PD-AAV-734

SEDERHANA EVALUATION

IRIGASI/REKLAMASI/SEDERHANA

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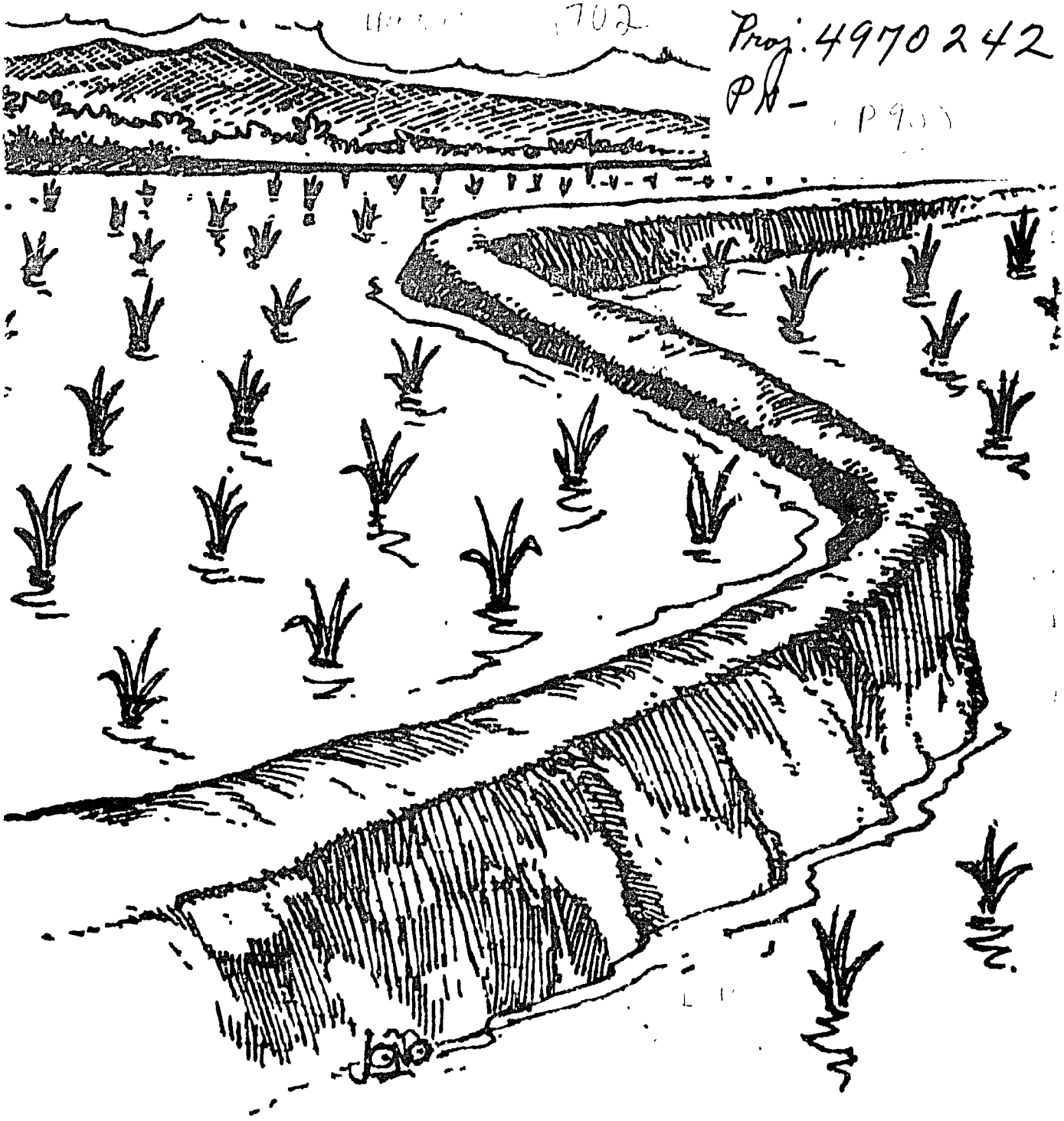

IRS INCREASED PRODUCTION THROUGH BETTER WATER MANAGEMENT

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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	- Sub-Directorate Land and 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	- Hectare 10,000 square meters or 2.471 acres.
20.	I .	- University graduate engineer.
21.	STP	- Special Tertiary Program of the DGWRD. 3 years target is 360,000 Ha.
22.	CTP	- Complementary Tertiary Program of the DGFC. 3 years 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	- Bachelor 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 Chief)
3.	Kecamatan (Subdistrict)	- Headed by Camat
4.	Desa (Village)	- Headed by Lurah or Kepala Desa (Village Chief)

Foreword

The Sederhana I evaluation prepared by Dr. Clive Gray (Team Leader and Economist), Mr. John Duewel (Rural Sociologist) and Mr. Henry Gembala (Engineer) is summarized in the following paragraphs. The evaluation is based upon over 220 total person-days in-country, including 70 person-days spent in the field. Actual field inspections covered 47 individual subprojects in 14 provinces. Detailed discussions were conducted at all levels from individual farmers up to top GOI officials. Field trips included detailed inspection of subprojects, participation in Sederhana training programs, seminars and evaluation workshops, and discussions with local contracting firms, educational institutions and other foreign donors.

Further, it is recognized that the above contract evaluation team is only the cutting edge of the Sederhana I Evaluation process. The major inputs have been provided by the DGWRD and the DGFC. Both Departments have devoted many person-hours to the design and preparation of evaluation questionnaires, the subsequent training of enumerators and the conducting of the surveys. Many additional person-hours have been devoted by key GOI data processing and evaluation technicians to building a new and significant data base for the Sederhana Program.

Finally, a significant contribution to the evaluation has been made by the consulting team since their direct involvement in all aspects of the program gives them a unique perspective of policies, progress and problems.

The Evaluation Team has concluded that the Sederhana Irrigation and Reclamation Program (IRS), although relatively young and unique, is proving to be a worthwhile and effective program promoting increased rice production, increased incomes for the rural poor, and a strengthening of GOI and village institutional capacity to develop simple irrigation systems.

SECTION I - EXECUTIVE SUMMARY

The Sederhana Irrigation and Reclamation Program (IRS) was launched in Indonesia in FY 74/75 with 100% local financing. In June 1975, AID approved a $20 million loan for the program which was later increased to $23.7 million. By late 1977, IRS had expanded irrigated rice hectarage by 18,000 hectares and gross crop rice hectarage by 26,000 hectares in irrigation systems scattered throughout Indonesia. In the 1976/77 crop year a subset of 132 "mature" subprojects accounted for an annual production increase of 20-30,000 tons of milled rice. A study of 517 subprojects, 90% of those undertaken in the program's first three years, pointed to an anticipated expansion of 75,000 hectares of rice paddies, 153,000 gross crop hectares and about 400,000 tons of milled rice upon completion of Sederhana I. The 132 mature subprojects are already yielding a net return to labor about equal to the social opportunity cost of labor (62-90 cents per day) after allowing for a 15% opportunity cost of capital invested in IRS infrastructure. This can be expected to increase as more land comes into production in the areas concerned. The return to labor at maturity for the 517 subprojects is even more favorable ($1.10 per day), assuming an average social cost of about $1,000 per hectare for clearing and paddy formation on 70,000 hectares required to achieve the full revised hectarage target.

Pari passu with its contributions to increasing Indonesia's rice output, which is one of AID's three main purposes for Sederhana I, the program has clearly also served a second purpose of enhancing income for several hundred thousand farm families, nearly all of them cultivating less than a full hectare of paddy. Progress toward AID's third purpose, strengthening the institutions responsible for implementing IRS, while readily observable, appear nevertheless to have been slower than projected. This can be attributed to the inherent difficulty of administering a program spread over hundreds of sites, about 80% of them in the Outer Islands, where the establishment of functioning irrigation systems and the absence of site feasibility studies put a premium on individual judgment of irrigation officials. A major benefit is the experience gained by these officials in the course of the program. Not surprisingly, recruitment and assignment of staff and administrative follow-ups by the provincial irrigation services has been closer to target than in the case of the agricultural services. The contribution of the agricultural services has been, primarily the development of tertiary networks, water-user associations, and extension/training programs (focussing on improved water management, operation and maintenance, but including agricultural cultivation activities).

The evaluation report advances the following principal recommendations:

I. <u>Improvement of Current Procedures, Project Implementation and Follow Up</u>

A. <u>Subprojects Design Feedback</u>. The functionality of many subprojects' designs can be improved by requiring contractors to return to the field

to evaluate preliminary design concepts and layouts in consultation with local engineers. The associated costs of such feedback would bring a high return.

B. Operation and Maintenance. Lack of significant movement towards instituting a formal system of O&M for IRS subprojects is not an unmitigated portent of disaster for the system. In the long run, projects on IRS' scale are more likely to succeed if the beneficiaries find themselves obliged to handle O&M of components which are technically within their capabilities. However, the team recommends instituting, on a trial basis, an O&M budget allocation, of which the 1978/79 budget "improvement" allocation for half the first three years' subprojects may be regarded as a precursor, to service major structures in lieu of handling this as new project activity, with its attendant delays.

C. Monitoring. It is desirable to continue both the comprehensive monitoring the IRS subprojects by irrigation and agricultural officials, and the collection of more reliable data on a scientifically selected sample of locations along lines pursued hitherto by the Survey Agro-Economi (SAE).

II. Future IRS Investment Policy

A. Subproject Selection Procedures. There is general agreement on the need to intensify consultations by irrigation officials with local farmers and authorities, as well as with other technical agencies (who already enter at a later stage by having centrally organized Appraisal Teams). The BAPPEDA (Provincial Development Planning Boards) should be involved in the process of clearing subproject proposals before they are considered at the national level.

B. Project Selection Criteria. Planning diligently is a useful way to achieve program objectives. Social benefit-cost analysis is an accepted technique of project evaluation that might be applied systematically in the IRS selection process, to some degree offsetting higher nominal returns perceived by establishing subprojects in previously existing village irrigation schemes.

C. Supplemental Investment in IRS Subprojects. Incremental benefit/cost analysis should be applied in evaluating proposed investments in tertiary network, land clearing and paddy formation. Each extension of development brings benefits, but should not be viewed as invariably required to make initial investments in major works economic. Optimal targets for government activity in these areas cannot be determined without further investigation and experimentation, designed to learn, among other things, how much investment the farmers will realize themselves, once water is available to them.

III. Staff Development

The team received concrete proposals from several provincial irrigation officials as to the further duration and content of training required to remedy shortcomings in the training required for different categories of staff members. In the time available, the team was unable to map out and cost alternative programs for training development but it believes a high return is obtainable here. This should be the first priority for expanded technical assistance.

IV. Future AID Assistance to IRS

A. Technical Assistance

(i) Training. Technical assistance extended so far has been deficient in its concern with fast training. A full time advisor on programming and curricular development of technical training is needed. The curricula of the respective training programs should be reinforced with materials drawn from IRS case studies.

(ii) Engineering. The team supports the proposal to station additional engineering advisors in major provincial offices. The advisors could make strategic contributions, not only to execution of IRS, but also to the sedang/kecil (medium, small-scale irrigation programs) and other programs consistent with the Congressional Mandate. Serious study of the Indonesian language should be made part of the advisors' preparations. The team feels that AID dependence on the consultants' certification of subproject completion places them in a complicated dual role and the possibility of using an alternative mechanism is recommended.

(iii) Agriculture. The team felt the SINOTECH contribution had probably given a favorable return on expenditure up to the present. The Directorate General of Food Crops has indicated his desire that the SINOTECH input continue at approximately the same level.

(iv) Social Science. There would be a constructive role for three social science advisors, including the educator already referred to; an advisor on the institutional aspects of water management, and an economist to assist in subproject selection procedures and monitoring the program.

B. AID Reimbursement Procedures. Reimbursement procedures under Sederhana I have been subject to lengthy delays without any apparent compensating social benefit via increased efficiency of program implementation. The problem arises from trying to match AID's minimum engineering standards with a program necessarily involving widespread field operations. Since the question is essentially one of attributing AID assistance rather than determining which subprojects actually get carried

out, the team suggests that future capital assistance be met with a subset of projects, chosen on the basis of convenience for AID's inspection and approval and reimbursed at a higher rate than in Gederhana I.

SECTION II - INTRODUCTION

1. The Irigasi/Reklamasi 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, referred 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 IRS 1978/79, the percentage 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 loans/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 criteria in selecting locations for IRS subprojects were from the

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*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 continue 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, 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 the principle 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.C.'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 to between USAID and representatives of the GOI, the overall 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, 300-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 on 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;

c) Survey Agro-Ekonomi - five monitoring/evaluation reports supplying baseline socio-economic data and discussing IRS implementation problems in 71 subprojects in 18 provinces; and

D) To consult IRS program documentation, the engineering and agricultural consultants' reports, 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 Sulaveri-Kalimantan, visiting a total of 32 IRS projects (plus one "Khusus" project) in seven provinces.

5. <u>The Evaluation Report</u>

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 the irrigation 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 the provincial 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 the data 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. Bintamidjaja, 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 opportunity to participate in an exercise that has turned out to be a great professional challenge and will hopefully in the 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 outside 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) Strengthening GOI institutional capacity to implement IRS. Recent events suggest that the rate of expansion towards which IRS seemed to be building as AID assistance for the program was increased, 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 Resources 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 the subprojects included in the 1978/79 program.

Clearly the provincial services are facing 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 field 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 6.i 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 were still being sought at the time this

report was due.

Turning to the agricultural side, once 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 [illegible] 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 has reached the conclusion, based on discussions 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 parameters that serve as the primary indicators of subproject success or failure, first and foremost of 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 BAPPEDA (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 unwieldly 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 preceding, 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/quaternary 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 promulgating 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 networks, 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 yield 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 as 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 offsets 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 resistence 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 liberal 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 expanded 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 earmarking of external financial assistance may provide useful incentives for internal activity. The procedureal 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 capacity 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 to par.

2. The contractor's present terms of reference require its staff to inspect completed subprojects and certify whether or not they meet reasonable standards 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 placed 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 resources 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. Pengai-an 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 prospective 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 phased down. Sinotech 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 Central 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 IV

ECONOMIC BENEFIT-COST ANALYSIS OF IRIGASI/REKLAMASI SEDERHANA

A. General

The only data available on a comprehensive basis across the IRS program as a whole concerning economic benefits already registered by it are those obtained from the Directorate General of Food Crops (hereinafter referred to as Agriculture) survey carried out in late 1977, cited in Section I above. Economic parameters are also recorded in a series of five studies prepared by the Survey Agro-Ekonomi on behalf of the Directorate General of Water Resources Development. The provinces and subprojects covered by the SAE surveys are listed in Appendix Table II A-1. In general, apart from some discussion of the progress of execution of subproject works, together with problems encountered in executing the schemes and farmers' attitudes toward*, the SAE studies do not go beyond baseline surveys of the project locations, based on secondary sources at the kecamatan level and interviews with randomly selected samples of participating farmers. One of the five reports goes so far as to compare gross and net production and income on a per hectare basis over two successive semiannual periods, but the relationship to the timing of subproject effectiveness is not indicated and the comparison is most probably determined largely by seasonal factors.

In considering economic benefits it is logical to begin with the program's effectiveness or otherwise in delivering water to the farmers look at the extent to which it has brought about more intensive land use, and finally attempt to measure its impact on agricultural production and farm incomes.

B. Delivery of irrigation water

Agriculture, survey enumerators, mainly extension agents (PPL's) assigned to the relevant areas, reported that in 311 out of 517 subprojects covered by the survey some farmers were already receiving water from the scheme. In 35 cases (7%) the enumerators did not supply this datum; in 171 cases they indicated no farmers were receiving water from the subproject. If we ignore the missing cases, the survey

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* A perceptive discussion of these issues is to be found in the report on the 4th round of SAE's evaluation work, Survey Agro-Ekonomi, Laporan No. 01/78/L. Translated extracts are reproduced as Appendix II A-2.

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 II-1:

Table III-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	% of 317 cases not responding to this question
Rainy Season	7	38	44	11	19
Dry Season	10	45	40	6	22

C. Intensification of Land Use

Turning to the question of land use the enumerators were asked to estimate hectareages in various use categories

(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 II-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			Rainfed sawah	Total sawah	
	One	Two	Total		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.

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* 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. Within this sub-set, one third of the total sample showed total non-sawah area to have increased up to the time of the survey. By no means all the responsibility for these errors falls 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 II-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 1972, had increased in anticipation of the subproject, and that a number of farmers had previously planted rice, as it turned out unsuccessfully (until the current season) because the water level was too 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 but not cropped (grass-or bushland known as alang-alang)	23
Forest	18
Swamp and marshland	8
Total (rounded)	70

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

Table IV-3

Future land use in 517 IRS subprojects according to Agriculture Dept. survey (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 hectarcage (=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/kg (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 II-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 d 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	4228
Outer islands	4245	5029	4027	3486	4050
All Indonesia	4295	3614	4160	3352	4193
2. Simple/Village irrigation:					
Java	4016	3162	4143	3048	3860
Outer islands	3971	2659	4224	3411	3704
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	2663	2718
All Indonesia	3047	2182	2427	2561	2739

* 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 versue 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 =	878
Artificial fertilizer: 4009 - 3047 =	962
Combination of manure and artificial: 4148 - 2427 =	1721
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 II-4. The calculations are shown in the following Table II-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.		Production, areas X 3800 kg = '000 tons	Area '000 ha.	Production, (4) X3050 kg= '000 tons	Total production, (3) + (5) '000 tons
	One	Two				
1. 1976/77 crop year	10.8	11.9X2	131	4.7	14	145
2. Immediately before each subproject	10.4	4.4X2	73	11.4	35	108
3. Change in production: (1) - (2)						37

Source: area figures computed directly from survey returns 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 II-7 and II-4 we find computed production in the last full crop year before tha 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 159,000 tons is 10% in 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 overstated yield increases following execution of the IRS subprojects 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 to completion of all 517 subprojects included in the survey by applying BPS yield coefficients to the hectareages presented in Table II-3. This is done in Table II-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, One	Two	Production, areas X 3800 kg. '000 tons	Area '000 ha.	Production, (4)x 3050 kg. '000 tons	Total production, (3) + (5) '000 tons
1. Upon subproject completion (targets)	57	115x2	1,091	6	18	1,109
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 production: From begin to now: (2)-(3)						+107
Total associated with 517 subprojects: (1)-(3)						+696

Seeking to "calibrate" this model, we compare total production immediately before each subproject with total production computed from the Agriculture survey

production computed from the Agriculture survey for the last full year before the subprojects. The corespondence 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 most 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 to $350/ton

* A total expansion of 26,000 gross cropped hectares is given in Table IV-2, Table IV-7 yields an analogous figure of 8700 ha for the 132 subprojects (10,8 + 11,9x2 + 4,7 - 10,4 - 4,4x2 - 11,4 = 8,7).

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= Rp.67½/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

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* 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 1976, p.27. All production costs included except labor and taxes

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 ahad 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 must have grossly understated the work required in order to satisfy unit cost 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-quarternary 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 BPS 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. --0.4 thousand single-cropped plus 7.5 thousand double-cropped -- from the last crop year before the respective subprojects until 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 does not tell us how much of it came from the four categories of non-sawah land, all of which involve sharply differing costs of

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 83 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 A3, Incremental Labor Required ..., from Table A2, 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-clearing 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 government 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 ramainder as honoraria to local management committees.* Assuming that roughly

* 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	Geuiteut Geupeu Garut Uleu Keubang Timbang Gajah Paya Raof Cubo Rimba Raya Alue Pideuk Kr. Ulim	01/78/L
No. Sumatra	Bulian Lau Simone Perbarakan Timbang Deli Cinta Kasih Sei Balai Kp. Sukaramai Kp. Benteng Bukit Cermin Namu Lubilin	01/78/L
West Sumatra	Bandar Kuah Batang Sasapn Batu Pambin	2/77/L
Riau	Penyesauan Sei Jering Sei Buring	2/77/L
Jambi	Semayo Cupak Batu Lumut	2/77/L
Bengkulu	Air Kemuru Suka Bulan Lubuk Jala	2/77/L
East Java	Karang Tambak Cempaka Besuk Strek	6/78/L
Bali	Apuan Langkah Bang-Bang Biaung	6/78/L

West Nusa Tenggara	Poak Rengge	6/78/L
	Mamben	
	Tarusan	
East Nusa Tenggara	Tasipoh	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	Kadumait	2/77/L
	Makonsar	
	Katulidom	
Central Sulawesi	Malino	12/77/L
	Mapanga	12/77/L, 2/77/L
	Macnusi	12/77/L., 2/77/L
	Joncoge	2/77/L
South Sulawesi	Panaikang	3/77/L
	Wollangi	
	Leworeng Kanan	
	Kanang	
South East Sulawesi	Anororo	2/77/L
Maluku	Dueo	1/78/L., 6/78/L

(Total of 10 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 Sederhana 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 IRS locales. This observation is similar to that of a recent FAO perspectus on Indonesia, which concluded that village irrigation systems are generally better maintain ' 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 agencies to consider the institutional dynamics of small irrigation systems, and to recognize 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 24% of projects are situated in flat terrain (under 2% gradient) and many of these are surrounded by or 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 55% pre-existing IRS systems were situated primarily in the upper reaches or headwaters of watersheds, or else were generally self contained. From 415 locations on which agricultural survey data are available, 65% reported no upstreams systems while only 20% reported 2 or more. Likewise, 71% 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 perishible 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

i) Official Village Leadership. In most IRS systems studied, it is clear that the existing official leadership plays a major role in supervising and managing systems. The village headman frequently retains ultimate authority over the system, including (i) resolving issues that

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-ulu) 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 30% of 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 principally conducted by lower ranking Irrigation Service personnel who manned weirs and turnout gates. In some cases where watersheds or local canal systems were shared among several villages, formalized horizontal interactions were evident. Likewise, inter-system coordination of irrigation was on occasion exercised by locally acknowledged and hierarchically legitimated irrigation officials (such as the Sedehan 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, Undertake 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. 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.

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 IRS 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 subproject 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 1½ 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 un 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 'overdevelop', 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

i) 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 systems 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, attention will 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

i) 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 influence of previous village works is seen by the fact that where IRS constructed diversion weirs were built on existing irrigation systems in 40% of the cases they were built over village weirs. Even more noticeably, IRS built canals often followed existing channels, or were constructed adjacent to 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 indigenous works (which can be repaired by community action) by permanent structures introduces an element of dependency into the local irrigation system. If the government is unable to maintain a contingent capacity to see that structures are repaired when needed, the irrigation performance capacities of some systems may be undermined. The potential seriousness of this problem is seen by the fact that of 435 locations reporting, 13.6% reported considerable or major damage to headwork structures within a few years, with 17.1% reporting substantial damage to the more easily repairable canal networks.

3. Impact of IRS on Water Distribution Capacities

i) Technologies introduced by the government. The degree to which new technologies were introduced (division gates, weirs, lined canals) or old technologies upgraded (deepening of canals, replacement of existing structures with similar technologies) varied considerably. A similar conclusion can be drawn regarding their impact, although beneficial consequences appear to have substantially outweighed negative consequences.

ii) Impact of technologies on water distribution capacity. There are difficulties in evaluating the agriculture survey data on impact of IRS 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 to 11% of locations (at a minimum) reported that the availability of water had worsened following the implementation of the subproject--in many cases these involved 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 resentful. These water distribution problems again point to the importance of a contingent government capacity to undertake repairs to systems where such repairs are the result of the shortcomings of contractors or damage by floods and are byond the capacity of villages to solve.

iii) The elaboration of tertiaries. In most of the systems where improved technological capacity to distribute water resulted from IRS construction efforts, the major initiative to translate these potential gains into reality seems to have been taken by the communities involved--both as individuals as well as in groups. This included both the opening up of new sawahs and the elaboration of tertiaries. In a number of locations, the agricultural service appears to have performed a useful guiding role--often in conjunction with its activities to assist in the formation of water users associations (P3A's). The degree to which tertiary delivery systems were further constructed can be seen from the fact that only 32.7% of currently functioning systems reported receiving water on a field to field basis. The remainder relied primarily on direct access by cultivators to delivery channels, including 38.6% where delivery systems were present prior to IRS,

and 28.7% where they were developed or intensified subsequently. The 28.7% locations consisted of 11.4% where tertiary construction was undertaken without guidance, and 17.3% 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 IRS 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 IRS 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 30% 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 primarily giliran (rotational) methods of water allocation, although staggered planting (golongan) was also practiced.

4. Impact of IRS Implementation procedures on local institutional capacities, including the formation of water users associations (P3A's).

i) Introduction. A major goal of IRS as expressed by the most senior irrigation official responsible, is to encourage target communities 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 high. How projects are implemented, including the formation of viable water users associations where needed, will be important factors determining the degree to which these ideals can be attained.

ii) Water Users Associations. To date, the extension staff of the Department of Agriculture, working under the guidance of a central office, have been the key figures in assisting communities to form P3A's. The record has been mixed--although when placed in the context of the starting point, fairly good. P3A's have nominally been formed in 40% of the IRS communities, with some 10% to 15% reporting actively functioning organizations. This is not to suggest that in locations where P3A's are not

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. 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.

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. 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. Given the close link between physical layout and organizational possibilities this early role is critical.

iii) Government implementation procedures. In the past, a number of problems emerged from IRS implementation procedures that did not allow for participation by intended beneficiaries. For instance, in IRS 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 interact 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. Beneficiaries

i) Introduction. 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 grographical 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) Distribution of benefits. 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 of water

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 to 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 SUNGAI 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 Sedernana 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 every 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 [illegible]. A graduate engineer (BIE) would be in charge and have [illegible] 2- graduates from a technical high school (STM's) with 10 to 1[illegible] [illegible]ence. They would supervise and assist the BIE's and STM [illegible] [illegible]n 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 construction contractors to appraise them about contract responsibilities, policies and 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 more advanced principles of the course.

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

IRS Projects Visited by Gray and Gembala

Province	Name of Subject	No. of Subject
North Sumatra	Purbaganda	1207401
	Timbang Deli	1210402
	Lao Simeme	1210406
	Kerakesan	1207501
	Kuala Janji	1207606
	Bukit Cermin	1210607
	Sihail-hail	1204608
	Aek Simare	1204609
	Lumban Gaol	1204610
	Aek Mandosi	1204611
R i a u	Sirah	1404502
	Tampan II	1404610
Bengkulu	Air Durian	1702508
	Air Daup	1702604
	Air Sengak	1703611
	Air Kelingi	1702616
West Java	Ciaria	3201408
	Cidahu Girang	3201601
	Cumanggala	3205608
South Kalimantan	Sungkai	6303401
	Rawa Taras	6307504
	Rawa Palma	6303505
	Pampaia	6305604
South Sulawesi	Panaikang I	7303407
	Calendu III	7303524
	Kariu I	7303604
	Panaikang II	7303605
	Kariu II	7303606
	Kajenjung	7306607

1977/78 Projects

Central Sulawesi	Kekelor
South Kalimantan	Rawa Negara

Additional project visited by Gembala

South Sulawesi	Biangloe

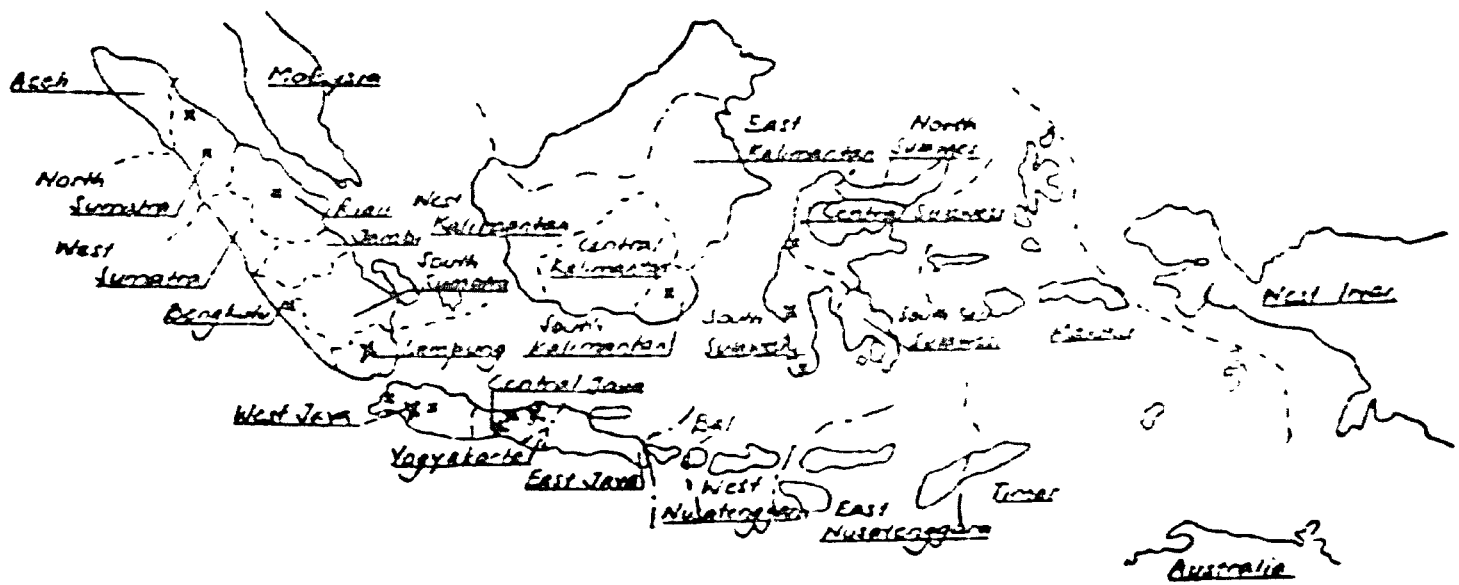
Exhibit 1

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 1977-73
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

Annex 1(a)


Aceh
Moluccas
North Sumatra
West Sumatra
Riau
Jambi
West Kalimantan
South Sumatra
Central Kalimantan
East Kalimantan
North Sumatra
Central Sumatra
Bengkulu
Lampung
South Kalimantan
Jawa Barat
Jawa Timur
Irian Jaya
West Java
Central Java
Yogyakarta
East Java
Bali
West Nusatenggara
East Nusatenggara
Timor
Australia