to contribute labor, they usually sent one male adult to participate in the work parties undertaking repair and maintenance. In most communities there were an average of from 20% to 30% of cultivating households who had sawah plots in more than one location. In such cases, the household usually provided one adult member for each of the locations where it had obligations. (In several villages in Sulawesi, which were exceptions to this rule, and where the hamlet was the unit of mobilization, all hamlet households contributed one member to work parties.)

If households could not provide one family member for each location where they had sawah holdings, it was permissable to hire someone (usually a landless laborer) to represent them at going rates for a half-day of labor (usually Rp.200 to Rp.500). By contrast, only under special circumstances were households permitted to hire laborers to undertake their own alloted share of communal work for their first (and frequently only) cult[illegible] ation location. Acceptable excuses included sickness and absence from the village, or participation as supervisors rather than laborers (ie. hamlet heads, irrigation specialists or assistants). It was made clear accross the board, however, that such exceptions usually represented only a very small fraction of those working (rarely ever more than 3%). Frequently there were punishments (extra manual work) or fines levied on those who did not turn up. Respondents were quick to note that norms regarding participation were not frequently violated. Absence from communal irrigation maintenance responsibilities, particularly during the seasonal cleaning of canals and repair of structures, for other than legitimate reasons was frowned on and considered to be a violation of communal norms and duties.

The preceding description of fairly strict adherence to communal labor requirements by village households can be contrasted to reports coming from research in some of the major lowland systems of Java and Sulawesi. In many of these regions, wealthy village residents in their role as patrons are able to substitute landless or tenant clients for their communal labor requirements. In other situations, those persons located near the heads of tertiary out-takes participate less than expected, if at all, leaving the burden on lower lying cultivators. In both cases, the quality of and control over the work force declines, as does the manpower pool available.

As we have noted, there are generally clear cut requirements for households with multiple sawah locations (irrespective of the size of their holdings) regarding participation in major maintenance undertaken in each such location. Where exceptions exist, they generally occur where the hamlet is the unit of mobilization, and where all desa residents are expected to participate. Such exceptions usually do not apply to routine, ongoing maintenance. What is interesting, however, is that these maintenance obligations usually exist for all cultivating households. They are not, however, related to the size of the holdings operated. Thus, at least with reference to seasonal maintenance contributions, households with small holdings make the same labor contributions as those with relatively large areas cultivated. It could be argued that as a consequence, those with larger holdings get off comparatively lightly, while those with smaller holdings are penalized. However, the organizational principle of 'one holding--one labor input' clearly is easier to implement, generally does not appear to be perceived as inequitable, and probably is a legacy of a period when most village households had their own holdings which were of roughly comparable size.

4. Work Duration and Celebrations Related to Major Seasonal Maintenance Activities.

In the locations studied in detail and visited in the field, the actual time required to repair and clean irrigation facilities varied from a few days to three weeks, with an average of about a week. Again the nature of the technologies involved, the physical ecology of the system, the amount of labor available and the complexity of tasks all were factors influencing the amount of time needed. In the two sample systems from the Bantenese area of West Java, one reported an average of 2-3 days, while the other 4-7 days. We observed earlier that the sample IRS system from Jember, East Java, had a 15 day period to undertake repairs, when the canals of the main system were being dried by the Irrigation Service.

Most locations reported that once the cleaning and repair of the village canal network was complete, it was followed by a general village meeting and celebration. During such meetings previously decided plans were conveyed to the populance at large, or were further discussed. These concerned the timing and nature of future labor inputs required for physical upkeep, plans for distributing water and for collecting fees (if any), and agricultural cultivation schedules and details. In some communities the peasant cultivators were free to cultivate as they wished (more so in the wet season than in the dry season when greater control was exercised over water distribution). In others, planting schedules and rice varieties were specified through a process of group consensus. The tendency appears to be towards greater village control over agricultural cultivation processes as high yielding seeds are disseminated, and in particular as wereng resistant rice varieties are encouraged. (See later Chapter.)

In general, with reference to the recent past, most IRS locations visited or surveyed reported that selamatan ceremonial rituals and practices and accompanying celebrations which followed the major canal cleaning were somewhat general in their orientation. Existing ceremonies dealt primarily with overall agricultural processes. Historically, it appears that specific irrigation ceremonies were carried out at diversion weirs or at springs and other water sources. While such rituals and irrigation related customs appear to have died out in a majority of IRS communities, in about 25% of the locations visited and researched they continue to be practiced--although sometimes in modified form. We will discuss such practices and their implications in greater detail in the chapter concerning agricultural cultivation and water management practices. At this stage it should be emphasized that the importance of irrigation rituals and ceremonies in legitimizing community norms and sanctions regarding water distribution behaviour and upkeep responsibilities, in helping to preserve a modicum of equity and harmony in irrigation affairs and in perpetuating organizational sensitivity to changing ecological rythms should be not underestimated.

5. 'Seasonal' Maintenance Needs and Problems Prior to IRS.

For the most part, prior to IRS, it appears that the organizational modes used to carry out major seasonal irrigation maintenance and repair tasks were adequate and effective. In significant measure one can attribute this state of affairs to (1) the perceived need for community involvement in such tasks, (2) the tradition of formal participation both by village leaders as well as cultivators in taking the necessary steps to restore weirs and canals to proper working order and (3) the capacity of communities themselves to manage and repair existing technologies. There were problems that cropped up in some locations, however, which deserve mention.

First, while not necessarily a problem, it is intersting to observe that the maintenance and repair on major portions of the irrigation physical infrastructure was sometimes more formally organized than that on tertiary or field channel levels. In the latter, cultivators on occasion tended to work in smaller, more informal groups when cleaning silt out of channels and replacing small diversion structures. In an IRS community in Jember, East Java, it was reported that cultivators less adequately undertook seasonal repair of field channels than primary and secondary canals and major diversion weirs--due to less direct supervision by village leaders. The situation in one location in Lumajang, East Java, was just the opposite. The areas of public domain (primary and secondary canals) were said to receive less attention than the tertiary canals and field ditches, which lay closer to cultivator plots.

Second, in some (although not all) locations where more permanent works (masonty weirs) had been constructed in the past, deterioration had taken place over time. Given the nature of the tasks involved and costs, repair of permanent weirs which may or may not have been originally built by the community concerned often was more difficult than repair of less permanent structures, which could be carried out from locally available materials. The implications of this finding will be discussed later with reference to technologies introduced under IRS. The example of a system in Wonogiri was cited earlier. Other examples are found in the Banten area of West Java. In Wonogiri the community concerned appeared unable to mobilize sufficient funds during the 1970's to purchase the materials needed to repair three weirs. In the 1950's, on the other hand, it had been able to raise the funds needed to construct the weirs in the first place. Inadequate technical skills may have been a problem in some communities where the original permanent weirs had been built by the Irrigation Service. Other communities, however, were able to user their own skills, and to capitalize on subsidy funds offered by the government both to build new and more permanent works, as well as to repair those already existing.

Third, in most IRS locations that received water via weirs and canals operated and maintained by the Irrigation Service, communities were called on to assist in maintenance. Usually such arrangements appeared to be accepted tacitly provided that the communities concerned felt that they were receiving adequate services and not having to do more than their share of the work. In several locations where villages shared facilities with communities situated further upstream, however, there were problems connected with the labor inputs needed for seasonal repair of the weirs and major canals. Where such facilities were not kept in shape or restored to proper working order, it was frequently primarily the downstream villages that suffered. An IRS community in Pandeglang in the far western Banterese portion of West Java, for instance, is a typical example. The village concerned (which lay downstream) had to undertake most of the repair and maintenance work on upstream facilities, if these were to be conducted at all. Furthermore, since the government assigned technicians did not (or were not able to) adequately supervise the distribution of water, during dry season periods of water shortage the upstream community frequently diverted water outside of its rotational turn. Such experiences created resentments among cultivators from the communities with disadvantaged locations, and occasionally led to overt conflict.

C. Emergency Repair of Damaged Irrigation Works.

Given the kinds of perishable structures typically used for diverting water from mountain streams and rivers, in most Sederhana locations communities undertook repair of damaged or washed-out weirs and canals at least once during the monsoon season. While more permanent structures such as masonry or concerete weirs and lined canals were often less vulnerable to damage than the simpler earthen canals and the stone, bamboo, wood and earth diversion dams--they too were subject to damage. Some portions of community irrigation works were more vulnerable than others to landslides and wash-outs, particularly during the sudden banjir (floods) that rapidly swelled flowing streams into raging torrents during heavy monsoon downpours. While terraces sometimes were also damaged, they were usually less subject to flooding and inundation than were the rice paddies of many of the lowland, flood-prone systems found in coastal areas.

The extent and frequency with which major repair was undertaken in the IRS systems at large is suggested in Table 12 presented earlier in this chapter. Approximately 80% of existing systems reported undertaking repair work at least once during the monsoon season. Over 40% reported such endeavors two or more times. While the problem of damage to community irrigation works was less during the dry season, 55% of the communities undertook major repair at least once.

The need to mobilize labor at sudden call so as to rebuild damaged works immediately has helped to ensure that a community wide organizational capacity remains existent--particularly when community interests and livelihood are threatened. This is not to suggest that community wide mobilization is the only alternative available--but that when it is needed, it will be resorted to. There is usually no question but that the requisite leadership will be forthcoming, and that community norms regarding cultivator responsibilities for participation will be observed.

In a majority of systems, when major damage occurs, the official desa leadership (headman, hamlet heads) will be called in to help take responsibility for (if not personal direction) of efforts to mobilize cultivators. The ulu-ulu usually will be directly involved as the village technical expert, and frequently will be charged with implementation tasks. In some systems, however, the ulu-ulu will take complete responsibility. When village wide interests are threatened, and a substantial input in labor is required, in approximately 60% of the systems studied or visited, all desa households, cultivators or not, are expected to participate. In the remaining 40%, only cultivators are liable. A community in the Jogjakarta area takes an in between approach--those responsible for participation include land owners who are not cultivators in addition to cultivating households themselves.

Much of the damage that takes place, however, may be of a localized nature or confined to specific systems. Most communities, therefore, appear to develop a capacity to aggregate or dis-aggregate organizationally to the level required to complete the tasks of repair. The specific organizational approach employed, of course, will be linked to the characteristics of individual systems. For instance, in the 3 small systems of the IRJ sample community from

Wonogiri, very minor repairs will be left to individual cultivators. If group action is required, then the kebayan (hamlet heads) and jogo tirto (ulu-Ulu) will mobilize groups of cultivators in the location affected. The desa head steps in directly only when community wide mobilization is required.

A similar approach but under different formats is followed in the West Sumatran sample community. When problems are localized and manageable by smaller groups of cultivators, the Tuo Banda and cultivators in the specific system damaged will work together. If damage within a specific system is heavy, or damage is widespread, then the desa Irrigation Committee will be operated through, with desa wide gotong royong mobilization. A similar pattern holds true in the 4 system network of Pandeglang, West Java. Only if the ulu-ulu and cultivators attached to a specific system find the task beyond their capacity do they refer it to the desa level with its broader manpower pools.

As noted earlier, within the irrigation networks included within community spheres of responsibility, some systems (or portions of systems) are more susceptible to damage than others. Accordingly, at what stage participation by cultivators from other systems can be secured will often depend on community wide understandings, and concurrent needs. Finally, it should be noted that the inputs required from cultivators may not only be contributions of labor. They may also include contributions of funds that are assessed on cultivators--as is done in the desa of Senduro in Lumajang, East Java, for the purchase of materials. Usually, however, the labor contribution has been the primary input--given the fairly heavy reliance on locally available materials (bamboo, coconut tree trunks, stones) for irrigation facilities in many IRS systems. The switch to more permanent construction materials, such as concrete and stone masonry, as suggested earlier, may have an impact on the capacity of communities to respond to breakdowns.

As in the case of major seasonal maintenance activities, cultivators are expected to partidpate in repair activities when called, or else (under special circumstances) to send a representative. For example, in the sample system in Jogjakarta, those sending representatives (who usually constitute only a small percentage of cultivators), are required to pay their wakil the equivalent wage for a 1/2 day's work.

Finally, one should not automatically assume that the effectiveness and the speed with which community organizational potentialities can be activated under emergency conditions is necessarily carried over to routine maintenance activities.

D. Ongoing/Periodic Routine Maintenance Activities.

1. Introduction. There was probably more variation in the pre-IRS organization of routine upkeep of village canals, dykes and diversion structures, and in the effectiveness in which these tasks were carried out, than there was in major maintenance or emergency repair. In many systems routine maintenance (1) was less formally organized, (2) did not involve the direct participation of hamlet heads and (3) often was carried out as the ulu-ulu or cultivators saw fit. Frequently the organizational modes used in routine maintenance differed from those associated with major seasonal maintenance or emergency repair. Such inter-community variation included the extent to which routine upkeep of irrigation was formally organized, the kinds of personnel used to coordinate work undertaken, the degree of participation by cultivators, and the frequency and regularity with which routine maintenance tasks were

conducted and at what levels (primary/secondary or tertiary and lower) within respective systems.

2. Types of Organizational Modes Associated with Routine Maintenance. In the discussion which follows, an attempt will be made to indicate organizational variation in routine maintenance. There are difficulties in drawing up simple categories, however--since some communities will follow one approach with reference to major structures, and another with respect to terminal facilities. As has been done throughout this Supplemental Report, brief reference to specific examples from communities studied in detail or visited will be cited.

Before looking at categories, however, it is important to note that the role of the village headman and hamlet heads in routine maintenance in most locations is relatively minor. Where routine maintenance activities are co-ordinated, for the most part the co-ordination is handled by the ulu-ulu--although there are some exceptions to this generalization. Whether systems have regularized schedules of routine maintenance, or irregular schedules based on perceived need, and whether they have full participation by cultivators or rather assign routine upkeep tasks to the core of irrigation specialists and their assistants--the ulu-ulu or village irrigator(s) usually remain responsible at a minimum for providing co-ordination of ongoing maintenance. Levels and patterns of involvement by the ulu-ulu obviously vary. In some communities they patrol systems to keep abreast of problems and needs, and then mobilize cultivators to carry-out the necessary tasks. In others, they implement such tasks on the spot, to the degree feasible, or work through assistants and other village irrigation specialists.

In others, they only address major needs.

The second point to emphasize is that for the most part cultivators are responsible for work in areas adjacent to their plots, or in the general irrigation locations where their holdings lie. When required to work on major canals (either those under desa management or those operated by the Irrigation Service where they are required to assist), they usually work in groups with neighboring cultivators. While hamlet heads continue to provide co-ordination and assist in mobilizing cultivators in a minority of communities, in only one case did the hamlet as a group take precedence over cultivation location as a principle of organization in routine upkeep. Thus, in the approximately 30% of locations where cultivators (or all village residents) were organized by hamlets (or according to place of domicile) during the major seasonal repair and maintenance activities, in only one was this principle of organization carried over to routine maintenance activities. In the remaining locations, the cultivators worked where their sawah plots were, should the location of these differ from those where the majority of hamlet household, had their holdings.

In the sample desa from Wonogiri, Central Java, the jogo tirto (or ulu-ulu) co-ordinated routine upkeep on a regularly scheduled basis, while the kebayan (or hamlet heads) were responsible for mobilizing cultivators once every week or two in distinct blocks. (The headman apparantly was not active in managing routine upkeep). Cultivators would work in the blocks where there hamlet was assigned. Since there was a close overlap between residential and cultivating units, usually this would also be in the vicinity of their plots.

Third, it should be noted that in almost all communities those responsible for routine maintenance were cultivators themselves. The desa which mobilized all households (be they cultivators or not) for the seasonal upgrading of the irrigation physical infrastructure, or for emergency repair, did not extend this principle to routine tasks of a more ongoing nature (with one exception, to be mentioned later.)

Fourth, while there was considerable variation among communities, it appears that routine maintenance carried out on major structures (such as primary and secondary canals) tended to be more formally organized, or less assigned to specialists, than did upkeep of tertiary or field level channels. The latter (be they tertiary, quaternary or field ditch channels) tended to be the responsibility of cultivators adjacent to or utilizing specific irrigation conveyance structures, who frequently cooperated together informally. Often cultivators remained responsible for the portions of the channels that passed their fields. We will discuss problems arising from this pattern of organization later in this chapter. There are, however, exceptions to the patterns outlined here, which will be mentioned.

It will be useful to take a closer look at organizational variations and similarities among communities included within the socio-institutional survey and field visits. Table 13, which follows, divides sample IRS communities from which data are available into categories according to the organizational approach used in carrying out routine irrigation maintenance tasks.

From the sample survey locations which had pre-existing systems and from which data are available, 50% could be categorized as carrying out maintenance on a periodic basis--in response to perceived need. In some communities routine upkeep was undertaken

Table 13: Frequency Breakdown of Sample IRS Communities* According to Organizational Approach to Routine Irrigation Maintenance Tasks.

Category	Number of Desa		
	Coordination Primarily By Ulu-ulu	Ulu-ulu (co-ordinates) Hamlet Heads (mobilize.)	Total
1) Periodic in Response to Need - with Cultivators as participants	6 (37.5%)	2 (12.5%)	8 (50%)
2) Regularly Scheduled - with Cultivators as participants	2 (12.5%)	2 (12.5%)	4 (25%)
3) Irrigation Specialists/ assistants as major participantors -			
a. Specialists - primary/secondary, cultivators-field channels	2 (12.5%)	-	2 (12.5%)
b. Specialists only	2 (12.5%)	-	2 (12.5%)
c. Total	(4) (25%)	-	(4) (25%)
T o t a l	12 (75%)	4 (25%)	16 (100%)

* Excludes 2 IRS communities from Lampung with inclomplete data, and 2 communities which did not have pre-IRS systems.

only several times in a season, while in others as frequently as once every two weeks. The approximate average was once a month. The freqnency of routine maintenance often depended on the season. For instance, in Pandeglang, West Java, routine maintenance, under the leadership of the ulu-ulu took place from 5 to 10 times during the wet season, and 4 to 5 times during the dry season. Likewise, it might vary depending on the level within the system(major canals or terminal facilities). In West Sumatra, for instance, routine upkeep (particularly as it related to facilities commonly shared by cultivators) occured less frequently on major canals (once in 2 months) than on smaller structures (once in 1 month).

In 3/4 of the communities which carry out routine upkeep in response to perceived need, the ulu-ulu were the overall co-ordinator of such tasks. How exactly the ulu-ulu discharged such responsibilities, as suggested earlier, varied. In a fairly common pattern, the ulu-ulu took responsibility for the major structures, and mobilized cultivators where needed to clean silt and weeds out of channels, or to make minor repairs. Field ditches, by contrast were left to the cultivators concerned. In the sample IRS community in Serang, West Java--where irrigation cultivator groups already existed prior to IRS--the ulu-ulu delegated responsibilities to these groups, and made suggestions where needed. In three communities in North and South Sulawesi, and Central Java, the Irrigation Service operated major portions of the irrigation systems. The ulu-ulu, however, co-ordinated cultivators working on the structures nominally the responsibility of the government, as well as the tertiaries which the desa managed--leaving smaller channels to the cultivators themselves. Often, if tasks were minor and did not require the degree of mobilization needed for major silt and weed-cleaning tasks, the ulu-ulu (or their assistants) undertook repairs on the spot.

In the remaining 1/4 of communities coming under this category, the role of the ulu-ulu as coordinator was supplemented by the continuing involvement of hamlet heads as mobilizers. In the desa Bilokka, South Sulawesi, where the Irrigation Service maintained major canals, the kampong (hamlet) heads led cultivator groups in maintaining tertiary structures. In Jogjakarta, by contrast, the dukuh heads kept an eye on routine maintenance, but were less active in actually mobilizing households.

The remaining 50% of sample communities were in some ways more organizationally diverse. The distinguishing characteristic of the communities included within this category is the institutionalized practice of implemeting routine maintenance tasks in accordance with a regular schedule. These tasks were conducted either by irrigation specialists and their assistants, or by cultivators led by their respective ulu-ulu or hamlet heads, or by some combination of the two. In 1/2 of the sample communities within this category (plus several other desa visited in the field), responsibility for routine upkeep had largely been delegated to a corps of specialists and their assistants. In the other 1/2, regular schedules for carrying out maintenance by cultivators themselves had been institutionalized. In both types of sub-categories, there were communities whose organizational practices dated back in time. Likewise there were others where pre-IRS irrigation institutions were of relatively recent vintage--representing community institutional adaptations designed to address specific irrigation organizational weaknesses and needs.

Of the 4 communities that had instituted routine work schedules (or 1/2 of the locations of the sub-category), two continued to rely on hamlet heads as the primary mobilizers. The example of Wonogiri, where the jogo-tirto (ulu-ulu) has co-ordinated routine tasks, but where the kebayan (hamlet heads) have led hamlet cultivators as a group, has already been mentioned. In the other example from the Kabupaten of Minahasa, in North Sulawesi, the desa head co-ordinated the hamlet heads, who in turn supervised cultivators. The cultivators in North Sulawesi, however, worked in the vicinity of their sawah plots under the appropriate hamlet head--in contrast to the Wonogiri situation or that applying in their own community during major seasonal maintenance. It would appear that the Atjehnese locations, where there has been a clear demarcation of responsibility between the kejeuren blang (water distribution) and the desa headman (maintenance), possibly have had similar practices. In any case, in the sample desa from which data are available, 25% assign significant roles to the hamlet heads in routine upkeep tasks--be they regularly scheduled or periodic in response to need.

In the other two communities that have regular work schedules assigned to cultivators for carrying out routine maintenance tasks, coordination is provided by the ulu-ulu. The organization of routine upkeep is substantially different if one compares one community with the other. In Jember, East Java, maintenance on the primary and secondary canals, which is regularly scheduled once a month during the rainy season and once in 3 months during the dry season, is coordinated and supervised by the ulu-ulu. These are on facilities that are in part the responsibility of the Irrigation Service. Routine maintenance on tertiary and field level channels, by contrast, is left to the initiative of the cultivators concerned.

In the Central Javanese mountain community of Kalegeh, routine maintenance is regularly scheduled at both primary/secondary as well as tertiary levels. It is supervised by one of three ili-ili--each of which works with a distint cultivator group--under the overall coordination of the desa ulu-ulu. Maintenance on major structures is carried out less frequently, once in 35 days, according to a calendrical system that has mystical meaning in popular Javanese cosmologies. All desa residents, cultivators or not, are required to participate on such days. Routine work on the tertiary and field level channels, by contrast, is more frequent (once in seven days) and conducted by cultivators only in the general vicinity of their plots.

With the formation of P3A's (to be discussed in later chapters of this supplemental report), there is a trend towards (1) delegating more routine upkeep responsibilities to specialists, with fewer obligations to cultivators, and (2) to instituting more regularized work schedules for routine upkeep by cultivators where they continue to participate. With regards to the latter type in the pre-IRS context, it is interesting to note that some communities visited or studied (such as Kalegeh) have specific schedules which apply on a community wide basis. Others, by contrast, will have regular community wide schedules which apply to major facilities, but leave the scheduling of routine work on tertiary or quaternary facilities to the discretion of the respective cultivator groups. Still other communities have schedules which are adapted to specific irrigation systems and their routine maintenance needs, which are likely to differ.

The final 4 sample communities, as indicated earlier, assign primary responsibility for not only coordinating but also conducting routine ongoing maintenance to the irrigation specialists (ulu-ulu) and their assistants, where present. In two of these communities there is a division of responsibility between the irrigation specialists and cultivators. In the remaining two, cultivators are only called in when tasks are too difficult or complicated for the ulu-ulu and their assistants.

In the sample IRS community from North Sumatra, the overall _ulu-ulu_ conducts routine upkeep on the diversion weir and primary canal, while three additional _ulu-ulu_ each maintain one of three tertiary canals and related structures. The cultivators, by contrast, are responsible only for sub-tertiary field channels. However, when circumstances arise in which necessary maintenance tasks cannot be completed by the _ulu-ulu_ concerned (individually or in cooperation with the other _ulu-ulu_), then cultivators in affected areas will be asked to step in by the _kampong_ heads. In the _desa_ of Senduro, in Lumajang, East Java, a similar pattern holds. The _desa ulu-ulu_ and his assistants maintain the major irrigation facilities, including primary and secondary canals. The cultivators retain responsibility for routine upkeep of the tertiaries--working in locations in the near vicinity to their holdings.

In the other two sample systems, both from West Java, the routine upkeep tasks are primarily in the hands of the irrigation specialists and their assistants. In Kuningan, for instance, major structures are maintained by Irrigation Service Personnel coupled with assistance by the specialists and cultivators, when needs arise. The substantial village portions of systems are maintained by the 5 _mayor_ assigned to each block, coordinated by the _Raksa Bumi_ (_ulu-ulu_). In Ciamis, the _petugas_ (or assistants) appointed by each kampong to constitute the _Korps Kerja Bakti_ maintain all irrigation facilities on a routine basis. On occasion _gotong-royong_ labor will be mobilized, where necessary, and cultivators will frequently be asked to help maintain the field channels near to their plots. The bulk of the work, however, is handled by the _petugas_.

Finally, the mountain community near Sukabumi, West Java (mentioned earlier) assigns all its routine maintenance tasks to the 40 jonggol (in contrast to cultivator participation during the semi-annual major cleaning of canals). However, cultivators sometimes help out on channels near their plots. And like the example from North Sumatra, if the jonggol assigned to a specific canal unit are unable to complete necessary tasks within a 3 to 4 day period, cultivators from that location will be asked to provide gotong-royong labor.

In short, while 25% of the sample systems had delegated routine irrigation upkeep tasks primarily to specialists, most retained the institutional flexibility to mobilize cultivators when needs arose. And in most, cultivators sometimes tended channels running by their plots. All communities which relied on a core of specialists for routine tasks had instituted irrigation levies on water users for the purpose of defraying costs of the services provided. These financial payments will be discussed in greater detail in a later chapter.

3. Routine Maintenance Needs and Problems. It was clear from the field visits and the sample socio-institutional survey monographs that there was considerable variation among IRS communities in the effectiveness with which routine irrigation upkeep tasks were discharged. A number of systems reported problems of inattention and neglect in portions of their systems.

In some locations, as we have suggested earlier, where several communities shared a single diversion weir, the downstream communities usually were called upon to undertake more than their share of routine tasks. Several communities also complained that portions of systems operated by the government were poorly maintained, and that the initiative and major input into upkeep came from cultivators themselves. Usually, where such needs became apparent, procedures were present to mobilize cultivators under the leadership of their irrigation specialists or village officials. However, unless work on such major structures was routinized according to a fixed schedule, downstream cultivators sometimes reported that there were delays between perception of need and actual gotong-royong repair. This could be due either to inattention on the part of the irrigation specialists, or to overwork.

Within some systems there were also occasions in which downstream cultivators would take the initiative themselves to go upstream to clear weeds and silt from canals so as to speed up the flow and volume of water to lower-lying areas. Where present, such problems occurred more frequently in multi-community than single community irrigation systems. (We will consider the question of incentives for equitable distribution of water and maintenance responsibilities in more detail in the next chapter on water-distribution activities.)

Problems of inattention and neglect, however, were more typically found in the tertiary or field channel portions of systems, which frequently were less formally organized, with less clearly demarcated spheres of responsibility. They were less apt to be found in communities which had specialized routine upkeep tasks in the hands of the ulu-ulu and full-time paid assistants. Likewise, neglect of tertiary or field channel upkeep cropped up more frequently in systems which were in part operated by the government than in single community systems.

One problem mentioned in the systems in Banten, West Java, and reported elsewhere, was the lack of sufficient elaboration of tertiary and field delivery structures. As a consequence, cultivators who received their water via the plots of others tended to shirk upkeep duties on the channels above--leaving them primarily to the cultivators with contiguous plots. This would not be the case with reference to the participation in major seasonal maintenance activities, where village norms regarding absence from labor pools were more specific and enforceable, and where implementation of tasks was more formally organized. More complete development of field delivery systems would help to demarcate more specific spheres of responsibility in routine tasks. Interestingly, one report noted that non-contiguous cultivators frequently took the initiative to encourage cultivators with plots next to channels to help participate in cleaning out weeds and silt.

In some of the communities, small groups of cultivators cooperated effectively in initiating and carrying-out routine maintenance tasks in commonly shared facilities. In other communities on the other hand, there were patterns similar to the sample community from West Sumatra. There the Tuo Banda would patrol their respective systems to search for needs, and then take the initiative themselves to mobilize cultivators. Without this active interventionist approach by the irrigation specialist, cultivators were generally unwilling to initiate group activities other than in small contiguous locations of direct interest to themselves.

Finally, some communities reported that the frequency of routine upkeep, including the amount of labor required, was considerably higher for non-permanent structures than for permanent ones--all other things being equal.

In sum, it clear that a substantial number of IRS systems could benefit from more complete development of delivery channels and more formal organization of routine irrigation tasks--if one looks at their pre-project situation. Others, however, had initiated institutional and technological modifications on their own accord to help address such needs. In some cases problems originated from outside of the desa. In other cases they were internal or technologically based.

VII. ORGANIZATIONAL CAPACITIES TO DISTRIBUTE WATER PRIOR TO IRS.

A. Introduction.

Most villages with existing irrigation systems prior to IRS had some form of community control over water distribution. Exactly how such control was organized, and to what extent, differed not only among communities, but also among different systems within communities. The degree to which communities placed controls over water distribution, in particular, varied widely during different seasons of the year.

During the rainy season(s), water usually was available in sufficient quantities to meet cultivator demands. Most communities, therefore, allowed water users to take water as they pleased from the channels that flowerd by their plots. Water usually flowed continuously throughout the network of irrigation channels included within community spheres of responsibility. (There were, of course, modifications and exceptions to these generalizations).

During the dry season(s), by contrast, when supplies of water usually were reduced in relation to demand, most communities tightened their control over water through one or more means. They could regulate agricultural cultivation and exercise more careful supervision of the technologies associated with the delivery of water from field channels to plots. Most important, they could supervise the allocation of water among differing portions of irrigation systems more strictly. Control over water allocation during the dry season primarily (although not exclusively) took one of several forms—(1) staggering water delivery among different sections of irrigation systems (golongan), (2) rotating water allocation among different units (giliran), (3) carefully regulating the amount of water entering cultivator plots, and (4) some combination of these three approaches.

The need for and extent to which controls were introduced over water distribution were linked to a number of conditions. These included the supply of water available relative to demand, existing customs and traditions, agricultural cropping patterns and varieties, the extent of inter-dependency with other systems and communities, the extent of external regulation, the types of technologies used and physical layouts present within irrigation systems, topography, the size of irrigation systems, types of leadership, levels of conflict, and community perception of needs coupled with willingness and capacity to act collectively. The list could go on.

It is clear from the field visits and socio-institutional survey that communities differed substantially with regards to their capacity to meet water distribution needs. Some developed technologies and instituted procedures on their own in an efficient and equitable fashion. Others did not. In general it appears that despite the ingenuity manifested in a number of systems, technological and organizational needs were more prevalent in water distribution than they were with regards to maintenance. The two types of tasks, and the capacity of communities to carry them out, however, often were inter-related--as will be shown later in this chapter.

It will be useful to take a closer look at common patterns as well as variations in water distribution among communities with existing systems prior to IRS. The data used will be drawn primarily from the soio-institutional survey of sample communities, supplemented by locations visited on field trips and during pretests of the questionaire. This chapter is somewhat difficult to put together in a systematic fashion, while at the same time bringing in ethnographic detail. Therefore, the reader is also referred to section V, C.5., pp. 56-59, of the main evaluation report, for a more succinct presentation of the findings.

B. Patterns of Control Over Water Distribution Above the Level Where It Enters Cultivator Plots.

1. Introduction. The organizational patterns associated with control over water distribution to portions of canal systems, and the procedures, personnel and technologies used occurred in a variety of combinations.

Under one approach, which frequently was associated with greater community control over water allocation, water was distributed to different portions of systems at different times. Communities divided water in this manner either through rotation (giliran), staggered planting (golongan) or a combination of the two at differing levels within the system. (The distinctions between rotation and staggered planting are not always clear-cut.)

The possibilities for a variety of combinations in water allocation procedures, both on an inter-system and intra-system (seasonal) basis, are evident. Specific patterns of water distribution (rotation, staggered planting, continous flow) might be implemented consistently throughout an irrigation system, at different levels (primary, secondary, tertiary or lower). Or, a community (acting either individually, or in combination with other communities and/or government agencies) could employ different water allocation methods at different physical levels of an irrigation system. For example, (1) distribution of water to secondary canals might be staggered at two week intervals, while (2) among branching tertiaries a rotational approach might be followed, and (3) from tertiaries receiving water on specific rotational turns, water might flow to cultivator plots continuously. These possibilities along with examples from the research will be discussed in greater detail in a later sub-section of this chapter.

Under another approach to water distribution, water flowed continuously (terus-menerus) throughout a canal network but with careful regulation of the amount entering different sub-units. This pattern is more or less followed during the rainy season in most systems. However, the extent to which controls will be exercised over allocations among lower units, and at what levels, varies considerably. During the dry season, approximately 25% of the sample communities continued to follow this approach. Most, however, switched to a rotational or staggered planting format in at least one level of their physical layout during the dry season. Frequently, intermittent with continous flow procedures were combined at different levels of distributary canal networks.

A key determinant of the extent to which communities regulated and controlled the distribution of water at any particular time was that of water availability relative to demand. During the dry season, the practice of switching from a continuous flow to an intermittent approach when conditions dictated, indicates the importance communities attached to retaining an institutional flexibility to adapt to changed water conditions. Some communities switched from one water distribution procedure to another, on an ongoing basis, throughout a specific season.

2. Physical Layouts and Technologies. It is not possible to consider institutional and organizational arrangements in water allocation without discussing the technologies and physical layouts or irrigation systems. The two are often closely inter-related.

The physical layout of tertiary delivery systems and quaternary sub-units tended to demarcate the organizational boundaries of water-user collectivities. Likewise, the installation of improved technologies, such as diversion weirs and division structures with mechanically adjustable gates, often improved the capacity of communities to open and shut-off as well as regulate water to different components of the local canal network. Increasing the intake capacity of weirs by making them more permanent sometimes facilitated new organizational approaches, such as the introduction of rotational allocation of water during the dry season, where it had not been feasible before.

Most communities expressed a desire to upgrade their technologies, with the expectation that doing so would lead to improved water distribution and increased availability of water. It is important to note, however, that upgrading technologies in and of itself is not a sufficient condition for equitable and efficient patterns of water allocation. While technologies help determine institutional possibilities, the institutional framework in which technologies are introduced will also influence the way in which technologies are used. We will discuss this matter in greater detail later in this chapter. We will also cite examples of communities which relied primarily on locally available materials, such as bamboo, stones and coconut tree trunks, to form intricate technological arrangements for delivering water throughout canal networks --and in an equitable and relatively efficient fashion.

First, it is important to note that the installation of more permanent technologies (such as concrete weirs, canal dams, etc. with mechanical adjustable parts) often increased the capacity of communities to switch to a golongan (staggered planting) or giliran format of water distribution. By turning levers it is a relatively simple matter to open and shut gates, and to divert water from one portion of irrigation system to another at relatively short notice. It is thus often easier (from a technological standpoint) to build in flexibility to alter the frequency and timing of rotation to match relative water availability. In communities which relied on less easily adjustable structures, such as bronjong dams made out of locally available and perishable materials, diverting water from one canal to another often necessitated the dismantling of one small weir and the building of another. Rotation in this latter context often took place in different forms than that in which mechanically adjustable division gates were present.

The employment of mechanically adjustable technologies, therefore, placed a premium on on-going decision making capacity to adjust to changing conditions. In systems with a fairly steady water supply, rotational schedules usually were fairly straightforward and regular. In systems with highly variable supplies of water, by contrast, periodic adjustements were required. The installation of mechanically adjustable gates at several levels within systems, therefore, often increased the need for community institutional capacities to set and adjust priorities and schedules and to see that these were enforced properly.

In some communities, this institutional decision making capacity was in theory partly in the hands of outside agencies, as was the case with systems where water was received via weirs and primary/secondary canals operated by the state. In the sample system from Kuningan, West Java, water was received via two secondary canals operated by the Irrigation Service, and by 4 tertiaries which branched off from these secondaries. (Water flowed on a continuous basis during the rainy season.) The community, in turn, rotated water between the upstream and downstream tertiaries on each of the secondaries. Thus, in theory each tertiary obtained water once in 6 days, on alternate turns. In this sample, water was opened and closed to different parts of the system on different days--both at the primary/secondary level by the Irrigation Service, and at the tertiary level within the community confines.

A critical function must be performed in inter-community and community systems which employ adjustable technologies. Specialists and other irrigation personnel must have skills and capacity to make and enforce decisions where necessary regarding adjustments in the technologies they are operating. There are two elements needed --(1) appropriate technical skills and (2) political-institutional backing and support for decisions made. A difficulty that frequently occurs in inter-community systems is the fact that technologies often are not operated as they should. (We will discuss this matter further, later in this chapter, when dealing with norms and incentives which influence patterns of water distribution.)

One problem that cropped up in some systems, both prior and subsequent to IRC, was that of breakdown or damage to mechanical or other permenent technologies. When such breakdowns occurred, the capacity of specialists (or communities) to regulate water distribution frequently declined, given the community's dependence on a specific form of technology. Some communities were able to undertake repair, or to make adjustments in distribution procedures--others were not. It appeared that water distribution in regularities and inequities cropped up more frequently in systems where technologies were mal-functioning and where water was shared with upstream communities. Respondents stated that repair of damaged structures and installation of additional mechanical technologies might enable relatively disadvantaged portions of systems to better press for their fair share of water--since the flow of water could more easily be measured and regulated.

An alternative type of technology used to regulate water distribution was that of emplaced structures--made from concrete or locally available perishable materials--which allocated water at division points according to fixed proportions. The adjustment process to reduced or increased levels of water within the system would occur automatically. Frequently, some form of consensus would be required prior to each cultivations season regarding the size of openings which channeled water to different portions of the system.

The trend among communities which was to move to more permanent, concrete division structures, has interesting implications for decision-making processes. When division gates were made from perishable materials--such as stone, bamboo, straw, mud and wood--they could be altered periodically to suit changing conditions. (In fact, they had to be repaired and changed, since they deteriorated over time and frequently were subject to damage during heavy monsoon rains.) This perishability, while demanding more labor, also provided communities with a technological/institutional flexibility that frequently was in part circumscribed with the installation of concrete structures.

Most cultivators, however, seemed to recognize the advantage of permanent concrete division gates, drop structures and lining of canals, once they were installed. But the process of deciding on what width and depth to make the openings was sometimes a difficult one, involving extensive discussion and debate in efforts to reach a consensus. Often,active leadership on the part of village officials, including the headman, was required. The socio-organizational implications of installing permanent structures, particularly when done in the context of increased water availability, were sometimes more complicated and far-reaching than would appear to the eye of the casual observer. It will be useful, in this regard to cite a specific example derived from a mountain system in West Java, where a community upgraded its irrigation technologies on its own initiative .

In the community concerned, the technological upgrading of its weir coupled with the lining of canals had increased the intake capacity and reduced conveyance loss. As a consequence, more water could be channeled to lower-lying portions of the irrigation network during the dry season. An additional 20 to 30 hectares were to be irrigated during the dry season in a lower portion of the system. Accordingly, the installation of a concrete division gate which dividied water between higher and lower lying distributary sub-systems required a change in the traditional amount of water that had been diverted through notched logs. This was,because, the net addition of land fell entirely within the confines of the lower-lying sub-system, at its end portions. Initially there had been strong resistance by cultivators from the higher-lying sub-system, who feared that changing the proportions by which water was sub-divided among the units might short-change them during dry periods. Eventually, the headman prevailed in his wishes, the concrete division structure was installed and functioned adequately, and cultivators from both sub-systems were satisfied, given the increased volume of water available overall.

When installing permanent concrete structures, a number of communities made minor modifications to the new emplacements so as to retain some of their previous technological flexibility. The example of the community just described is illustrative. At several places along the canals which had been lined, there were small holes with short pieces of bamboo inserted into them. These permitted water to be channelled to adjacent plots that might otherwise have been more difficult to serve. The bamboo lengths could easily be clogged up, when water was not needed or not part of a rotational turn. They were replaced annually. We will discuss this kind of example more when dealing with organizational patterns and technologies associated with water distribution to plots. In the same system, bamboo lengths were sometimes inserted into the wire meshed stone constructions found in gabion weirs, to divert water to channels feeding small sets of terraces nearby. Both of these examples give evidence of a successful adaptation and combination of traditional technologies with more permanent 'improved' ones. It is important to emphasize, furthermore, that these decisions were made after group discussion and in accordance with community water distribution norms.

The example of the community just cited illustrates the fact that in many community systems, which appear to espouse the principle of water allocation in proportion to land operated, there may be existing differential rights of access to water during water short periods which must be taken into account. Often these differential rights, which may not be easily observable during normal periods, are based on unwritten but generally recognized water rights of 'prior appropriation'. That is, portions of systems which were opened for irrigation well before others may be recognized as having preferential access to water under certain conditions. Professor Gil Levine, an agricultural engineer with extensive experience in Taiwan and the Philippines has drawn similar conclusions. He notes that in Taiwan there are often complicated rights and arrangements which operate below the surface of the formal regulations and procedures found in irrigation associations. These informal practices are often ignored in government descriptions, and yet they are important determinants of how water will be distributed in practice.

The concept of prior or preferential water rights during water short periods helps to explain water distribution practices found in some IRS systems. In these communities, upstream portions get water for rice during the dry season, while downstream portions only get water sufficient to plant dryland (*polowijo*) crops. It should be emphasized, however, that other reasons related to the efficiency of existing technologies may be just as important as explanations for such practices.

Some systems, for instance, with their crudely constructed weirs, have limited intake capacities when the water level in the streams and rivers that they tap falls and becomes very low. As a consequence, while rotational forms may be introduced, these may be confined only to the upper or mid portions of systems. Or where water is distributed to lower lying plots, it will be done so on a less frequent basis (once in 7 days) than that of more upstream areas (once in 3 days). A consistant underlying justification for this practice, where it is found, is that of efficiency. Frequently, the conveyance loss of water which occurs as it is channeled to lower segments of canal networks may be very high. As a result, if water is distributed equally throughout the whole network, the area potentially served may be reduced by as much as 20% to 30% of that possible when upstream portions are served only.

Most systems appeared to make some effort to compensate lower-lying areas by providing water at less frequent intervals. The fact that cultivators having prior rights often tended to be located in the upstream portions of systems resulted in a juxta-position of the various rationale relating to water allocation procedures--proportionality, prior rights and overall efficiency of water use. The resulting institutional practices probably represent a compromise under existing technologies. The preceding observations help to explain what happens when the physical water delivery capacity of existing community systems is raised through technological upgrading under IRS. As will be discussed in a later section, for the most part the benefits of such improvements go to lower-lying, more disadvantaged portions of systems which could be reached less adequately prior to such changes.

It will be useful at this stage to refer to several examples from the sample communities, which illustrate pre-IRS technological limitations in irrigation systems, and their impact on modes of organizing water distribution.

Our first example comes from the desa of Sariharjo, in Kabupaten Sleman of the Special District of Yogyakarta (DIY), and in particular from the system covering 5 hamlets served by the Randugowang Dam. Here, prior to 1970, only 7 hectares of 74 served by the dam could get water sufficient for a second rice crop. The three major problems were (1) the limited intake capacity of the then existing weir, and (2) the extreme porosity of soils, which prevented the channeling of water to lower lying areas, and (3) the poor state of development of delivery canals.

In 1970 the desa undertook rehabilitation of the Rondugowang dam on its own and increased the dam's dry season intake capacity. At the same time, the community extended the length of its primary canal by 500 meters, and elaborated its tertiaries to a total length of 10,000 meters, so that 19.5% of cultivators had direct access to water from channels. As a result, it became possible to provide irrigation for 20 hectares of rice during the dry season, and for 60 hectares of polowijo crops.

The addition of dry season cultivation could occur, however, only through organizational mofifications made to take advantage of the improved intake capacity as well as the better developed canal delivery system. Operating through the initiative of the desa and hamlet leaders, cultivators in the 5 dukuhs (or hamlets) affected instituted a rotational form of irrigation based on 4 major golongans, or groupings. Each golongan received water for one or two days a week. (We will discuss how this golongan system operated later in this chapter. Note, the term 'golongan' is used here to refer to an irrigation organizational unit consisting of a collectivity of water users. This usage of the term golongan differs from that which refers to staggered planting, although the two terms are sometimes inter-mixed.) In this example, technological improvements initiated prior to IRS facilitated a shift in the organization of water distribution during the dry season. During the rainy season water continued to flow on a constant basis throughout the systems canals.

The second example comes from the sample IRS community in West Sumatra. Prior to IRS its irrigation network consisted of (1) a number of very small systems averaging around 7 hectares each, and (2) one larger system of about 25 hecaters (it is now 75 hectares). The smaller systems generally had enough water during the rainy season, with some cultivators planting rice twice a year. The larger system, by contrast could irrigate only 25 hecaares of its present 75 hectares during the rainy season, the remaining 50 hectares having to rely on rainfall. Furthermore, the 25 hectares could only be irrigated through a system of water rotation. The Bandar Gadang Jambak system represented the only case of rotational irrigation practiced throughout the rainy season that was encountered in the sample survey.

The inability of cultivators to irrigate more than 25 hectares within the Bandar Gadang Jambak system during the rainy season, or any during the dry season, stemmed from the limited intake capacity of its existing *bronjong* weir. Thus, while a rotational form of water distribution was practiced during the rainy season, it applied only to the 25 hectares that were most upstream. Within this upstream area, there was a further breakdown of plots into those more upstream and those less upstream. The former received water for a 12 hour period during the day, while the latter got their rotation during a 12 hour period at night. The *Tuo Banda* (or *ulu-ulu*) was responsible for coordinating water distribution to plots.

The preceding example brings us back to our earlier discussion about the nature of technologies associated with specific forms of water distribution. *In that discussion it was noted that the introduction of mechanically adjustable, permanent technologies often permitted more carefully regulated, multi-level and flexible patterns of inter-unit rotation in water distribution*. The alternative approach mentioned was one in which water flowed continuously, being divided proportionately among different units through notches in logs or other locally made structures, or by concrete division gates. In practice many systems use a combination of these approaches.

It would be a mistake, however, to assume that the practice of rotational water distribution necessarily implied the presence of mechanically adjustable structures, or that it required the dismantling of small canal dams and the construction of others on a periodic basis. In some communities, of course, this was the case. In others, however, such as the Bandar Gadang Jambak system described above in its pre-IRS phase, the practice of water rotation could be implemented through alternate means.

First, a number of communities practiced rotation between upstream and downstream areas of a single tertiary (or sub-tertiary) canal unit, while water was flowing into the unit on a continuous basis. Within the unit, it would either flow into all plots simultaneously, or else in sequential turns.

In some cases, the water entering the upstream portion of the unit flowed through it on a continuous basis. Here, the water was diverted to adjacent plots simultaneously--through holes in dikes, cut bamboo lengths penetrating through earthen dyke walls, *cowal* (wooden etched troughs), and concrete emplacements. The only difference between this pattern of water distribution and that practiced in most communities during the rainy season, was that during dry season rotational turns, only a portion of the canal unit would be served at any one time. In the sample IRS community in Serang, West Java, for instance, water flowed simultaneously into all plots receiving a rotational turn when sufficient. However, when water was in very short sypply and the water level in channels was very low, cultivators dammed up the channels just below the entrance to their plots. When their terraces were flooded in sufficient depth, the water was passed on down the line.

Most communities which rotated water between up and downstream portions of systems (or within specific channels within systems), followed this latter practice of moving water from one cultivator plot entrance to the next, sequentially. The Bandar Gadang Jambak system of West Sumatra and the Wonogiri system in Central Java are examples. As we shall note later, under a variety of water distribution approaches, similar practices were found at the terminal channel level of many other systems.

Reports from several sample IRS communities illustrate a second way in which inter-unit rotation was implemented, but without reliance upon mechanical division gates or resort to periodic dismantling of canal dams. Rotation among portions of systems took place in turns of one dry season each, with a complete cycle taking place over two or three dry seasons. During any one dry season, water flowed to those portions of the system having a rotational turn, either on a continuous basis, or intermittently.

In the sample community from Pandeglang, West Java, the irrigation system which was fed by a spring had sharp reductions in supplies of water during the dry season. The right to water, accordingly was rotated during dry seasons among several kampongs--each having a seasonal turn in its own area defined as a golongan.

Finally, it should be emphasized that within sample IRS communities, there were often differences among irrigation systems (or components of state run networks) in technologies, relative water availability and physical layouts. These intra-community variations, in turn, influenced organizational practices in water distribution.

sometimes resulting in different patterns of irrigation behaviour between one intra-community system and the next.

First, in desa where portions of irrigation facilities were shared with other villages, technological problems and organizational complications often were more frequent than in systems and facilities that were completely internal to the community. To illustrate, in the sample community from Kuningan, West Java, portions of two Irrigation Service run secondary canals and 4 tertiaries were shared with another community. Problems frequently cropped up due to actions of cultivators from the upstream community taking water out of turn, as well as from the irrigation block within the community that was most upstream. In the remaining portions of the network which ware completely internal to the village, by contrast, water distribution usually took place on a more orderly basis.

Second, as indicated in greater detail in Chapter 3 of this Supplemental Report, a number of the sample communities had irrigation networks consisting of more than one system. Some of these systems had different water sources (rivers, streams, springs) rather than different weirs tapping a single source in several locations. As a result, within a single community there might be inter-system variations in water distribution procedures linked to differences in relative water availability.

In the Pandeglang community from West Java, referred to previously, there were two river based systems in addition to the 66 hectare spring-fed system. In the river based systems, where water was more plentifully available during the dry season, it was distributed on a continuous flow basis--although only 50% of cultivators could cultivate two rice crops. Conflict with upstream desa sharing the respective systems over illegal diversion of water on occasion reached the level of '<u>senjata tajam</u>' (fighting with sharp instruments). In the spring fed system, water supplies were much more sharply reduced during the dry season than in the river based systems. Accordingly, inter-kampong water rotation took place in seasonal turns. The enumerator reported that off-season water distribution was the best managed in the water-short spring-fed system, which was completely encompassed within <u>desa</u> confines.

Our final example comes from the sample mountain community Haranganom, in Lumajang, East Java, which had five small systems (average of 40 hectares each). Four of these systems drew their water from springs, while one diverted water from a river. In contrast to the situation in the West Javanese community, the river based system had substantially sharper reductions in water during the dry season than did the 4 spring fed systems.

In the East Javanese community, all 5 systems instituted water rotation during the dry season as well as employed a similar organizational format. The frequency of rotation, however, varied. In the river based system, land was divided into three blocks, each of which got an irrigated rice turn (<u>gadu</u>) once every three dry seasons. In the spring fed systems, by contrast, there were only two blocks, each cultivating a rice crop on alternate years. The locations which did not cultivate rice during the dry season, however, did get water for <u>polowijo</u> crops, although on a less frequent basis than the <u>gadu</u> (off-season rice) areas. When water was sufficient during the dry season, it was distributed on a continuous basis. When its volume lessened, then rotational forms were introduced. The <u>gadu</u> areas would get water once in three days, while the <u>polowijo</u> areas would get it once in 7-10 days.

The examples that have been cited in the discussion so far have been designed to illustrate some of the important interactions between technology and organization in water distribution. In the sub-section which follows, an effort will be made to take a closer look at variations and similarities in patterns of organizing water distribution among sample IRS communities.

3. Organizational Approaches to Water Distribution.

a) Introduction. In this sub-section, the major focus will be on organizational approaches to distributing water--as categorized by the manner in which water flowed throughout the irrigation networks which serviced sample communities prior to IRS. Discussion of the types of personnel present whthin systems, and the division of responsibilities for implementing water distribution tasks between cultivators, village irrigation specialists and officials, and outside agency personnel, will also be mentioned.

In the presentation which follows, the term 'sample' communities will refer to 17 pre-existing sample villages studied where appropriate data are available, plus 3 additional IRS communities. The three additional communities include (1) the sample Balinese community which did not pre-date IRS, but which employed water distribution practices similar to those found elsewhere in Bali, (2) a Lampung transmigrant village visited on a field trip which was substituted for the sample Lampung transmigrant village for which data were incompletely recorded, and (3) the mountain community near Sukabumi, West Java, which was surveyed in the pre-test of the questionaire and which has been referred to extensively throughout this report.

b) Rainy Season Water Distribution Approaches. With one exception, in all 'sample' Sederhana communities studied prior to IRC water flowed through the canal network primarily on a continuous basis during the rainy season. The exception, which has been discussed earlier, was the Bandar Gadang Jambak system of West Sumatra, where water was rotated on a day-night basis between portions of the network.

While cultivators generally were permitted to use water as they pleased during the rainy season, water distribution was not completely free of controls. Division structures tended to channel water to distributaries in rough proportion to the land area served. Furthermore, informal norms regarding the discharge of excessive water to lower-lying terraces, and the distribution of water during monsoon downpours were in operation. Several communities reported (and probably others practiced) some controls over water distribution, including staggered planting and rotation, during certain periods of rainy season cultivation. The imposition of such controls over water distribution demonstrates the institutional and technological flexibility that communities attempt to retain, so as to adapt to changing water availability--even during the wet season.

Controls are most frequently introduced in the wet season during its early phases, when water may not be available in sufficient quantities to service all portions of systems simultaneously. Where controls are introduced, it frequently occurs in the form of staggered planting among different irrigation units, usually (although not automatically) commencing at the upper reaches of systems and working downwards. For example, in the transmigrant 'sample' village visited in South Lampung, cultivators in the lower portions of the system received water first to prepare their terraces, before water was allocated in stages moving to upstream locations. By the end of the calendar year, after two months of staggered planting and rotation, water was usually available in sufficient quantities to switch to continuous flow for the remainder of the wet season. A similar pattern was followed in a community in West Java.

In a mountain village visited not far from the north coast of Central Java, where IRS upgrading of technological facilities took place in 1977, a golongan (staggered) planting approach was practiced at the beginning of the wet season cultivation for a different reason. The shortage of drought power, rather than water, was the primary constraint inhibiting simultaneous land preparation throughout the system. There were hints in several other villages visited during field trips that similar constraints also influenced the pace at which land preparation activities could be carried out prior to wet season rice cultivation.

Finally, in the sample desa Sukorambi, in Jember, East Java, it was reported that water for the most part, flowed continuously during the wet season. There were short periods, however, when rotational forms of water distribution were introduced due to water shortages. The institutional practice of switching organizational approaches to water distribution at short notice, rather than sticking to one pattern throughout a cultivating season, was found in a number of sample communities. It was implemented primarily during the dry season, when water constraints and water variability were more pronounced.

c) Dry Season Water Distribution Decision-Making Patterns. While village irrigation specialists, officials and cultivators tended to be more active in carrying out maintenance and repair tasks during the wet season, in most sample IRS systems studied, activity in water distribution intensified during the dry season. Since the demand for water was often higher than available supplies (at least without careful regulation), the level of potential conflict in irrigation systems was heightened during the dry season. The need to implement more stringent controls and more careful supervision of irrigation, added to the amount of time that those with authority as well as cultivators had to spend in allocating water. Furthermore, while not all peasant cultivators engaged in rice production during the dry season, those who didn't frequently planted polowijo or other short term cash crops which also had water needs. For these and other reasons, the complexity of water distribution tasks rose during the dry season, particularly during periods of water shortage.

In earlier sections we have discussed the decision-making processes connected with pre-seasonal cleaning of canals which apply also to water distribution processes. In some communities, schedules were handed down from Irrigation Service officials, around which community decisions were made regarding water allocation among tertiary facilities. In other desa, water initially flowed on a continuous basis during the dry season. Contingency plans existed for introducing rotation when needed. Still others distributed water continuously throughout their networks during the entire dry season. In short, there was considerable variation among communities not only in the complexity of dry season water distribution tasks and in accompanying institutional modes, but also in the complexity and timing of related decision making processes. In communities where irrigation networks were large and interdependent, decision making often was more complex (although not automatically) than in locations with several smaller, independent systems.

The decision-making processes regarding water distribution cannot be separated from those regarding agricultural cultivation. We will discuss this matter in greater detail in the following chapter. At this stage it is important to note that communities often exercise some regulatory control over agricultural production, since patterns and timing of cultivation determine the nature of demand for water.

The following Table gives a breakdown of 'sample' communities according to the percentage of households with irrigated rice cultivation who were able to plant two rice crops a year prior to IRS.

Table 14: Frequently Breakdown of 'Sample' IRS Communities According to the Percentage of Households in Irrigated Rice Cultivation with 2 Rice Crops a Year Prior to IRS.

% of Irrigated Rice Households Cultivating 2 Rice Crops/Year	No of Desa	% of Desa
1. 90% +	3	15%
2. 40%-70%	14*	70%
3. Below 30%	3	15%
T o t a l	20	100%

* Includes Bali.

It indicates that in 85% of the communities, close to 1/2 or more of the households then involved in irrigated rice cultivation were able to plant an off-season (gadu) crop. All three locations falling in the 90% + category had mountain systems operated primarily by the communities concerned.

An important question that most communities had to address was that of what to do with cultivators who planted non-rice crops (primarily polowijo) in their sawahs during the dry season. With a few exceptions (ie. Bandar Gadang Jambak in West Sumatra), non-rice areas were not left fallow during the dry season. Some communities apparently treated non-rice areas as a residual--to receive water when it was in excess of the needs in the irrigated rice areas. Most communities, however, appeared to have either explicit or informal procedures for allocating water to the polowijo crop areas, although on a less frequent basis than to sawahs with standing rice.

One problem that cropped up in a number of systems was that of what to do with padi gadu that was gelap (not sanctioned, or out of turn). It was often extremely difficult to shut off water to cultivators with a standing rice crop, even though planted out of turn. In some systems, upstream cultivators surreptitiously took extra water outside of their rotational turns, to irrigate illegal rice crops. While many communities attempted to draw clear-cut distinctions and to regulate areas permitted to rice, others did not. The latter often had fringe areas in the mid-lower portions of their systems where it was left to cultivators (1) to decide whether to risk planting rice and take the chance of losing a crop if insufficient water would be available, or (2) to stick with less risky polowijo crops which had lower water needs.

It will be useful to refer again to desa Karanganom, in Lumajang, East Java, which was discussed earlier in the context of its multi-season cycles of water rotation. Karanganom illustrates the complexities of dry season procedures to regulate cultivation in both rice and non-rice areas. Karanganom had 5 mountain systems, averaging 40 hectares in size, 4 of which received water from springs and one from a river. In the river diversion system, where dry season water availability was substantially reduced, the gadu areas were rotated among 3 blocks, each getting a turn once in three years. In the four spring-fed systems, each of which consisted of two blocks, gadu (rice) areas were alternated from one dry season to the next.

During the wet season, cultivators took water as they pleased, but during the dry season they had to follow standards set by the ulu-ulu. The regulations were discussed and established during a rembug (full desa) meeting attended also by representatives from the agricultural and irrigation services, prior to the onset of the dry season. Decisions were made regarding which blocks could plant rice and which had to stick with polowijo crops, and concerning the timing of planting among golongan groups. In addition, the rotational schedules by which water would be allocated to the gadu areas and the polowijo areas were outlined. Usually these schedules specified a rotational turn of once in 2-3 days for the gadu areas, and once in 7 days for the polowijo.

If at the beginning of the dry season it appeared that the water supply was sufficient, the ulu-ulu informed padi gadu cultivators of their right to plant without waiting their golongan turn under the normal staggered planting procedures. The scheduled polowijo cultivators would also be permitted to cultivate rice as they wanted, with the understanding that when water rotation schedules were introduced, they would only receive water on the basis of their polowijo allocative rights--once in 7 days. During the pre-rotational phases, water would flow on a continuous basis. The responsibility for implementing the distribution of water and rotation schedules was in the hands of the ulu-ulu and his assistants. The ulu-ulu, however, was the key authority in supervising implementation of water distribution plans. Cultivators, however, were active in watching over water that entered their plots, and in seeing that schedules were followed.

During the wet season in Karanganom, by contrast, meetings regarding water distribution were 'incidental'. Sometimes they involved a convening of the whole village--on other occasions the <u>ulu-ulu</u> discussed general plans with cultivator groups assembled in their fields. If insufficient water was available during the early part of the rainy season, the <u>ulu-ulu</u> had the authority to introduce water rotation schedules until sufficient water was in the streams to switch to a continuous flow pattern of distribution.

d. <u>Dry Season Organizational Approaches to Water Distribution</u>. In the discussions which follow regarding dry season water distribution approaches, the 'sample' IRS communities have been divided into several categories. It should be remembered, however, that the irrigation networks of most communities are more complicated in their internal organizational make-up than these simple categories might imply. For instance, irrigation systems whic utilize a rotational form at one level, may switch to continuous flow at another. Vice versa, those which allow water to flow continuously throughout their canals may have informal 'rotational' modes at the field channel level by which cultivators pass water on down the line. These categories, furthermore, do not take-into account inter-community variations in types of participation by various actors involved in performing water distribution tasks.

In the table which follows, an attempt has been made to divide 'sample' IRS communities according to the dominant organizational approach used to distribute water during the dry season. <u>Interestingly, 29% of the sample locations let water flow continuously for</u>

the duration of the dry season, while 70% practiced some form of water rotation prior to IRS. The latter locations can be further sub-divided into (1) those (20%) that rotated irrigation turns between upstream and downstream sections within specific systems or canal units, (2) those (10%) that allocated water turns to different units in accordance with a multi-season cycle, and (3) those (40%) that distributed water among distinct units on an intermittent basis during a single season.

Table 15: Frequency Distribution of 'Sample' IRS* Communities According to Organizational Approach to Dry Season Water Distribution Prior to IRS.

Type of Dry Season Water Distribution Approach		Number of Desa		% of Sample Desa
1. No Dry Season Irrigated Cultivation.		1		5%
2. Continuous Flow				
a. Regulated Plot Entrances	(3)		(15%)	
b. Unregulated	(2)		(10%)	
c. Total Cont. Flow		5		25%
3. Rotational				
a. Upstream--Downstream	(4)		(20%)	
b. Multi-Seasonal Cycle	(2)		(10%)	
c. Inter-Unit (Periodic)	(8)		(40%)	
d. Total Rotational		14		70%)
4. Total		20		100%

* Includes also 3 substitute IRS communities for which appropriate data were available. See also discussion in VII. B. 3.(a.).

The five communities which let water flow continuously throughout their networks during the dry season have been further subdivided according to the extent to which water entering the plots of cultivators was regulated. Three communities which exercised fairly tight control over the flow of water to plots also carefully regulated the volume of water allocated throughout their irrigation networks. The confidence that these communities placed in the 'continuous flow' approach apparently was conditioned significantly by the level of water control possible through their existing technologies.

In the 400 hectare system from North Sumatra, cultivators were able to plant rice in 100 hectares during the dry season. The remaining 300 hectares either lay fallow or else were under polowijo crops. The head ulu-ulu supervised the water entering three irrigation blocks in proportion to the land area served. Each block consisted of two tertiaries. The block heads (or ulu-ulu) managed the distribution of water in their respective tertiaries and quaternaries, down to and including entrances to cultivator plots. Most cultivators had direct access to tertiary or quaternary channels. Prior to IRS the local irrigation organization had begun to put complete control of irrigation in the hands of the ulu-ulu. Cipoletti type weirs were being installed on entrances to all terminal channels, and were replacing the bamboo tubes used to deliver water to plots. Even prior to IRS, cultivators apparently were not permitted to tamper with the cipoletti devices, nor were they allowed to insert them deeper or supplement them with bamboo tubes pushed through earthen dyke walls. If cultivators had complaints, they could submit them to the ulu-ulu or to their kampong heads. They were being discouraged, however, from taking action on their own. After IRS, the quaternary channels were completed, rules tightened, and the installation of cipoletti weirs in plot entrances to terraces accelerated.

Of the 465 hectares in the mountain system near Sukabumi, 400 hectares were under a gadu crop during the dry season when water flowed on a continuous basis. The 23 major canals (4 primaries and