TECHNICAL PAPERS FROM THE

EXPERT CONSULTATION ON IRRIGATION WATER CHARGES

Rome
22-26 September 1986

VOLUME I

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

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Sponsored jointly by FAO/USAID

FAO Land and Water Development Division
USAID Water Management Synthesis II Project

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PREFACE

This document contains the Papers prepared during the course of the meeting. In a few cases, slight editorial changes have been made.

These papers form a companion publication to the "Report on the Expert Consultation on Irrigation Water Charges", published in 1986. Together, they comprise a proceedings of the Expert Consultation.

Owing to the decision to print all the working papers, it has been necessary to divide them between two volumes. Volume 1 contains an introduction and its background, and the Technical Papers. Volume 2 contains the Country Papers and the Annexes.

Any queries should be referred to Prof. J. Němec, Chief, Water Resources, Development and Management Service, Land and Water Development Division.

CONTENTS

A. THE CONSULTATION

1. Background

Many countries of the world are in a dilemma: development of their rural economies is becoming ever more expensive at the very time when increased productivity from the agricultural sector is needed to reduce domestic pressures for food and fibre imports and to earn foreign exchange. International donors and national leaders are pressuring local bureaucrats to pay greater attention to projects already in place and generate or devote more resources for their operation.

In the case of irrigation infrastructure, there is considerable evidence that the potentials are not being fully realized. Production is less than what is possible and systems around the world are plagued with financial and managerial problems. The result is poorly maintained and deteriorating facilities that require costly rehabilitation and do not deliver the water to crops in a timely and efficient manner, as well as farmers who become discouraged and are turned into ineffective managers. An obvious response to this situation, wherever it is encountered, is to look for domestic financing and management resources that can be employed to improve the situation as far as possible.

Participants in the expert consultation seemed to share the most interest in the effects of cost cost recovery, and its twin, cost reduction, on better system management. Many examples of bureaucratic mis-management of day-to-day operations were cited, along with concerns about lack of operating budgets, and why more money was needed. A number of benefits were linked to placing mire emphasis on administrative decentralization, for example. Beyond this, however, two interesting considerations also emerged. One was that many irrigation systems, in diverse regions of the world, operate quite well, and the administrative rules, procedures and charges are accepted by the water users. A variety of clever methods to get around or circumscribe potential physical and social problem causing situations were described. Another consideration is the wide range of irrigation situations that exist throughout the world. It may be natural to think of high man/land ratios in connection with irrigation, even in lots of African situations, but in Brazil, the nation is trying to give irrigation resources away!

Generally speaking, two main reasons have been put forward for charging users for publicly supplied irrigation water: one is to recover part or all the costs of construction/betterment and operation and maintenance in order to have the sub-sector be as self-supporting as possible, and the other is to obtain better farmer utilization of the water delivered. But it is possible that these objectives conflict in greater or lessor degree. Some potentials are explored in the background papers.

2. Objectives

The Consultation was organized to provide an opportunity for knowledgeable persons from various parts of the world to discuss existing information and offer new ideas on these principal issues:

i. To review existing experience relative to imposing, collecting and utilizing water charges for cost recovery in the rational use of irrigation water.

ii. To consider alternative approaches based on past experience, including policies and practical methods of addressing problems identified.

iii. To recommend solutions and lines of action for donors, international financing agencies and governments in general, as well as FAO and AID in particular to deal with this ever important topic.

3. Arrangements

The Consultation was jointly organized by FAO and USAID and was held at FAO headquarters in Rome from 22 to 26 September 1986, at the invitation of FAO Officers. All plenary sessions and working group deliberations were conducted in English.

The plenary sessions and discussion group meetings were chaired and reported on by various participants so that most people present shared some official responsibility for the objectives reached during the meeting.

Mr. Juan A. Sagardoy, Land and Water Development Division, FAO and Mr. Allen LeBaron, Utah State University, USAID's Water Management Synthesis II Project, acted as Secretaries to the Consultation.

4. Attendance

The Consultation included 34 participants and 3 observers, including 7 senior government administrators from as many nations and 30 participants/observers representing intergovernment agencies, international financing agencies, research centers, and universities.

A complete list of participants and observers with addresses is given in Annex 1.

5. Programme

The programme of the Consultation consisted of a welcoming session, a technical session lasting two and a half days, sessions for special study groups, and two plenary meetings to present and discuss the progress of the special study groups.

The Agenda is shown as Annex 2.

The Consultation was formally opened by Mr. G. M. Higgins, Director of the Land and Water Development Division, FAO. Special welcome addresses were presented by Ms. Joan Atherton, on behalf of the United States Agency for

International Development, and Mr. P. Dieleman on behalf of the United Nations Food and Agricultural Organization. The Consultation was closed by Mr. Jack Keller, Co-director, USAID sponsored Water Management Synthesis II Project (Utah State University, Cornell University, Colorado State University).

In his welcoming address, Mr. H .M. Higgins expressed FAO's appreciation to the US Agency for International Development for its valuable cooperation in co-sponsoring the Consultation, and to the international agencies and institutions for sending their most qualified experts, which indicated the degree of international concern with such an important issue.

The programme of the technical sessions was divided into presentations of background and individual country papers. The country papers generally followed the requested format (see Annex 4), and focused on irrigation programmes in each country, detailing methods, amounts, and rates of irrigation service fee recovery. General policies for financing irrigation costs, and policies for establishing the farmers' responsibilities were also included.

The background papers covered a range of topics, but considerable emphasis was placed throughout on the question of the potential for farmers sharing the cost burden of operating, maintaining and financing the systems which provide them with a valuable and necessary production input.

Annex 3 provides some information on the 5 small working groups which were organized to discuss specific topics and make recommendations to the consultancy as a whole. Details of each group's deliberations may be found in the "Report" volume already mentioned in the Preface.

6. Acknowledgements

FAO and USAID express sincere appreciation to all of their respective overseas mission personnel and representatives who graciously took the time to help the authors of country papers make arrangements to join the Consultation in Rome. The World Bank was especially supportive in sending two participants. Further appreciation is extended to all the authors for preparing and delivering such interesting and high quality papers, and to all participants and observers for their personal and collective contributions to the deliberations that took place within the working groups and plenary sessions. Without a keen desire on the part of every one to go forward with the debate on the topic of the Consultation, very little could have been accomplished.

5 ·

B. BACKGROUND PAPERS

APPROACHES TO FINANCING IRRIGATION

Ian Carruthers
Wye College, University of London

1. INTRODUCTION

An old adage claims there is no such thing as a free lunch. Despite much apparent evidence to the contrary, there is no such thing as free irrigation. Irrigation always consumes resources - land, labour and usually capital, which have valuable alternative uses.[1] In this paper we consider various methods of supplying any necessary finance for effective operation of irrigation. The alternative to proper finance is deterioration, repeated failure and finally abandonment. Abandonment can be prevented by periodic rehabilitation. In these circumstances rehabilitation can be regarded as an idiosyncratic system of finance, not to be recommended except in exceptional circumstances.[2].

Broadly speaking financial allocations for irrigation can come from one or more of several sources: internal borrowing from the public; Central Bank credit creation; foreign loans and grants; general tax revenues; and user fees. The scope for regular dependence on the first three sources is limited and other areas of the economy may have a prior call. For these and other reasons those responsible for irrigation finance might look at the latter two sources of tax revenues and user fees.

In a few countries a tradition of free irrigation water for farmers is maintained. Yet there is a widespread and growing economic ethos in capitalist, socialist and mixed economies alike, that prices should be used to signal broad national economic priorities. 'Get the Prices Right' (GTPR) is the current slogan and whilst it is at best a little vague for most policy implementers and it clearly begs the key questions, it usually implies a particular mix of efficiency and equity goals. But Governments have other relevant responsibilities notably those relating to achieving full employment, price stability and growth. It may be important when studying irrigation finance to devise and use pertinent criteria in relation to these latter goals as well as efficiency and equity. For example, in many countries without appropriate irrigation finance sub-optimal growth is inevitable.

Irrigation is increasingly important and increasingly productive but paradoxically most societies are failing to devise mechanisms to adequately finance the service.

2. IRRIGATED AGRICULTURE AND THE MACRO-ECONOMY

Use of general tax revenues, rather than user fees, to finance irrigation is admissable and indeed desirable when the agriculture sector is squeezed by one means or another squeezed to finance the Treasury. In many countries the large agriculture sector has suffered discriminatory trade, exchange rate, fiscal and monetary policies plus inefficient and expensive parastatal marketing boards. All this has created adverse domestic terms of trade for agriculture compared to industry. If farmers are receiving only a portion of the export parity prices the case for user charges for irrigation is clearly weakened. This is the situation in many countries. The World Bank estimate protection of agriculture in the 1970s and 1980s to be 0.76 in Philippines (1974), 0.88 in Mexico (1986), 0.75 in Egypt (1981), and 0.35 in Nigeria (1980) (World Bank 1986 p.62). World Bank studies have also shown, in countries as widespread as Malaysia, Sri Lanka, Guyana and Mexico, that indirect, implicit taxes by fixed product prices below import parity prices were a much higher burden than recurrent costs of irrigation. Sometimes, the indirect charges are several times higher burden than water charges. In these countries there is little point in the irrigation agency campaigning for user fees in line with costs. On the contrary, they might campaign for free water and stress the need to transfer some of the indirect charges to sustain the wealth creating irrigation system

The general point here is that fiscal policies relating to irrigation have to be seen as part of the macro-economic management problem. If irrigated agriculture is already subject to implicit taxation the scope for user fees is clearly restricted. This can be readily accepted. In Burma irrigation water is 'paid for' by indirect recovery through compulsory purchase of a portion of the crop at prices below export parity price. David Potten (private communication) points out that this can be inflexible. In recent times the agree rice procurement price has been higher than export parity so a rice 'tax' has become a subsidy. Success of the rice element of the Green Revolution, leading to self-sufficieny at 'normal' prices, is a real threat to any parallel revolution in raising revenue. In Burma, Thailand, Indonesia and Sri Lanka (amongst others) Governments are more concerned about a rice price collapse or financing surplus purchase and export, than about raising revenue. Increasing user fees at a a time of falling prices of a dominant crop is not good politics.

However,if depressed prices precludes fees being collected the converse is also true. If, in response to a new macro-economic climate favourable to agriculture we find macro policies neutral or assisting that sector, irrigation agriculture can be reassessed as a tax base for general revenue or at least it can be expected to bear its real costs. GTPR is not just a slogan for pricing agricultural products, it is equally relevant for production inputs including irrigation water.

3. IRRIGATION WATER AS A TAX BASE

One of the potential impacts of GTPR is to reduce Government revenue sources. If agriculture is not to be squeezed excessively then new revenue sources, at least in the short run, have to be found.[3] Irrigated land can be used as a tax base. To some it will seem unprincipled to regard water as a source of taxation. For example, Boulding (1980) speculates whether the sacredness of water as a symbol of ritual purity exempts it in some degree from the dirty rationality of the market. Tax authorities are not normally so squeamish as to exempt vital or essential commodities. In the Middle Ages in Europe the essential commodity salt was subject to a tax! The loss of revenue as governments move to (GTPR), by for example removing export duties, will force them to reconsider all possible sources of tax revenue.

In principle water charges can be levied with an eye on total costs, marginal cost or benefits. In practice cost approaches are only options if benefits are sufficient to provide the minimum incentive for farmers. All user charges thus boil down to variations on the benefit system. If benefits are substantial then a tax approach can be considered to raise revenue from irrigated land.

4. THE SIMPLE GRAPHICS OF REVENUE GENERATION

In some respects irrigation water would make a good tax base. In arid areas there is an inelastic demand for water at the price presently charged. Raising the price of water would not affect the quantity demanded. In fact at the low prices normally charged the capacity is exceeded before demand is satisfied.

This is shown graphically in Figure 1. The demand curve DD is relatively steep over most of its range.[4] At price P1, demand would be q2 which is greater than the available supply Oq1. This is what leads those favourably placed on systems (i.e.nearest the source) to steal additional water or to offer canal operators 'prices' higher than the official charge. Direct water charges are generally set at levels much below supply costs and far below the benefits-in-use to the farmer.

If water was a tax base it might be worthwhile from a revenue viewpoint to charge even higher prices to maximise revenue. For example, price P2 would raise substantial revenue but with less than full capacity use (hence there would be an economic loss). Price P3 would be the highest price that could be charged to use all capacity.

The effect of improving agricultural technology would be to shift the demand for water to the right (to Di Di) increasing the level of prices that could be charged and incidentally increasing the returns to supplementary supplies. It is the shifting of demand curves for irrigation water with new agricultural technology that have made tubewell irrigation profitable and which create the opportunity to recoup the costs of new water supply enhancing investments such as rehabilitation of schemes. The shift of demand for assured water supply is also likely to keep political pressure on Governments for new schemes which are likely to be in less favoured sites and thus with more expensive capital and recurrent costs. Typically water charges are much below O & M of existing schemes but, more seriously very much below the long run marginal costs of new capacity. Indeed long run marginal costs are often greater than gross value of production.[5]

Simple graphs such as this can also be used to demonstrate the problem of inflation and the effect of failure to adjust user fees in time with financial needs. Sometimes (normally) Governments fail to adjust because of inertia or a misplaced sense of fighting inflation. In Figure 2, P1 is the price to farmers in year 1, P2 is the same price in real terms in year 2 after serious inflation. This problem is exacerbated if collection or transaction costs are considered. If C1 is the collection costs the margin between collection costs and revenue will diminish each year. If, as often happens, governments 'protect' civil service pay, then differential inflation occurs and collection costs will rise in real terms to C2 further squeezing the net revenue from irrigation. No studies are known on the real costs of collecting irrigation water rates but this is clearly an important topic. It is the first rule of revenue collection that revenue must exceed collection costs - in terms of our diagram C must be below P.

In a mixed economy taxes are judged first by two criteria: is the tax fair (equity); and does the tax interfere unduly with the market and economy (efficiency). Irrigation taxes might be considered equitable if all who had irrigation paid the tax (the benefit principle) but it would only be 'horizontally equitable' if all families with irrigation had similar circumstances and bore similar taxes (no special scheme taxes, tubewell irrigators paying the same for irrigation as gravity scheme irrigators) and only 'vertically equitable' if ability-to-pay was considered. The ability-to-pay criterion generally assumes that those who earn greater income such as by taking more or better (i.e. more reliable) irrigation should assume greater burden. This burden could be progressive - with average tax rates increasing with increasing benefit, proportional - with average rates constant with increasing benefit, or regressive - with average revenue rates falling. Most irrigation pricing schemes are proportional but an imaginative radical government, tired of land reform, might consider progressive water charges as an alternative and sound measure for achieving equitable taxation.

5. OPTIONS IN COST RECOVERY

If Governments are to restrict their concern to irrigation cost recovery several options face them:

- Direct water charges
- Betterment levies
- Land tax
- Agricultural product taxes
- Price controls

Water charges appear the most obvious mechanism but they are seldom successful because volumetric measures of water used cannot yet be economically made (a technology gap?), particularly on large schemes, in open channel flow with high silt loads and large seasonal variations.

Betterment levies require recouping a portion of the increase in capital value of the land, that occurs once irrigation is supplied. This is a tax, readily understood by farmers but the most strongly resisted even when due to be paid over a number of years. One reason for this is that it often comes soon after the irrigation of a scheme, before yields reach potential and when on-farm capital requirements are at their highest. However, the betterment levy deserves careful re-examination after rehabilitation projects. It is likely that modernisation and rehabilitation of old-established schemes will provide an increasing proportion of capital investment in the next few years.

Land taxes are indirect measures of cost recovery. The limits to their value include the fact that they are usually set very low, seldom adjusted regularly in line with inflation, and often not allocated to irrigation (e.g. Indonesia).

Taxes on agricultural production work well when the crop is processed. For example on the modern irrigation schemes in Morocco a tax on sugar beet is sufficient to pay most of the O & M irrigation costs for the whole scheme. If these taxes are on a percentage of value basis the inflation effect is taken into account.

Price controls on crops, export taxes, maintaining an overvalued exchange rate to undervalue agricultural exports, are all devices to accumulate or apportion to the public exchequer a part of the value added from irrigated agriculture. In this GTPR era it is an unfashionable method and it effects rainfed and irrigated products alike. However, although it is a crude instrument it has been the most successful way in which part of the income accruing to farmers is recouped by Government. There might be less criticism of it if it were applied more wisely and the productive assets such as irrigation infrastructure that generated the wealth had received a due share to maintain them.

Direct irrigation prices are a preferred mechanism for charging for water so that the users get a clear signal of the resource cost of their economic activity. The literature on pricing provides the premises, theory and guidelines for application of this mechanism.

6. THE LITERATURE ON PRICING

The economics literature on pricing policy stresses efficiency rather than equity. A recent text is Gerald Meier _Pricing Policy for Development Management_ (1983) Johns Hopkins University Press, which consists of a carefully edited set of classic readings with a very strong editorial theme. Paul Samuelson, Joseph Schumpeter, Peter Bauer, Robert Dorfmann, Tibor Skitovsky, Ian Little, James Mirrlees, Basil Yamey, Harry Johnson, Kenneth Arrow and other neo-classical economists feature prominently but socialist writers such as Janos Kornea's and Oscar Lange appear. This is the recommended basic textbook for anyone concerned with irrigation finance or any public sector pricing problem.

Several literature reviews specifically addressing irrigation pricing issues have recently been completed. These include Carruthers _et al_ Annexe VI (1985) from Devres Inc. for USAID; Easter and Ellingson (1982); and Small _et al_ (1986) from the International Irrigation Management Institute for ADB. (See also Westgate (1984), Cruz _et al_ (1984)).

A recent broader review of the theory and practice of water prices in urban and rural use has been produced by Diana Gibbons (Gibbons 1986). This relates theory and practice in the United States of America and is a monograph showing more that could well be repeated for developing countries where water is in multiple use with high opportunity costs.

Most of the economics literature assume the necessary benefits accrue and has looked at the costs of irrigation and has applied guidelines derived from theories of public utility pricing.[6] Unfortunately irrigation systems do not fit well into the apparently simple and straightforward marginal cost pricing solutions often advocated in applied economics textbooks (e.g. Killick 1981). The marginal cost pricing rule aims to raise economic efficiency by pricing irrigation water at the marginal cost of delivering it. Meier (1983) explains how pricing any input such as water at marginal cost maximises the economic benefits. However, he admits problems of measuring marginal cost (very problematical in the case of irrigation), problems in measuring differences between short run and long run marginal cost (very large in the case of irrigation), and difficulties of coping with cost variations of a geographic or locational nature (should there be different rates for different schemes, should farmers at the head pay more than those at the tail of irrigation schemes?). Furthermore the difference between the financial costs generally considered and the economic or social costs actually incurred can be large, difficult to estimate and impossible to apply. To be thoretically valid it should be applied in all sectors of the economy simultaneously.

In such circumstances the urge to ignore or at least to downplay marginal cost pricing rules is tempting. We would accept the validity of the theory and the problems of application and would also accept that any move toward marginal cost pricing is likely to increase economic efficiency. We also accept that there are some ingenious adaptions to the theory to cope with application problems (Saunders et al 1977).[7] Nevertheless we shall downplay the role of marginal cost pricing theory in this paper, not on the grounds of these operational problems but because narrow financial or cost recovery matters are more pressing and more direct approaches are preferable. We accept that pragmatic application of social (economic) long run marginal costs would in most circumstances improve economic efficiency. However, in todays economic climate cost recovery finance must be considered to trump economic efficiency. The global recession of the early 1980s was longer and deeper than most ancitipated, the voluntary and involuntary obligations of Government are growing faster than revenue, debt burden has increased and 'structural adjustment lending' has produced much less adjustment than the advocates intended. In short many developing Governments face a revenue crisis.

7. PRIMACY OF COST RECOVERY

Social marginal cost pricing will normally result in large financial deficits in the case of irrigation. Irrigation has high fixed costs and economies of scale. Average total costs are normally decreasing over the design range and therefore the marginal cost curve is below average cost curve. In these circumstances marginal cost pricing will always result in a financial deficit (see Killick 1981).

Under these conditions the normal response is to accept the deficit and to accept the case for an irrigation service subsidy. Introduction of an irrigation subsidy to promote use, to stimulate development of an area or a group, to promote income redistribution and such benefits are legitimate goals. But with public sector revenue falling below needs the opportunity cost of all subsidies will rise. Recent studies of subsidies have shown that they may not reach the target group or they may not be the least-cost way of pursuing the declared goal.[8] More generally Meier (1983) argues that advocates of a subsidy will find it necessary to meet the criticisms "that the subsidy will lead to unanticipated distortions elsewhere in the economy, may require counter-subsidies to offset distortions created,[9] may become burdensome administratively, may inhibit incentives to efficiency, may give unwarranted market protection, and may be difficult to terminate" (p.222).

Elimination or moderation of food subsidies can spark riots or have other harmful political impact. Irrigation pricing is potentially as explosive an issue, albeit a rural rather than an urban problem. This accounts in part for the often found reluctance of Governments to increase user charges or even to enforce agreed legal fees. In those economies dependent upon subsidised irrigation we can expect, in present harsh economic circumstances, increasing financial shortfalls in irrigation departments. This in turn will result in a slow deterioration in O & M standards (Carruthers 1983 Ch.7). If adequate and/or unreliable supply is combined with a tax or other financial squeeze on irrigated agricultural products to finance or satisfy urban priorities there is a double loss. Squeezing agriculture at this time when irrigation is becoming increasingly productive (i.e. when the response curve to water input is shifting upwards because of developments in complementary agricultural technology) will increase the opportunity costs of failing to find finance. In principle if irrigated agriculture is burdened by maintaining an overvalued exchange rate, by export duties or by other macro-economic measures (see World Bank, World Development Report 1986 Ch.4) the Treasury can justify 'subsidising' irrigation.

Treasury economists are usually reluctant to admit 'earmarked' revenue. We can look for evidence or comparison in the form of good financial support for O & M when agriculture is squeezed. There is no discernable inverse correlation between adverse terms of trade for agriculture and high standards of operation and maintenance. For example Nigeria, Egypt and Philippines all give substantial manufacturing sector protection compared to agriculture, and thus squeeze resources from the agricultural sector, but their irrigation is not known for its excellent operation and maintenance standards.

Earmarked or retained revenue is found in some countries. Even if scheme revenue is retained this is a necessary but not a sufficient for sound irrigation operation finance. Scheme finance has been found in China for at least 25 years (Nickum 82 p.33) and introduced into Sri Lanka very recently. In China an irrigation district or a pumping station should be fully self-sustaining but in Sri Lanka a contribution toward operating costs is presently sought. It is intended in Sri Lanka that O & M should, in time, be fully financed by farmers but during field visits by the writer in August 1986 it appeared that the Government was, naturally enough, pre-occupied with national security and other higher-level political goals and seemed unlikely to provide technicians with the strong political backing necessary to implement unpleasant policies. The general lesson for those concerned with irrigation finance is that water charges are always unpopular measures and the political will to sustain these unpopular policies is seldom to be found. This theme is taken up again later.

8. SOME PRACTICAL ACHIEVEMENTS

The case studies in this Conference show that achievements in raising user-fees are exceptional. Even in the rare instances where costs are proportional to water delivered, such as with pumps or tubewells, distortions occur. For example in Egypt energy prices are a fraction of world prices and in India electricity prices are often subsidised.

The 1985 Devres study (Carruthers _et al_ 1985) concluded that in all five countries visited a growing financial liability was being created. Irrigation in all countries was underfunded. However, although finance was scarce and charges are levied, little serious effort has been made to actually collect revenue. In Peru it was claimed that all this will change to offset revenue losses from lower central government allocations. (Such expectations are oft repeated in planning documents - they are clearly a triumph of hope over experience).

In Dominican Republic collecting water rates is taken more seriously and they are set to recoup half the O & M costs and the team expected them to come close to this. However, over the next five years they plan to reach collections equivalent to full O & M costs. Once again optimistic expectations of unprecedented events.

In Morocco collection on a large modern scheme runs at 80 per cent of levied rates. This high percentage is obtained by deducting the charge _before_ paying for a sugar beet crop that has to occupy a proportion of the farm. Clearly collection problems are minimised if a cash crop goes through a central processing unit.

In the Philippines we found another irrigation agency full of good intentions but this time the extremely severe macroeconomic problems have put some urgency into resolving at least the O & M financing problems. The National Irrigation Agency's approach is to realise Treasury support is not to be forthcoming and to implement a hastily prepared devolution scheme with promising if optimistic plans for water user groups taking over many management functions. The easy-to-organise groups have already been formed (25% on the Scheme we visited) and a good deal of determination and political support will be required if a large slice of management responsibility is to be handed over to farmers. The farmers' financial liability is expressed in terms of a weight of paddy (or its cash equivalent) which is a crude method of indexing the charge and a way of ensuring 'payment' if cash is not available.

In Indonesia there have been major investments in recent years to rehabilitate and modernise old systems. Considerable management responsibility is assumed by farmers and they do pay a land tax that can find its way into the O & M budget. But very little of the land tax appears to go to irrigation at present. We were left with the impression that central government funding is likely to be the major source of finance for some years. Without it the rehabilitation works of the last 20 years will soon deteriorate.

My conclusion after studying marginal cost and efficiency approaches is that if this rationale is pursued there will be serious underfinancing of irrigation and a dangerous complacency will grow that the low or even zero charges are in line with economic efficiency. A mental attitude will develop that assumes Treasury subsidies are justified and will be provided just at the time when the Treasury officials are switching back from economic to financial logic and appear hell-bent on reducing subsidies often with outside leverage to encourage them. For their own good it is time for irrigation officials to join up with the accountants and go for user fees. The battle with Treasury officials should be on the issue of retaining all revenue collected from farmers, not on the grounds of more subsidies to sustain economic (marginal cost) pricing. Once agreement on instruments, fee levels and their retention is achieved, the Treasury and Irrigation officials should jointly seek the strongest political support for what is inevitably just the beginning of a battle to turn policy into achievement.

9. PROBLEMS OF SUCCESS

A special financial problem, mentioned previously, is emerging in the rice economies of Asia. Successful modern rice production is following hard on the heels of the success with irrigated wheat production. Several economies are faced with self-sufficiency and even surpluses in rice at present prices. Strange as this may seem, this is not an immitigated benefit. The rice cannot be exported on a large scale at present domestic prices. It cannot be put on the local market or prices will collapse to the benefit of purchasing consumers but to the great loss of many farmers. Purchase for storage and subsidised export presents financial problems that only an oil exporting country such as Indonesia could contemplate and even then if oil prices recovered to former high levels. Subsidised exports will depress international prices and give traditional exporters additional financial problems. Switching irrigation systems designed for rice to other crops is possible, but potentially expensive and, given the massive area in rice, fraught with new marketing problems.

The emerging market conditions in reice economies do not create auspicious times for pushing a cost recovery programme based on user-charges.

Some observers argue that the benefits from the additional rice go largely to consumers and thus they should share the costs of producing the rice. Attributing the incidence of benefits from a technological improvement is an economic nightmare, but the notion has obvious political appeal.

10. A NEED FOR POLITICAL ECONOMY

In these circumstances we see the key problems of irrigation policy analysts are to devise policy instruments to obtain relatively small amounts of finance from large numbers of widely scattered, often very poor farmers and then, this being achieved, establishing how to provide an effective and efficient irrigation service. If irrigation user fees were to be the sole method of obtaining such finance, many countries would have to increase water rates severalfold just to reach operation and maintenance levels. To do so presents firstly political, secondly administrative problems.

We have seen that there is some elegant economic theory that appears to support rational practical financial policies. However, in the real world very few Governments act on these guidelines. If we follow the precepts of positive economics we note the sections which dictate that when facts and theories contradict each other we must reject the theories and search for a richer hypothesis. We can postulate two potential weaknesses in the economic abstractions - first simplistic views of people and their behaviour and second a lack of politics. These are really two aspects of social organisation.

Michael Cernea and collaborators have recently highlighted the failure to balance our technical physical and economic understanding of irrigation by social insights (Cernea 1985). They blame technical difficulties upon inattention to the social organisation of irrigators. Coward, Freeman and Lowdermilk, Bagadion and Korten in their contributions to the Cernea book stress the importance of sociological frameworks to assist preparation of projects, the introduction of new technologies and the management of water. None of the writers discusses at any length the link between sociological insight and irrigation finance. However, it is implicit in their discussion that anything so complex as trying to get relatively poor people, collectively, to pay for a basic service requires a high level of social insight and political determination if it is to be successfully achieved.

Politics can be defined as the art of Government and this art must therefore feature in deliberations over assessing and collecting revenue or user fees. Technical agencies such as irrigation departments are sometimes uneasy with acknowledging and accepting the political dimensions of their activities. Economists are also sometimes ambivalent about the nature of their work. For example, Young (1986) in an excellent review of the economies of allocating and pricing natural resources cites Kenneth Boulding's three mechanisms for ordering natural resource use: 'prices', 'policemen'; and 'preachments'. He explains prices represent the market system but 'policemen' the legitimate enforceable political order and 'preachments' the moral order. Politics determines the enforcement methods, hopefully conditioned by the moral order or human values system of the community.[10] Young goes on to elaborate the pro's and con's of market oriented approaches but does not take up the enforcement and moral issues despite concluding 'water has been viewed as too important to be left to the market-place, so that its administration falls largely in the political realm'.

Stanley Please (1985) is the most coherent critic of a failure of political commitment to policy. He persuasively asserts that the policy cycle should replace the project cycle because the "project cycle has proved to be too weak a conceptual and operational framework for handling policy issues". His policy cycle comprises:

"1. The formulation of development objectives.

2. The diagnosis of the policy constraints to the achievement of the objectives.

3. The formulation of alternative packages of policy changes which could relieve these constraints.

4. Agreement within government of a politically acceptable package of policy reform including its broad time phasing.

5. The formulation of the detailed measure which reflect the politically acceptable program of policy change, i.e., program development.

6. Implementation and monitoring of policy reform measures including feedback to the formulation of subsequent stages of policy reform.

7. Evaluation of impact of policy changes on achievement of objectives and lessons for the future."

He describes obtaining political commitment as the weakest link in the policy cycle. "It is all too easy and all too common for situations to arise in which politicians pronounce ill-formulated rhetorical objectives while technocrats (particularly economists) work on detailed programs to implement such political pledges, but the two groups fail to get together sufficiently often to ensure that what is technically required is politically acceptable. It is no use pursuing the detailed legislative, financial, institutional, etc., aspects of policy reform until the broader implications of reform have been accepted by the political leadership."

Put simply economists and financial analysts are talking to each other and not to the people with power.

A political analysis of irrigation would soon focus on the question of corruption. The beneficiaries of low offical water rates are often the irrigation department personnel who can tap the 'economic rents' being reaped by farmers. Sometimes a complicated 'parallel' tax system involving engineers, revenue personnel and politicians exist with interests that are favoured by the present unsatisfactory system (see Wade, 1982 and Jagannathan, 1986). These issues are seldom faced frankly by national governments and the donor community. Irrigation is becoming too important to agricultural development for this issue of illicit payment to remain hidden and neglected.

Economists and financial analysts are also talking at too ethereal or at too macro a level. Few really able technocrats appear to be prepared to create the detailed administrative arrangements necessary to translate abstract principles into operational policies. Some years ago, whilst acting as a planning officer in an East African country, I found what I considered to be a brilliant marginal cost pricing scheme for rural water supplies (see Carruthers, 1972) rendered ineffective because I failed to recognise revenue could not be collected by local Chiefs without account numbers, appropriate forms and revenue books, safes to store money, Askari's to guard safes and so forth. Here was a prime example of a failure to take account of transaction costs and detailed administrative arrangements.

Please (1985) makes the additional point that bureaucratic barriers exist because aspects of policy are split between different ministries each, with its own separate interest. Fragmentation of responsibility results in no overall view and no authority for implementation. In the East African case cited previously the responsibility for implementation was split between the Ministries for Water Development, Agriculture, Treasury, Planning, Health, Local Government amongst others. Policy was supposedly coordinated by an Inter-Ministerial Committee but within a year the senior bureaucrats assigned to it had been replaced by relatively powerless junior substitutes. Revenue was never near budget estimates, but no effective action was taken.

Some few years later poor finance resulted in a need for project rehabilitation. Although there should be no direct link between poor revenue performance and inadequate O & M provision it is often found to occur.[11] Many aid donors find policy dialogue hard to define, defend and execute. In particular inter-ministerial policy dialogue is very difficult to carry out.

Aid donors prefer to deal with technocratic planning groups, usually from a single ministry, who are often divorced from political power or real political interest. Please puts it this way

> "At best planning ministries are led and staffed by highly espected economists and technocrats who formulate programs f policy reform in an impressive manner. But policy reform equires political acceptability based on the opportunity to se political muscle. It does not depend simply on logical rgumentation. At worst planning ministeries are virtually n irrelevant part of the government machine which become ore and more marginalised as their irrelevance to policy aking becomes apparent to both the staff and others. At imes it is almost as though they existed to keep external onors happy and busy and to provide a pretence that overnment is taking development and policy reform eriously."

What is clearly necessary to improve policy implementation is a political commitment to an agreed programme and not just a technocratic argument. Perhaps this means shifting the venue for meetings such as this from FAO to UN New York and from water personnel such as ourslves to Finance Ministers. We have perhaps the right agenda but the wrong participants and all too often we are addressing the wrong audience. In any event I believe we should shift concern with water charges and related covenants in aid agreements from project level to sector policy dialogue.

A final comment on the political line. In some countries the public sector financial crisis has resulted in stringent cuts in public expenditure in key areas such as education and health as well as agriculture. These cuts are often agreed and in effect supervised by the aid community through structural adjustment lending. If public services are to be improved and expanded recurrent funding cannot come from further cuts or savings, nor where people are poor or receiving bad services can it come from increased user fees. In these circumstances it seems inescapable for aid donors who wish to promote a particular sector, to provide medium or even long-term recurrent budget support.[12]

11. ASSESSING SYSTEMS

A hierarchy of criteria including financial issues for determining successful irrigation can be derived from a review of the available literature and less accessible agency evaluations. Suggestions are set out in Table 1. First and foremost irrigated agriculture has to be <u>profitable</u> to farmers. Increasingly it seems likely that Government induced economic distortions will be reduced but they are unlikely ever to be eliminated.[13] In many situations irrigation is becoming more profitable because of innovation in irrigation itself and the complementary advances in agricultural technology. This will continue with scientific progress. Not all irrigation projects are likely to be profitable. In many arid zones a backlog of investment including rehabilitation needs, land levelling and a lack of drainage is likely to preclude profitable irrigation. In such circumstances major change to increase farmer pay-back is likely to fail. This does not necessarily mean that the project should be phased out. Irrigation might still be the least costly development investment. Unprofitable schemes may be accepted for complex but legitimate social and political reasons. In any event, the least-cost system of ensuring effective if not efficient irrigation of good and bad schemes is likely to require profits for the farmers. Furthermore, waste will be minimised if farmers have high value-in-use for irrigation water. It is high value water not high cost water that prevents waste.[14] Farmer profitablity is thus the first criterion for success.

Table 1.

A HIERARCHY OF CRITERIA FOR
EFFICIENT AND EFFECTIVE IRRIGATION

1. Irrigated Agriculture is profitable to farmers

2. Irrigation systems are manageable

3. Finance for good O & M is available

4. Irrigation is adequate and reliable

5. If equity is a criterion charge farmers for irrigation.

Secondly irrigation systems have to be manageable. Some systems have poor original design (e.g. no flood escape provision on main canals) and some have such deteriorated facilities that they are to all practical purposes unmanageable in some or all conditions. Some systems have important exogenous constraints outside the control of managers such as unreliable electricity supplies.

Sometimes the system is unmanageable for socio-political reasons. For example political powers may preclude certain actions such as an even distribution of water, the implementation of sanctions against offenders of irrigation rules or even the raising of charges in line with inflation. Sometimes ambiguity exists. In Jordan cut-off sactions were applied to non-payers and payments jumped to near 100 per cent but no increase in rates were allowed for several years despite double digit inflation.

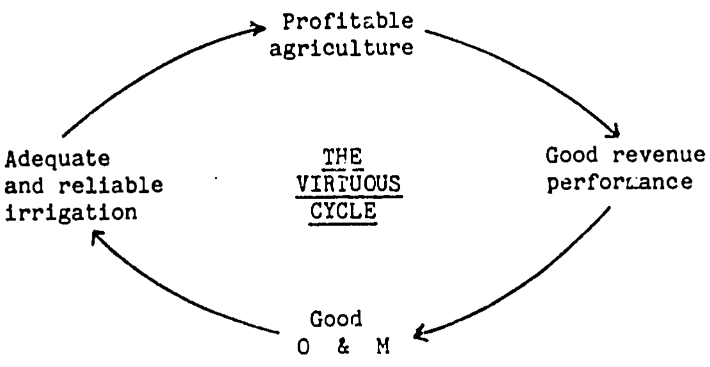
The third criterion is that adequate finance must be made available for the operation and maintenance budget. This can come directly or indirectly from farmers, from taxation or other Government sources and the provision must be indexed and adequate to sustain realistic standards. Whilst financial shortages are commonplace we should note that many engineering standards are inappropriate to the resource endowment of the country concerned. Technical rather than economic efficiency dominates engineering plans with designs that appear to be drawn from, say, Californian rather than local experience. It is important that irrigation departments recognise that given widespread poverty and financial stringency all public institutions have to operate in below technically optimum level. Irrigation advocates have to acknowledge that it is not good public sector policy to create 'islands of excellence' at the cost of the general good. In economic terms the trick is to obtain equi-marginal returns to all investments within the economy.

It is imperative that any agreed financial flows are fully compensated for inflation. The use of non-indexed budget allowances are powerful but harmful ways of achieving savings in public expenditure. In some circumstances appropriate finance does not imply funding on historical levels. Many irrigation departments have low productivity and excessive staffing levels. Financial stringency has exacerbated the staff to other recurrent cost ratios. In some departments overmanning is an obvious problem.

The fourth criterion relates to adequate and reliable irrigation. Farmers in field visits stress this, particularly rehability. Under-investment in a variety of ways (less ploughing, less weeding, less fertiliser etc.) is the norm when reliability fails.

The final criterion is the oft mentioned, seldom implemented one of equity. My conclusion from studies of farm economic surveys and field interviews is that irrigation farmers, though often poor, are seldom the ultra-poor and therefore, on equity grounds some form of user charge and/or some ways of encouraging greater farmer responsibility for management is highly desirable. Engineers have to relinquish substantial managerial responsibility to increasingly better educated groups of farmers, and politicians have to back up the detailed plans for user charges drawn up by administrators fully sensitive to local culture, customs and mores and the opportunity costs of failing to obtain revenue.

Given farmer profits, sound scheme design and management, good operation and maintenance, an adequate and reliable irrigation supply should be assumed. This could create the 'virtuous circle' shown below:



Three comments are in order. First the cycle can be ground to a halt by external influences. For example if weather is bad, fertilisers fail to appear, food aid floods the market or one or more of a myriad of factors disturb farm profits then revenue will fall and disrupt the cycle. Second, the cycle will not flow automatically and administrative aid may be needed to ensure it works. For example, good revenue performance will not result in O & M resources without administrative commitment. Third the cycle may work better backwards. Profitable agriculture may manage to command adequate and reliable irrigation and good O & M which in turn will give good revenue performance. Those who argue for more farmer control will favour this view. Farmer managed irrigation is becoming a slogan (to which I generally subscribe) given emphasis by shortages of Government finance. Advocates have to acknowledge the widespread failure of farmers to construct on-farm works, to level fields, to connect up to drains and so forth. Such experience needs detailed analysis before the slogan becomes policy. Finally it may be worth repeating that before and during rehabilitation would seem the best time to make detailed and agreed plans with farmers to get this cycle rolling.

FOOTNOTES

1. In the case of labour the generally preferred alternative is leisure if remunerative work is not available.

2. Rehabilitation projects may be the preferred form of finance where temporary shortages of finance preclude maintenance. It is then deferred maintenance. Rehabilitation may also be preferred if finance is only available for rehabilitation e.g. from an aid donor with an offer of capital but no recurrent budget support and with rehabilitation classed as capital and regular maintenance as recurrent expenditure. Aid donor rules relating to recurrent budget support can encourage rehabilitation.

3. The problem is exacerbated in Pakistan where Government is removing the explicit and implicit taxes on agriculture operating through export duties and overvalued exchange rate and has also abolished the old land revenue tax in favour of a religious tax to be used for social purposes.

4. New developments in agronomy are creating technology that increases the return to assumed water supplies. The demand curve for water is shifting to the right and becoming more inelastic.

5. This is not just a developing country problem. 'Pork-barrel politics' in the American West have created highly subsidised rent seeking farmer interests - see for example Gardner (1983).

6. Studies of the theory and practice of public utility pricing are numerous. The earliest reference is Jules Dupuit, 'On the measurement of utility of public works', Annales des Ponts et Chaussees ser. 2, vol.8, 1844 (English translation in International Economic Papers 2, London, 1952). Theoretical aspects of marginal cost pricing are discussed widely and a classic survey article is Nancy Ruggles, 'Recent developments in the theory of marginal cost pricing', Review of Economic Studies, 17, pp.107-26, 1949-50. Most studies of application to particular industries have been concerned with electricity; e.g., M. Crew, 'Electricity tariffs' in R. Turvey (ed.), Public Enterprise (Penguin Books, London, 1968). For water supply the best article is by J.J. Warford, 'Water requirements: the investment decision in the water supply industry (with an appendix by W. Peters)', Manchester School, 34 (1966). There are a few examples of the application of the general economic principles to the particular conditions of less developed countries. One relevant study is Nasim Ansari, Economics of Irrigation Rates - a Study in Punjab and Uttar Pradesh (Asia Publishing House, London, 1968). A study relating to domestic water supply in a developing country is I.D. Carruthers, 'A new apporach to domestic water rating', Eastern Africa Economic Review, 4, (2), 73-96 (December 1972).

7. The literature also has some simplistic advocacy of marginal cost pricing. A recent example OECD (1985) suggests " The 'quantity of water' notion covers, in fact, several commodities which can be priced separately:

i) Total volume supplied in the year (measured for instance in cubic meters);
ii) Maximum available flow (measured in litres per second);
iii) Energy potential (measured by the pressure or by the altitude of point of supply);
iv) Geographical location of supply (measured by the distance of transportation);
v) Supply period and time (since water in peak hour, or in the hot season is more costly);
vi) Water quality (which depends upon a great number of parameters, such as salinity, and upon the use of water, such as irrigation or drinking).

A marginal cost, as well as an average cost, can be computed for each of these commodities, and the pricing can be set up in accordance with the results of these computations".

8. For a pesticide example see Repetto, 1985; and for a review of fertiliser subsidies see Dalrymple, 1975. The World Banks World Development Report 1986 is a very strong attack on all ill-considered subsidies and public sector distortions.

9. For example in UP in India groundwater irrigators have been able to lobby successfully for subsidies on the grounds that canal irrigation is subsidised. Their subsidy takes the form of cheap electricity tariffs. The uptake of tubewell irrigation exceeds the capacity of some local aquifers creating social costs (higher pumping) and the excessive power consumption causes economic costs elsewhere in the economy. R. Palmer-Jones - private communication.

10. This moral imperative explains the insistence in many countries that water shall be free. No amount of external pontificating on opportunity costs and the like will change their collective will. For them 'get the prices right' in the case of water means it should be free.

11. In the rural water example a senior Treasury official told me he thought the rural water supply was premature and that poor revenue performance was evidence of this. No support would be coming from him for Treasury subsidies.

12. This is the conclusion of Kydd and Hewitt (1986) in relation to health and education. For an irrigation example see Carruthers (1983. p.104)

13. Please note the relevant distortions are not just those taxes and subsidies on irrigation and irrigated crops. All distortions within the economy make it impossible to be sure that any price is appropriate. I have heard Indian irrigationists saying until urban electricity, telephone, water supply and such services are economically priced (all subsidies removed) irrigation shall not be subject to the logic of efficiency pricing. This is an example of what economists describe as 'the general problem of the second best' (see Killick op.cit, pp.18-20).

14. The somewhat puritanical notion that high prices rather than high value prevents waste is still extant despite very little evidence to support it. M.E. Jensen, National Programme Leader on Water Management and Salinity, USDA wrote recently 'The efficiency with which water and need is linked to its cost to the user or the value placed on water. Water as a primary resource needed for food production should not be provided at little or no cost to agricultural users. Free or low cost water leads to waste". M.E. Jensen (1985).

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EFFECT OF WATER CHARGES ON ECONOMIC AND TECHNICAL EFFICIENCY OF IRRIGATION SYSTEM OPERATION AND CROP PRODUCTION

by

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1. ASSUMPTIONS AND SUMMARY

Taxpayers are assumed to gauge efficient use of irrigation works only in terms of some broad desire for high output per unit of water applied to crops. Any complementary desire to recover public funds invested in water development projects or to cause farmer beneficiaries to bear the recurring costs of operation and routine maintenance is not a focus of this paper.

Farmers are observed to use all the irrigation water they can lay their hands on. This trait naturally leads to the thought that they would be more conservative if they had to pay for access to the resource. As a consequence, a belief has spread that in one form or another, and in various situations, charging farmers for water will increase irrigation water use efficiency.

Our conclusion is that this belief to a large extent is a myth: manipulating water fees will have meaningful impact in reaching society's productivity goal in only carefully defined settings.

It is possible that some persons who have contributed to the literature on irrigation water pricing have an incomplete understanding of important aspects of agronomic and hydraulic efficiency. For example, assume there are no charges.

a) If a farmer is short of water he will use what he receives as best he can. A pricing system is not required in order to make him "efficient". In this situation, where water is the scarce resource, it is obvious that a charge might very well reduce use, but whether the social result would be positive would depend on whether the "saved" water could be used more beneficially somewhere else.

b) If a farmer has an excess supply of water, any amount not used by plants, (i.e., "waste") will reappear in the local water basin hydrograph and might be re-used elsewhere. All the production potential, in a basin sense, might still be obtained per unit of available water. If there is no other beneficial use for runoff, it makes little difference to society (on efficiency grounds) whether fees are levied or not.

c) Whether or not water deliveries to a farmer's headgate can be measured by the unit is immaterial to this argument.

Imposing unit water fees or some hybrid charging system might have a direct impact on preventing water from entering a "perimeter" or "unit command area" if fees are imposed or increased. The physical layout of individual systems within hydrologic basins will determine what the result will mean for society's goal of beneficial use. especially if water is in tight supply.

d) If the farmers inside a project perimeter take less as a group, compared to a free supply, "saved" water will presumably be beneficially used elsewhere; otherwise, society would have no interest, on efficiency grounds, in the portion excluded from the command area by the fees levied. Over the long-run the fees, by themselves, will not have contributed to any net gain in general beneficial use one way or another.

e) If the system in question includes some storage possibilities, the location of a beneficial use alternative, in the short-run, might be holding in a reservoir. But this possibility does not mean that volumetric or other pricing has accomplished anything by way of water use efficiency that could not have been achieved directly through reservoir management. Indeed, in the long-run, all things normal, the managers might have to let the reservoir spill, in which case the analysis reverts to (d) or even (a) or (b).

The most firmly entrenched element of the whole irrigation efficiency/fee myth is that unit charges will be effective in pumping situations.

f) This variant also might be incorrect. All that is certain is that the fee can stop water entering the perimeter, i.e., keep it from coming out of the wellhead. Once it is past this point, the situation is the same as water passing through any metered tap: who knows what happens to it and how beneficially it is used? This means that a society paying for irrigation works (or granting and protecting competing water rights) is not specifically concerned about what crosses a perimeter; it is interested in what water crosses the root zone. Unless society can be assured that the farmers' intentions for field application are transmitted 1:1 to running the pump, then economists' forecasts of charging impacts must be somewhat imprecise.

g) A distinction must be made between the water entering a command area and technical "efficiency" achieved by in-field applications. (This point does not involve anything about conveyance losses.)

If our thinking is directed to water entering a command area, but under conditions where volumetric or hybrid measurements are not part of whatever fee mechanisms are employed, what can be said?

h) Farmers pay some fees, but the water deliveries to the command area are affected only by what the system managers and nature decide.

i) If a shortage of water is the result, then (a) applies.

j) If an excess of water appears, (b) applies.

The task of the main text is to work out all of the above contentions in considerable but not exhaustive detail. No claim is made, however, that paddy irrigation fits into the entire argument.

The last section of the paper, entitled "Microeconomics of Field Irrigation," contains important additional results, pertaining at least to the case of traditional upland crop irrigation settings, while assuming existence of a system of unit water charges.

k) It is profitable for an upland crop farmer under gravity irrigation to not be highly efficient with his water supply, especially if we think of an "excess" supply in terms of moving toward maximizing crop output relative to that supply. Precision irrigation by hand is extremely costly in value of labor time, and farmers cannot do it, especially for low value crops (data for wheat production in India's Maharashtra State are utilized in an example).

l) It is also more profitable for a water-short farmer to not concentrate his water on a small part of his land in order to try to obtain the maximum output from the land/water combination. It is more profitable to seek high output relative to the constrained resource, water. This is the condition that traditionally has come to mean maximizing economic efficiency.

m) The agronomists' definition of "efficiency" applies in the excess water situation and vice versa. Therefore, from a societal standpoint, and the way economists think about scarcity, higher irrigation water benefits accrue to the economy if water is "stretched" inside perimeters. This stretching is accomplished by system managers, no water charges of any kind are necessary to attain the beneficial use results.

n) A farmer has little or no incentive to invest in precision irrigation on low value crops such as wheat. This is true for both the farmer with excess supply and with short supply. The greater the uniformity of water application potentially achievable by investment in improved technique, the greater the likelihood that unit water charges would affect intra-seasonal water use decisions. To repeat, efficiency of non-precision irrigation practices can be improved only marginally by unit water pricing.

In sum, if farmers are short of water they do not need water prices to make them careful with its use in the field. If there is a surplus of water, who cares about "efficiency"? Another argument is that sales by the unit might somehow reduce head-end/tail-end tensions by making more water available to lands farthest removed from turnouts. The obvious way to handle these distribution problems is to manage the systems as designed.

The many difficult issues involved in poor project management are not the primary focus of this paper, although they are not wholly ignored. The assumption is that if water charges are levied, they are paid. Revenue goals may be separated from efficiency goals. The tax incidence of collecting revenues may be discussed without distinguishing between public or private systems, leaving to one side, as well, details of confusion, maldistribution and legal contraventions.

2. IMPACT OF CHARGES UPON IRRIGATION RESOURCE UTILIZATION

The State may levy any tax or charge it chooses to recover construction costs, O&M costs (or both), or simply to obtain general revenue, or possibly to achieve some desired impact on the level of resource use. The State has the power to utilize any collected revenue as it sees fit. Just because a water charge is collected for O&M does not mean that the revenue will really be dedicated to that purpose. Collections to secure general revenue, say from users on private systems, might be handed over to a nation's hydraulic agency or be treated as an offset to that agency's general and administrative budget. However, collections made relative to retiring a construction loan probably will be applied to reduce debt.

The level of water charges required to carry out selected purposes may be quite removed from any mechanisms available for fee collection. In turn, the range of operable collection mechanisms is governed by the physical characteristics of the systems in question. Generally, not a lot of choice is open.

From an individual farmer's viewpoint, whether a system is private or public has virtually no effect on how he reacts to a tax. Moreover, insofar as cash is involved, the individual farmer does not distinguish between fees for operation and maintenance and fees for investment cost recovery. He merely hopes that the collections will support smooth operation and good maintenance; he may or may not have influence in bringing this result about.

2.1 Fees and cost curves (LeBaron,1984)

It is natural to imagine that imposing water charges may affect rate of use of resources in the short-run. This is because any fee acts as a tax, and the reaction to a tax may be to reduce output (input). When collected or how collected defines whether or not the tax shifts farmers' variable costs or annual fixed costs. The textbook way to affect day-to-day production decisions would be to levy some sort of excise on each unit of a product sold or upon each unit of a variable factor utilized in production. A fee to acquire a permit to do business, purchase a franchise, etc., is an overhead that may increase the short-run fixed costs of doing business, but will have no affect upon the rate of production.

In practice, it is unlikely that irrigation charges could get incorporated into short run variable cost curves (there needs to be a volumetric measuring system in place and possibly that the water releases can be controlled). At the same time it is incorrect to imagine that "fixed costs" might not have impacts upon seasonal water utilization--there is always some moment in time when they are also variable. For example, payments made at the start of the cropping season are going to have a different impact on water use than if made after the season has passed.

2.2 Impact of method and timing of water charges collections

It is common for farmers to attempt to purchase or trade water when their crops are dry. They may try to bribe the ditch rider to give them some extra water or they may steal from their neighbors or complain about someone else who is taking water out of turn. These tactics do not constitute a charging mechanism, no matter how beneficial they may be as an intra-seasonal water resource allocator. A typical charging system requires the farmers to pay a flat amount per season depending upon the quantity of land owned or operated. If farmers have learned from experience that they do not get equal treatment from the system managers, they resist paying.

What follows is not meant to describe any exact situation. Every water user is assumed to pay an assigned share of the charges (taxes). How does the form and timing of the levies affect the average farmer and the amount of water entering his project? In the real world the irrigation Authority may act as the tax collector, but that does not mean that the authority does not want to deliver water--or ever reduce use by very much due to the charges.

2.2.1 Start of season

If the levy is made at the start of the irrigation season, and water can be supplied to farmers on a flexible basis, the amount of revenue collected will be a function of the general price elasticity of demand for water by the group before land preparation begins. Water demanded from any source will be cut back by such charges, possibly by agreeing to shortened turns or through some other adjustment. It is not unusual to have to make some sort of declaration about upcoming water needs, before planting gets under way (based on proposed cropping patterns, for example). Thus, it is possible to obtain an allocative adjustment from individual farmers or from the user group through a tax that will be treated as a short-run fixed cost.

Once such an agreement or decision has been made, an individual will be happy to receive as many actual units of water during the growing season as possible since payment has already been made. Indeed, farmers have to live with what they get, but they would be unhappy to not take delivery of the minimum purchased.

These speculations serve a purpose because we are forced to realize that some questions would need to be answered about uses for the "unsold" water if taxes were imposed or increased and the farmers reacted by cutting back average water demand.

2.2.2 Middle of season

If the levy is somehow collected during the course of the growing season, as units of water are delivered, there may be some general reduction in use if farmers run short of cash or there is a lot of rain, or whatever. The Authority might raise prices to cut consumption or lower them if marginal costs warrant the action. We might imagine that these individual "purchase" decisions would cancel each other out (if the farmers who were willing to pay for more water could obtain it), thereby ensuring that the net water flow into the system would be unaffected. But why would such decisions cancel? There might be a tendency for the majority of users to make the same kind of decision at the same time. Again, whether there is an alternative use for any "unsold" water, "outside" the current user group could be an issue.

There might be run-of-the-river situations where for some reason less than possible diversion is occurring. It would be technically possible for farmers to purchase "at will" within the irrigation season if diversions are increased. If some purchasers do not come forward, the water wastes or is used by some other group downstream. This description suggests a scene where average irrigation demand from within the project is low and it is conceivable that <u>lowering</u> a charge would induce farmers to take more water. But, since individuals cannot store much, it is unlikely that they will pay any amount if they do not need it. So this is hardly realistic. It would be more usual for engineers to push through all they can divert.

In short, even the most casual analysis leads to the conclusion that if intra-seasonal charges are expected to affect overall project use rates there needs to be a mechanism to utilize any "water savings" that could possibly be supplied to additional farmers, plus recognition of a requirement that water deliveries be capable of being switched on and off or shifted here and there at will. Probably a minimum requirement to achieve this amount of flexibility would be for a system to at least have provision for storage. In addition, a secondary requirement probably would be existence of some sort of local "water market" that would "clear" the supplies that some farmers were unwilling to buy in a particular part of the season. These requirements are seldom satisfied, although some systems in California, or Spain, France, and Morocco come to mind.

2.2.3 End of season

Suppose the tax is collected at the end of the irrigation season, what then? This timing of collections conforms with experience, but not much really changes. In unusual situations, as noted, an individual farmer might be able to request water when he needs it during the season and, no doubt, some sort of real or estimated volumetric delivery record would be kept so that he could be billed accordingly at harvest time. As hinted above, it is possible that the amount to be collected or the rate of charge would be known in advance of the moment of collection, probably before the cropping season begins. Therefore, farmers might make some water use adjustments in contemplation of what the final charges are likely to be. By the time harvest is in, a farmer will have received whatever was delivered (or that he was able to get his hands on). If no record has been kept and there has been no pre-seasonal dedication (that he was held to), the farmer is controlled strictly by how the system is operated and how well it has been designed. He knows he will pay some fee based upon some average unit of reference.

2.2.4 Other considerations

Fees to recover construction and O&M costs of irrigation facilities can be levied in any number of ways that have no connection with water deliveries, or in amounts that have no connection with the cost of providing water. An easy way to link irrigation water with fees is via the land area served. This is fine if actual water deliveries satisfy general crop needs or are stable and proportional.

If an irrigation system is capable of responding to intra-seasonal variations in individual farmer demands, or certain farmers can obtain more than their allotted share, a means of tracking actual volumes delivered is desirable. Many tubewells and some specialized surface systems satisfy this requirement. Individual farmers or even entire systems might use "excess" water, but at least they would pay for it.

It is possible to imagine ways to collect fees that might affect levels of farmer use in other situations. Declarations about the amounts desired during a season could be followed up through adjustments in ditch rider routines. It is also conceivable (but improbable) that irrigation water levies could cut down the amount of water entering a project. If fees are collected at the end of the irrigation season and have not been influenced by farmers' desires, then what happens during the season depends entirely upon how the systems are operated.

A lot of utility may be obtained from ordinary system measuring devices even if individual farmer deliveries cannot be tracked. A real benefit of measuring canal flows is to help ensure that the seasonal quantity of water available to the system is divided up among the commanded land units according to system design, i.e., according to sizes of the various land parcels to be served. Once even this level of equity is achieved, collecting according to irrigation water units or land area amounts to about the same thing.

2.2.5 Orderly systems

Thus, the actual measurement units on which water charges are based or collected have little if any seasonal effect on farmers served by systems that run more or less as designed. If the fees are raised, all farmers are affected on the same relative basis. Furthermore, there is no need to reduce average water use by fee increases in a system running as designed because if "extra" water is available from the source in a given season, and there is a use for it elsewhere, the excess does not need to be turned into the system. If there is a shortage of water, the managers will push through all they can. Only if there were enough flexibility in the entire delivery system to accommodate intra-seasonal requests for water, would volumetric measurements make a difference to farmers' decisions. Otherwise, they simply do the best they can with whatever is delivered.

2.2.6 Disorderly systems

Apparently the important thing is whether the system being considered operates in an orderly fashion. As is well known, many do not. (There are various manifestations of disorder which, in this paper, are lumped together as "head/end-tail/end" [HE/TE] problem systems.) Probably a large share of literature dealing with irrigation water pricing overlays an image of HE/TE problem systems. Therefore, we have to ask, "What twist does a HE/TE situation put into the conclusions reached so far?"

The basic contention runs about like this: it is probably a good idea to have a system of water charges, and if it is based on a volumetric rather than area measure, then farmers who take or use the most water for land unit will pay above average and might cut back. On the other hand, given existing HE/TE relative utilization levels, collections on an area basis do not get the job done from either an efficiency or equity standpoint. This sounds reasonable at first glance because, within a project perimeter, somehow any excess over crop requirements in one location would be made available for use in another.

There might be a role for the use of volumetric measurement to achieve a defined type of project efficiency, e.g., that it operate more or less as designed and solve what economists would term a distributional problem at the same time. The reasoning says nothing about whether the tail-enders would be willing to pay for the newly available water, and assumes, conversely, that head-enders will not buy something they do not really need. All that is sought is potential for equi-marginal production efficiency based on equi-marginal water distribution within the perimeter. The idea, introduced above, that tax collections might reduce the average amount of water entering the perimeter in the first place, does not seem to be involved.

The way to reach distribution goals in disorderly systems is through regulation and direct action. For the price of relinquishing water charges as an instrument for achieving distributional "efficiency," we retain some freedom for using them to pursue other goals that may be quite separate.

As a matter of fact, if an irrigation authority has the power and the skill to collect fees, it almost certainly has the power to get order into the system and solve HE/TE problems directly through rationalized delivery patterns. Once "order" is gotten into the system, earlier conclusions about collections mechanisms apply. The number one rule for irrigation system management success is to maintain order.

2.3 Apparent volumetric measurement and demand system exception

The main elements of a demand system have already been described: physical ability of the system to respond to intra-seasonal measured requests. Irrigators in a demand system are in a situation analogous to householders in cities who are supplied electricity or water for home consumption by flipping a switch or turning on a tap. Two features are involved: a) usage is monitored in some fashion; and b) demand tends to come in peaks. Thus, capacity (storage or source flow plus delivery) must be adequate to service the peak loads--at all other times the system is underutilized.

Since the system is responsive to farmer demand, a change in price will affect the volume of irrigation water utilized, as long as the deliveries can be measured. Pumped systems can be operated on demand but, as the discussion indicates, true demand gravity systems are rare. They usually would require storage and probably pressurization as well. Storage allows water demand to be even more "peaky" because users prefer to irrigate in daylight.

It is easy to conceive of off peak periods within a demand system's operation, particularly if cropping is continuous, and farmers could irrigate at night. The periods immediately before and after the main irrigation season could be thought of in the same way. Then, in true demand systems, some useful benefits might be had by <u>lowering</u> water prices at certain times.

But it would require a very sophisticated gravity system to make such conceptions realities. At the same time managerial requirements conceivably might be reduced. This is because such systems greatly lower some short-run variable costs, so that within limits users need only pay for installation in some "equitable" manner and then metering usage could be ignored. Prices might not be necessary.

This is not a strong argument in itself; it says nothing about pumped systems, which have relatively high variable costs. Nevertheless, upon closer inspection, demand systems (including pumps) represent only <u>partial</u> exceptions to the idea that irrigation charges have little affect on farmers' intra-seasonal water use decisions. The justifications for this claim are developed in the last section of this paper.

3. EFFICIENCY GOALS

The word "efficiency" as utilized in an irrigated agriculture context has several meanings, few of which are formally equivalent. Although it is true that some differences basically are rooted in the well known distinction between "engineering" and "economic" efficiency, for the purposes of what follows a number of additional distinctions are spelled out in more detail.

For example, it is clear that on-farm water application efficiency is quite separate from whatever hydraulic efficiency is achieved in the conveyance facilities. It is also clear that application efficiency might be a good index of social benefit: the higher the former the higher the latter (if few scarce resources are engaged in water conveyance. But a similar input/output relationship does not hold for conveyance efficiency beyond the idea that the same amount of water obtained from the same source will serve more farmers if the conveyance efficiency is high. In turn, the potential for high conveyance efficiency says nothing about day-to-day utilization of the facilities, once in place, and so on.

3.1 Efficient utilization of conveyance facilities in the short-run

Marginal cost pricing is the touchstone for economists' policy prescriptions involving the level of utilization of public resources. Where a large fixed investment is involved the short-run social costs might be quite low. In this section the argument is made that, although sunk costs are involved in public irrigation facilities, lowering prices to MC will not affect rates of utilization in situations where the rule can be invoked, and that in many other situations, MC pricing cannot be invoked in the first place.

The main lines of economic thought about efficient public resource utilization can be summarized as follows: a) the best situation would be to utilize the resources at the level where the marginal benefits (marginal value or revenue product) equals marginal social cost, thus maximizing the sum of producers' and consumers' surpluses (See Figure 1); b) if the value of the

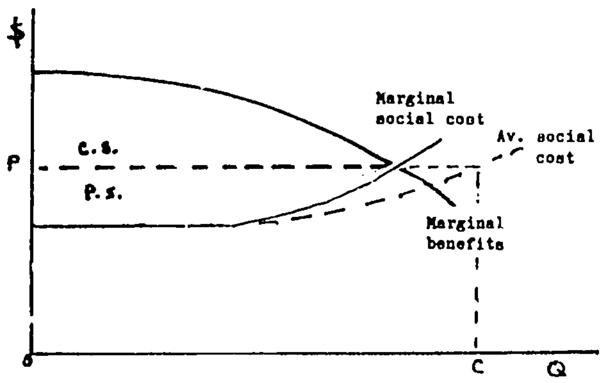


Fig. 1 Efficient use level of public investments (elastic supply w/congestion)

marginal product is unclear, prices might be set at the level of marginal costs associated with whatever level of usage materializes. Thus, prices would be adjusted as costs move up or down. Either of these methods might not generate revenues that would cover all investment costs, so resort might be made to a two-part tariff; and c) pricing on an average cost basis might be less efficient, but cost recovery would be automatic.

Optimum resource usage requires that supply of service inputs(s) is expandable or is adequate to equate marginal social benefits and costs. This is the type of flexibility enjoyed by public tubewells, for example. Ignoring possible physical limitations on aquifer capacity, these systems may be utilized as suggested by the intersection of the functions in Figure 1. This is because the "output" of the well can be adjusted to obtain the marginal cost/benefit equality. If there are too many wells relative to aquifer capacity, restrictions equivalent to tolls may be imposed.

The first consideration is the time period before any resources are committed to an investment. During this period, risk and potential payoffs are evaluated, based upon expected selling prices of the expected production. In the private sector, if all goes well, the investors will meet expenses, recover capital along with interest, and maybe earn additional profits. Businessmen may may be happy to roll their capital over into another round of investment. If they are unlucky, they lose capital or go bankrupt and are driven out of the industry. Of course, if the next investment horizon appears brighter, a new batch of capital can be rounded up and the promoters may try again.

Public sector investments may also fail if hoped-for demand does not materialize or if operating costs cannot be controlled or if prices are deliberately set to confer subsidy on consumers. If costs are not covered, constant decapitalization will take place, and this might be accompanied by a fall-off in ability to offer services.

In the private sector, if planned-for demand does not materialize, the firm does the best it can to cover variable costs and recover any portion of fixed costs possible. The firm does this by accepting any unit prices above average variable cost and produces where price = marginal cost <u>or</u>, if it can control selling price, management cuts back output until the new marginal revenue = marginal cost. In this manner it earns as much return on the fixed investment possible.

Managers of a public entity facing a slackening in demand may not view their options in quite the same way. Although the entity tends to have monopoly (price setting) power, it would prefer to maintain output as though there were competition, i.e. where mc=mr (or ar=mc). This choice is due to the relationship between sunk costs and society's opportunity costs. Once resources are fixed in place, the short-term social costs of utilizing them are low; the more use the better. User fees need only be high enough to recover variable costs of day-to-day operation. In some extreme cases, even the variable costs are very low or nil; then the use of such facilities as railroad tunnels might not cost society anything once they are committed. Setting prices accordingly would encourage use and increase social benefits.

Where individual use decisions control "flow," the low cost or free use of a public facility may create congestion so great as to lead to total blockage (f_{max} in Fig. 1). As individual costs rise due to congestion, marginal social cost rises even faster. The free or low cost use policy has to be abandoned. A special toll, equal to the difference between marginal and average social cost at peak use, may be introduced to limit passage (control waste of resources due to congestion).

The conveyance facilities of surface irrigation systems are somewhat like a footbridge or railroad tunnel: there is a maximum amount that can flow, given the pipe or canal dimensions and the rate. The investment in the facilities, once put into place, also represent sunk costs. But at this point the resemblance ends. Unless the facilities are quite flexible, individual farmers cannot directly add to flow rates; they cannot cause congestion in the highway sense. There is no difference between average and marginal social costs at capacity; there is no gap for a toll to close. Charges may be set to collect revenues and their effect might be to cause the facilities to run at less than capacity. And if the charges are later reduced, the system might revert to full flow. Even if the costs of O&M were to be zero, and water charges were to be removed entirely, the systems could not carry additional water, even though farmers presumably would be willing to take more.

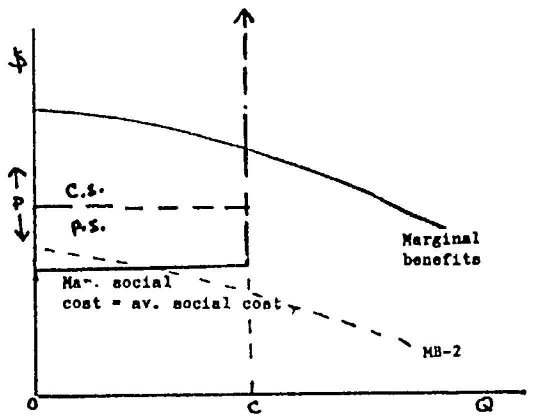


Fig.2 Theory of resource utiliztion in traditional irrigation setting (inelastic supply w/o congestion)

This situation is depicted in Figure 2. The marginal cost of operation consists of what normally is termed O&M; however, it is the "operation" component that is of most interest and maintenance may be ignored unless this cost category is assumed to consist of regular, scheduled, recurring expenditures. Operating costs mainly consist of technicians' salaries and there only is minor variance in the wage bill related to alterations in amounts of water delivered from time to time. Thus, marginal O&M expenditures as defined are level up to the set capacity (o-c) of the water delivery elements of the system.

Various estimates have been made of the marginal value product of irrigation water based on sample survey and experimental production function data. No known study also includes a description of the "shape" of the marginal social costs of utilizing the associated fixed investment. However, there are separate studies that do make social costs estimates that might be consulted to decide whether the marginal costs are reasonably depicted in Figure 2.

It may not be possible to bring marginal social benefits and costs together by means of adjusting prices, due to capacity constraints in many irrigation systems. (As drawn, the State could collect more and more revenue by raising prices and vice versa if it wanted to create certain producer surplus impacts.) To see what is going on in a high cost irrigation system or in a "wrong crop" system, readers may wish to shift the appropriate curve(s) up or down, bearing in mind that farmers also shoulder some "transaction" costs which are not shown.

Suppose, for example, that the "costs" are above the expected benefits at all levels of water delivery or only in the relevant range (MB-2, Fig. 2). If MB-2 in Figure 2 is interpreted to include an allowance for average fixed costs, we would be depicting an all too common situation in the real world of expensive construction. Benefits are less than average costs in many newer situations, in fact exceptions are starting to be unusual. However, for this discussion, all that need be assumed is that the benefits are below marginal social costs (i.e., below the level of O&M). This is not an impossible situation, and it has some significance in terms of our overall argument. Obviously, if ability to pay is below the level of O&M, there will be limitations on what farmers can contribute to any form of cost recovery. For the present discussion, the important point is that advocating marginal cost pricing in such a situation would be meaningless, because if farmers had a choice, they would not "consume" any of the water. In other words, in the B/C situation depicted by MB-2 (Fig. 2), ability to pay is the only cost recovery criterion. Further derivations are left to the reader.

The remainder of this section simply follows what seems to be the implicit assumption in most literature on water charges, namely that benefits are above marginal costs.

3.2 Classification of systems by source

Irrigation water sources such as run-of-the-river, springs, bogs, seeps and some drains, automatically put some inflexibility into system response to farmer demand for water. Intra-seasonal control and adjustment of deliveries to the command areas are limited. It is impossible to obtain more than the average yields at the source unless the flow is temporarily above average or the conveyance capacity of the facilities is generally less than water availability at the source. In these systems you take what you can get. Often the source must be shared with some other right-holder.

Underground and surface reservoirs/tanks afford control over deliveries at least until the storage gets low. The storage feature confers operational flexibility. Water will be released according to the system management plan, or according to some balance of need to carry over water to the next crop cycle, spill excess runoff, or generate electricity, etc. The management plan will tend to require that facilities run at design capacity during the main irrigation periods. A certain amount of scheduling adjustment may be possible. Not all tanks and reservoirs have "surplus" to sell, even if some farmers would pay for extra water.

Thus, what has been termed flexibility does not really mean ability to be totally responsive to crop (farmer) needs, except under the most sophisticated systems. In fact, society obtains the most benefit from its investment in public irrigation systems if the facilities can be operated on a continuous flow basis. But such congruence of supply delivery and farmers' needs does not exist in many upland or even rice cropping systems--some are totally shut down for major parts of each year.

The very control that is possible in flexible systems--assured or stable water releases--tends to make marginal cost pricing inapplicable, at least in the high season, because storage permits the facilities to run continuously or stay on strict lateral rotation, and the flows cannot be increased by lowering price to marginal social cost. In uncontrolled systems, some of the same argument applies. When there is too much water (early in the season) the managers will be diverting all that is possible (or all that farmers can use). During the remainder of the year, there may be excess capacity in the delivery works, but lowering price will not bring forth more. Thus, marginal cost pricing still might not be applicable.

There are certain unusual situations where this argument may be modified (storage capacity appears excessive relative to the conveyance network). The social cost of making greater use of the storage is low, but adjusting prices or water purchase contracts downward will not encourage more throughput if the canals and ditches are running full. However, at the start or end of the irrigation season, or possibly at night, it might make sense to try to move some "excess storage" by some sort of off-peak pricing. (The limitations to this procedure have been brought out earlier.)

Society's direct investment in irrigation is represented mainly by conveyance facilities, whereas the hoped-for benefits depend on farmers' combining a lot of additional fixed and variable assets. Therefore, it is not very useful to think in conventional terms about the social opportunity costs of utilizing public facilities. This conclusion also affects how much weight to put upon advocacy of marginal cost pricing. As a general operational "rule" for establishing fee levels, marginal cost pricing is probably a misleading guide.

The general basis for this conclusion is immediately transparent: according to the "law of sunk costs," water prices should be reduced to society's marginal cost of short-run utilization of project features, whereas charges need to be raised to reduce farmer "waste"!

3.3 Efficiency of irrigation at the perimeter interface

This section covers how water charges can be related to a hydraulic definition of efficiency of use. The fact that irrigation supply sources are always separated from point of utilization by some distance no matter how short, and that some provision must be made at the command area entrance for bypass, or overflow, means that the physical interface between the main conveyance features and the interior of the irrigated perimeter requires special consideration.

"Hydraulic efficiency" refers to the notion that once water is brought under some human control, gravity may be employed to push it from one place to another. What winds up in the drains of one project can be used again. And what percolates into an aquifer may raise a water table somewhere else (with good or bad results) or recharge the river it was originally diverted from.

Maximum "hydraulic efficiency" means obtaining the most "duty" from a developed water resource. Thus, efficient water use may also imply something about a global view of utilizing an irrigation supply source and possibly about a whole basin or watershed; a single project or project command area viewpoint is too narrow.

Already it has been noted that increasing project water prices to users might cause some overall reduction in water entering into the command area if the charges cannot be focused on particular users. The residual amount will be available for use somewhere else, or maybe it will simply flow into a lake or the ocean.

3.3.1 Water charges in "excess" and "deficit" situations at the perimeter

Private (non-pump) irrigation systems tend to be left alone by officials, although this may be because they can be monitored at the source or diversion easier than at the farm level. Probably the tendency is to collect any required fees from private groups in as direct a fashion as possible; for example, in the form of an annual lump assessment of some sort. In any case, as we have seen, the collection method may or may not have important impacts upon rates or methods of water use. The group may levy its own fees in addition. This does not suggest that there might not be some adjustment of water supply during the irrigation season. But the adjustments will come about as a group management decision and have nothing to do with levies on individuals. Group procedures and systems of conflict resolution may be relied upon to generate whatever the private users are willing to accept as "efficient" or "fair."

Public systems are another matter. For example, those based on tubewells might be somewhat special. Some operate about like individual private systems because the farmers can request water. Deliveries may be metered and users charged for quantity taken. In others the user group may be asked to buy diesel fuel if they want the pump to run or be asked to take up a collection for spare parts when there is a breakdown. Thus, there is a kind of self-imposed "efficient" use of water in such cases of farmer controlled ("demand-driven") systems. It is the same as saying that only the amount desired will be diverted. Supply adjustment is not a problem because the aquifer source is a reservoir (unless it is "mined" by separate "pumpers"). Many pumped systems are not in pipes, but are designed to operate just like any other open channel system, and much of what has been covered earlier applies.

As already noted, in non-sophisticated, public gravity systems, fee collection may easily be adjusted to cut down overall water use at the command area entrance (cut back diversions). The charges may or may not affect intra-seasonal water application rates by farmers. But why cut back diversions unless there is ample supply and a demand for any residuals? Also, it is another matter to try to use charges to solve water distribution questions; only specialized situations lend themselves to tracking individual deliveries. This is an important problem area that might better be handled by direct action to make members of water user groups follow the rules of project operation.

3.3.1.1 Excess supplies

In discussing efficiency in the context of traditional systems, we should recognize that even a well designed gravity/furrow system will throw off water which normally will be used elsewhere, outside the project command area, as supplemental supply or to irrigate dry land. The only way this will not occur is if the project is designed for high technology in the first place (and no leaching is required), or if the known average supply is stretched to cover "too large" of a project perimeter.

Crops can only utilize so much water. If the amount available is "adequate" or "over-adequate," any excess percolates to underground aquifers or returns to the river system. As already mentioned, planners should take the local water hydrograph into account and view achievement of on-farm efficiency in global drainage-basin terms; their productivity concerns should not be limited to the specific command area of interest. Water charges estimated for a project might very well be imposed on beneficiaries outside the perimeter. (We have already covered the possibility of "overuse" in one part of the perimeter relative to another.)

If more project-wide "efficient" irrigation is introduced, by whatever means, less water is diverted to fields. And, again, the residual, left in the supply network, may be used elsewhere (immediately, relative to waiting for it to appear via aquifer movement or overland return). It is also possible that diversions are not reduced and more land inside the command area is irrigated with the same amount of water (and there is reduction in potential overland return and irrigated land elsewhere). Again, the available water is used.

Leaving aside the HE/TE problem systems, the most important potential use of water charges to reduce average project-wide water use will be in situations where land is flat and waterlogging is a threat or is already occurring. (There might be some concurrent shifts in farmers' production decisions, especially since associated salinity problems also may be present.) Whether the reduction in water application due to charges would make possible some shifts in supplies to new areas would depend on the specific water source and its basin hydrograph.

3.3.1.2 Deficit supplies

A common situation is that irrigation systems do not deliver "excess" water. Designers and managers tend to stretch supplies and farmers feel that they need additional amounts. Any time water is constraining, farmers are automatically forced to make an efficiency of water-use decision (it may not always be a wise one. New techniques will be introduced to deal with persistent shortage if cost-effective methods and market incentives are available. In the very short-run they may realize before a season starts that water will be inadequate. Then they have to decide whether to leave some land unplanted in order to concentrate expected water supplies on less space. Or they may be well into a growing season before some choices have to be made. At that point they have to decide whether to short all crops, concentrate on a cash crop, or save a food crop and let the others go. In all of these situations, in orderly systems, efficiency of water use is guaranteed by physical shortage.

Systems that are persistently short of water, however, operate under a lot of "tension." There is great temptation to steal water and disrupt whatever pattern of operation has been devised. Thus, one of the side effects of attempting to include as many families as possible inside the perimeter of a planned command area is the tendency for subsequent system operation to be disorderly.

A system may be well designed in the sense that an attempt has been made to match the available supplies with the expected consumptive use demands of the crops, and it may still experience bad years. This is especially true for run-of-the-river and other uncontrolled, inflexible systems. Vital off-season precipitation may not materialize and farmers will be faced with water shortfalls during ensuing critical crop growing phases. Unless operating rules for such contingencies are enforced, tension builds as the tail-enders suffer. In the western USA, such suffering is automatic because "prior rights" holders are supplied first in a dry year. But inside formalized, public project perimeters, designers and planners do not look forward to such institutionalized distribution effects. Probably they would prefer to spread the suffering. One of the most important aspects of keeping systems orderly, therefore, is the requirement to give even-handed treatment to all users, rich and poor alike. Water user associations (or other allocating authorities) have to be both strong and fair.

In a water-short situation, existence of a system of water charges will not affect efficiency of use one way or another in an orderly system (unless they are set so high as to reduce diversions across the perimeter interface). There is no "waste" to control. If a system of charges is overlaid on top of generally inadequate irrigation supplies, the goal can only be to collect revenue.

3.3.2 Apparent demand system exception again

We now have in place enough background arguments to begin to make good on our earlier claim that operating a demand system still may not be a guarantee that farmers will be efficient water users under a regime of unit water charges. At best, the combination is only a partial guarantee.

This is because all the charge does is control the quantity that crosses the "perimeter"--this can be the whole command area as related to the average farmer or the boundary of an individual farmer's field. Increasing unit costs will eventually reduce the quantity taken, but whether the reduced amount is used "efficiently" in an agronomic or economic sense is still up to the farmer. For example, the price charged to a modern housewife for domestic, metered water supply may be increased or decreased, but there is no actual control over what physical use is made of the decreased or increased water purchases--they may go straight down the drains, into stomachs, or onto lawns.

At this point we do not have to be concerned with excess delivery situations. Presumably any excess would have no social value or supplies would be managed better.

Even in a tight supply setting, what a farmer does with the actual units of water purchased is not directly linked to the higher unit charges. Indeed, increasing water costs will only make the individual farmer more efficient under particular conditions that are governed by physical relationships underlying the way plants utilize water and the costs of doing precision irrigation. Again, this is why paddy rice cultivation is a special case that is not adequately covered by these comments.

It is the task of the next section to spell out the details of these interactions. Once that has been done, we will have shown via three separate chains of reasoning that manipulating irrigation water charges in traditional upland cropping situations (including unit charging mechanisms) will have little or no effect on farmer intra-seasonal utilization decisions.

3.4 Microeconomics of field irrigation

It is very difficult to do a good job of furrow and basin irrigation by traditional methods. Agronomically efficient irrigation is expensive in time, effort and money. A rational farmer will substitute water for labor every time he has the chance and will possibly profit in the process. Yet, if planners overlook these application costs, farmers seem to waste water in an uneconomic and irrational manner.

Probably the single biggest boost to irrigated yields is high uniformity of water application. This is what sprinkling and other improved technology i mostly about. (The casual observer may think that the important goal of these devices is to save water, but that is secondary.)

In traditional surface systems, the only way to get uniformity is to have level fields and basins. A really high degree of uniformity requires precision leveling that is impossible to obtain by hand or animal methods. The harder a farmer works to attain uniformity, the greater the amount of total investment or the more costly on-farm water management becomes. An average 2.5 cm cut across a single hectare amounts to 125 m^3 of earth to be shifted. This explains why rice seems to be the single crop that farmers know how irrigate--the standing water covers up surface irregularities that even very careful paddy preparation cannot eliminate.

A farmer has no other option than to do some minimum amount of leveling if he wants to irrigate at all. Each year a farmer may devote the energy and money to do a little more leveling, plus he always has to touch up deterioration from the year before, rebuilding bunds and so forth. After that, if he aims for efficient water use, two choices are open: he can either run up and down each furrow or basin during his irrigation turns, "cutting" the water through all the high spots, or he can invest in more serious hand, bullock, or machine leveling or alternate application technique.

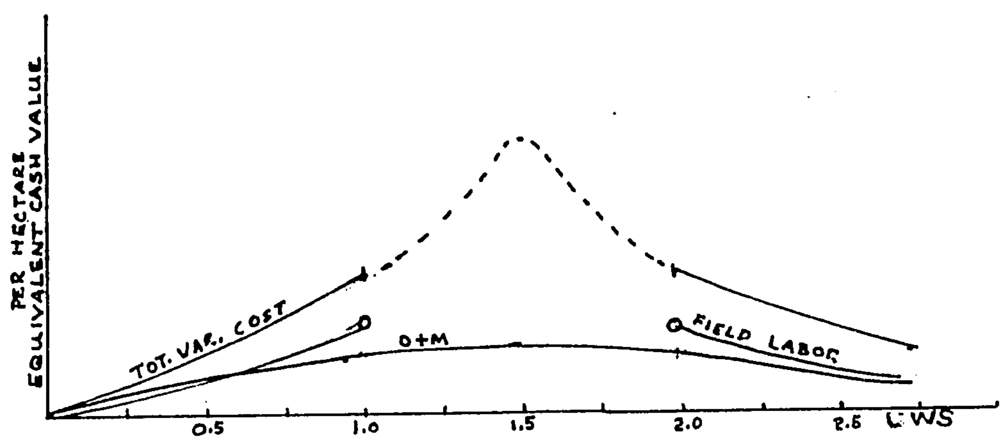


Fig. 3 Hypothetical practical upper limits (o) on seasonal water handling costs for upland crops in traditional gravity system--no special leveling investment

3.4.1 No special leveling

Figure 3 shows the hypothetical costs at the farm level in a traditional furrow irrigation scene. The costs are the total sums that would be required to support or handle various amounts of available irrigation season water. A unit water supply (UWS) = 1.0 defines a situation where the ratio of available water applied (AW) to the amount necessary to maximize production (AW_{max}) is exactly adequate to support a ratio ET_a/ET_m = 1.0, the evapotranspiration condition that must be met at maximum output of a crop. A 1:1 relationship between the ratios requires a laboratory or experimental setting. In the real world, lack of uniformity of water application increases the AW requirement in order to compensate. If the highest field efficiency possible in a traditional gravity surface system is 67 percent, the ratio AW/AW_{max} must be about 1.5 in order for ET_a/ET_m = 1.0. In Figure 3 maximum production would therefore take place at unit water supply (UWS) = 1.5. (See Annex A for further explanation of these relationships.)

Actually, a traditional furrow method farmer cannot operate at UWS = 1.5 due to the tremendous intra-seasonal water handling costs that would be involved. Therefore, intra-seasonal irrigation management costs are discontinuous either side of UWS = 1.5. Even if he were supplied exactly a unit water supply of 1.5, he could not obtain maximum production. He would operate to the left, at a lower UWS value. If he is supplied a UWS > 1.5, he will operate to the right. In either case, his field efficiency probably will not reach even 50 percent.

If a farmer chooses not to invest in leveling he incurs an annual cost for irrigating his fields that is a function of how hard he tries to be efficient with the water delivered to him. The seasonal irrigation cost the farmer must bear is mainly composed of labor effort, although some amount of "O&M" is involved (hoes, dam materials, and calls from associates upon his energy or resources to help to maintain the general conveyance network, etc.). The "dashed" segments of his labor cost curve (Figure 3) indicate that he can only go so far in achieving high water application efficiency in any given season. By spending some additional money on tools and dams, however, he might be able to manage O&M where UWS = 1.5. Therefore, we show that function as continuous, but with a hump.

O&M costs rise with any attempt to be more efficient because more tools and materials are needed by the additional laborers required to manage precision water application. Where water management is less important, i.e. to the right of UWS = 1.5, these costs fall. The shape of the discontinuous labor cost curve has already been partially explained. The remainder is straightforward: left of UWS = 1.5, a farmer has less and less water and reasons that he can put it in any easy location with about the same effect. Moving to the right of 1.5, he has more and more water and less and less need to manage every drop.

Of course if he has enough confidence in the future of his "water right," he might decide to make a big investment in leveling, and subsequently he would be able to operate closer to 1.0 and raise his agronomic efficiency above 50 percent. A good market for a specialty crop may call forth some extra intra-seasonal watering effort. A farmer can employ hand tools to create "dead level" basins if he makes them small enough, say 2m x 2m, but part of the agronomic efficiency he gains in leveling he looses in the soil that goes out of production because it is tied up in all the checkerboard bunds. In addition, his intra-seasonal water handling costs are still tremendous.

In Figure 4 hypothetical net crop return (excluding the on-farm costs of water handling) has been introduced. The cost and returns data are similar to the example shown in Annex B, where calculations are made for wheat production in Maharashtra State, India.

The gross profit curve is revenue less crop production costs, but excluding the field costs of irrigating. Net profit is the difference between the gross profit and total water handling costs (T_c). The underlying production function decreases to the right of UWS = 1.5 due to waterlogging and is pulled down more sharply by increasing salinity. Production costs do not fall proportionately in this process, so that the net return (less irrigating costs) falls even faster, (see Annex B, Figures B.2, B.3, B.5).

Suppose a per unit water levy is made. This is indicated by the ray (W) from the origin in Figure 4. The sum of the computed seasonal O&M, labor and water costs is shown as the highest dotted curve (T_c). The labor costs shown (L) only take into account the average effort and energy and number of irrigation periods necessary to apply various volumes of water at some relatively low level of uniformity, a level that could be expected when raising wheat. Although not shown, it must be assumed that some amount of sunk leveling costs have been incurred, otherwise little or no irrigation would be possible for any conceivable water supply level. These costs could be estimated in a real situation. Certain aspects of labor costs probably cannot even be estimated because little or no information is available about the special effort and extreme labor costs that would be necessary to "spread" the water in a precision manner in order to operate near UWS = 1.5. (See Appendix C for discussion of the effort necessary to manage micro-size, dead-level basins). Therefore, the actual necessary costs that would be incurred to operate in the region of UWS = 1.5 are unknown. However, they would "peak" at UWS = 1.5, as noted in the figure. The highest attainable profits are therefore on either side of UWS = 1.5.

3.4.1.1 Excess supplies

Ignoring the unattainable area, we see by inspection that, without water charges, profit near UWS = 2.0 is greater than at 1.0. Farmers with adequate water may therefore opt to operate in the region where UWS > 1.5. When water charges are included, profits are reduced, but not by enough to cause the farmer to give up "wasting" water. That is, he will purchase a relatively large amount of water given that the same output could be physically obtained with a lesser amount at UWS = 1.5. The decision to continue to operate at UWS > 1.5 is governed by profitability. Allowance for unit water charges greater than those shown in Figure 4 would cut profits and eventually force the farmer to "flip" clear across the unattainable production region, into the zone UWS < 1.5. Once that happens he will purchase a "far smaller" quantity of water, even though output and overall profits may not have been reduced very much at all.

Volumetric charges, therefore, can cause some reduction in individual water use in the supply zone UWS > 1.5 and, given high enough user fees, the charges can force farm operators to skip to the relatively water deficient zone. But the charges may not help society reach the objective of maximizing agronomic output because it is not profitable for the farmer to reverse out of Stage III of his production function until until charges reach a level that would put him short of where Stage II ends. (Note that as long as water is not a physically scarce commodity, the social optimum [relative to society's sunk costs] is to

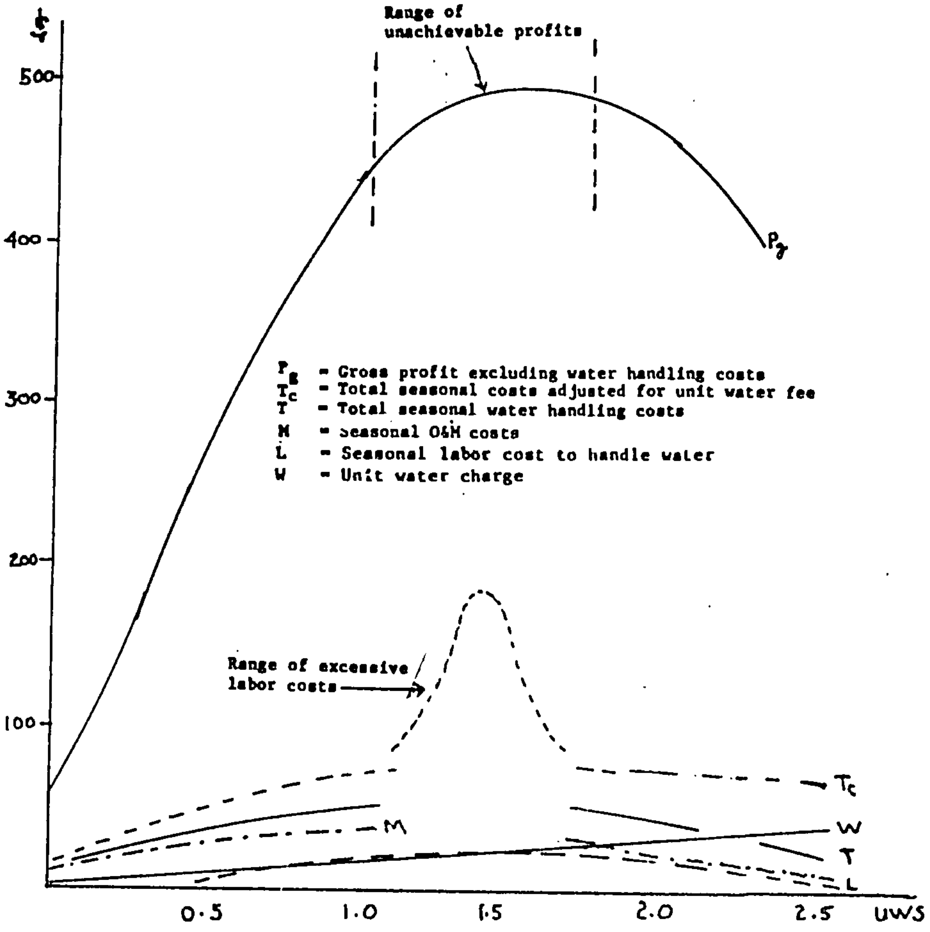


Fig. 4 Hypothetical gross crop production profits excluding seasonal water handling costs shown--traditional furrow

produce where individual farmer output is maximized. There is no necessary distinction on the underlying production function between agronomic and economic efficiency).

It is possible that the farmer will make more money (or minimize his losses) on either side of UWS = 1.5. In fact the farmer has little choice in the matter. To repeat, he cannot operate at 1.5 even if that is the supplied amount, gratis, no matter how hard he tries. This means water is "wasted" in some cases. Remember, however, that although our attention is on excess supplies it is still possible to imagine that this "waste" is utilized elsewhere, or could be.

Figure 5 illustrates the net profit potential for the hypothetical example. These data reflect hand conditions with some allowance for the extra labor costs to attain somewhat better efficiency in irrigation water utilization on a rough crop, such as wheat. Even if a more valuable crop were to be involved, when account is taken of the additional costs that would be incurred to do precision water management during irrigation turns, the transition between Stage 2 and 3 of his production function will not be of interest to a traditional upland crop irrigation farmer.

3.4.1.2 Deficit supplies

We have argued that water fees are not necessary when farmers are already operating in the UWS zone < 1.5. Nevertheless it is instructive to think through what imposition of a unit charge system would accomplish in a water deficit situation. In terms of Figure 4, if the ray is rotated counter clockwise (fees go up), the water users almost certainly will be pushed further left with each higher fee increment. If the starting point is close to "UWS=1.5", the movement might increase efficiency of resource use if the effect of the fees is not to move farmers too low on their production functions. This is the only traditional low field efficiency situation where unit charges might produce clear-cut production benefits. This is because in a deficit situation it is natural to think that any water "not purchased" by project farmers would be certain to be used somewhere else.

On the other hand, if the initial starting point is already at a critical UWS position relative to the underlying production function, increasing fees will push production below the economic efficient level and total output will fall.

Until this point size of the command area has been treated as the constraining factor. In many irrigation situations there is not really enough water for the land that is supposed to receive it. Then land may be varied to optimize the value of the fixed factor, water. There is no need for unit water pricing in a situation where the farmer is constrained to operate in the UWS zone < 1.5.

In the real world a farmer that is short of water in the middle of an irrigation season will put critical supplies on the crop he most wants to save. At the beginning of the season, however, he has a different decision to make if he thinks he will have even less than normally tight supplies. Should the water he expects to receive be concentrated on a smaller area, or should it be spread out? The general answer is well known, if we assume he wants the most return per unit of water. He will stay low on the "production function"; according to the equi-marginal rule, he will equate the returns from each unit as

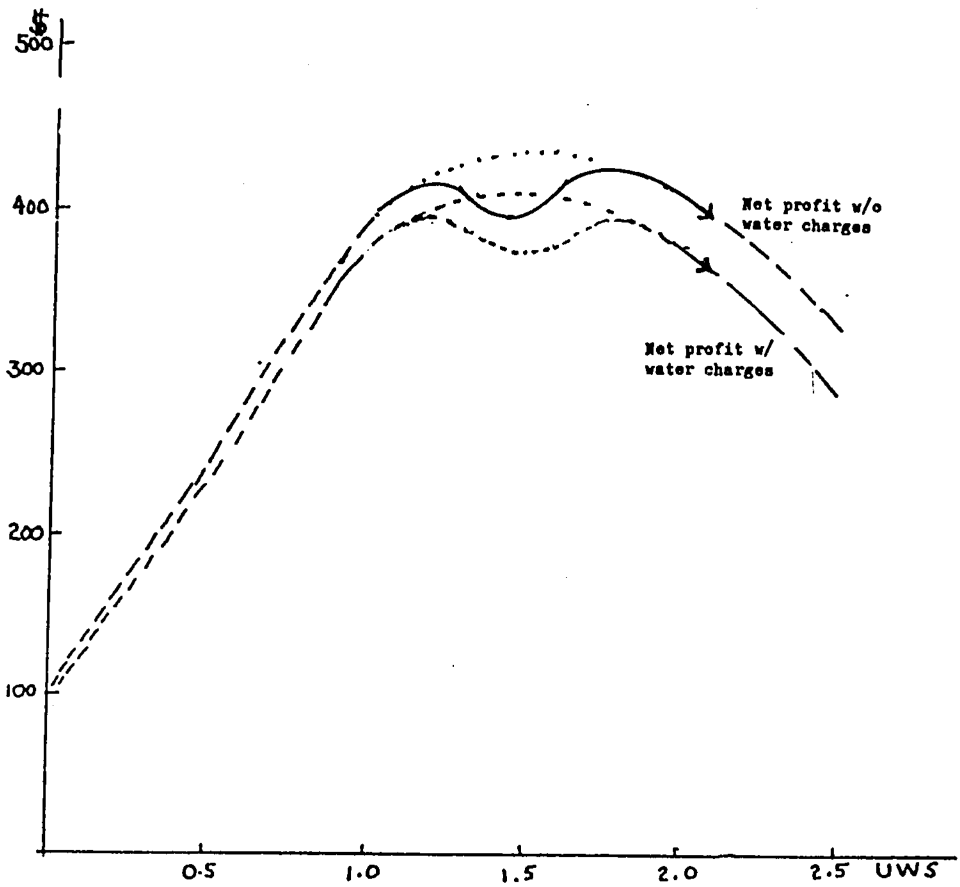


Fig. 5 Hypothetical net profit/ha relative to available UWS showing depressing effects of water hadling costs costs at agronomic optimum--traditional furrow

necessary. This means he will spread the water, unless experience has taught him that intra-seasonal shifts and alterations in what actually gets delivered requires that he start off with a certain amount of water concentration as the basis for his cultivation plan.

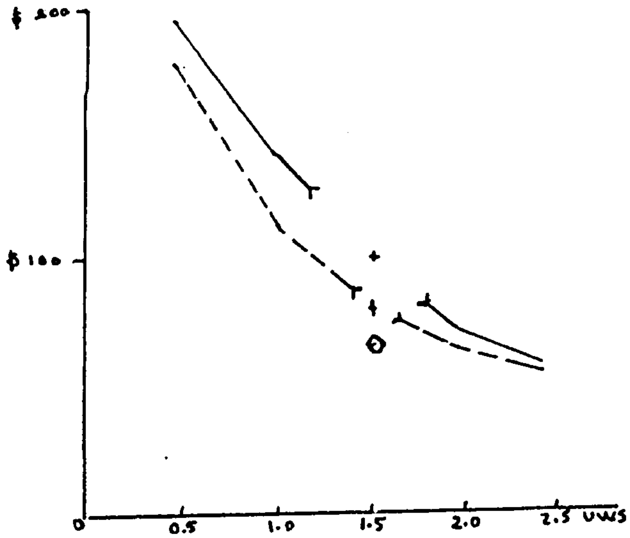


Fig. 6 Effect on net profit/ha by varying cropped area when expected UWS fixed @ 0.5--Maharashtra example

The upper curve in Figure 6 is based on the profit information implied in Annex B, Figure B.2. This involves data similar to that shown in Figure 5. Suppose a farmer operates 1.0 ha of land and expects a fixed water supply equivalent to UWS = 0.5 per ha of land. In other words he has a deficit supply relative to the available land area.

If the farmer applies the water at that proportion, the net return per ha (ignoring water charges) is $325 (see calculations in Annex C Table C.1). If he decides to concentrate the area of water application until the UWS is equivalent to 2.5, he would only need 20 percent of his land. At that UWS value net profit per ha is about $404. Thus, one fifth of this is $81 per ha. Again, we assume that the region either side of UWS = 1.5 is unattainable. The greater the effort, to be efficient, the lower the profit. The value marked by the diamond symbol is a representation of the hypothetical profit if he could in fact operate at 1.5.

The lower curve in Figure 6 illustrates the same range of water spreading choices except that the underlying data allow for the long-run average variable cost that could be expected with some additional investment in better technology (bullock/tractor leveling). (Profit estimates are taken from Annex Figure B.3, where it is assumed that the investment will increase efficiency closer to 67 percent, i.e., UWS = 1.5 is still optimum for maximum production, given the technique.) Depending on the scale of the proposed better leveling investment, the area near UWS = 1.5 may or may not be attainable, or even desirable, for profitability. The fact that profits in the region near UWS=1.5 is more profitable than that symbolized by the diamond symbol is irrelevant since the farmer will not concentrate his expected fixed water supply. obviously the relative locations of the curves must be reversed or the farmer will not invest. Whether the potential incremental increase in profits is really negative, as indicated by the available Maharashtra data is not clear because, as mentioned, no allowance has been made for sunk costs that underlie the current situation.

3.4.2 Investment in machine leveling and other techniques

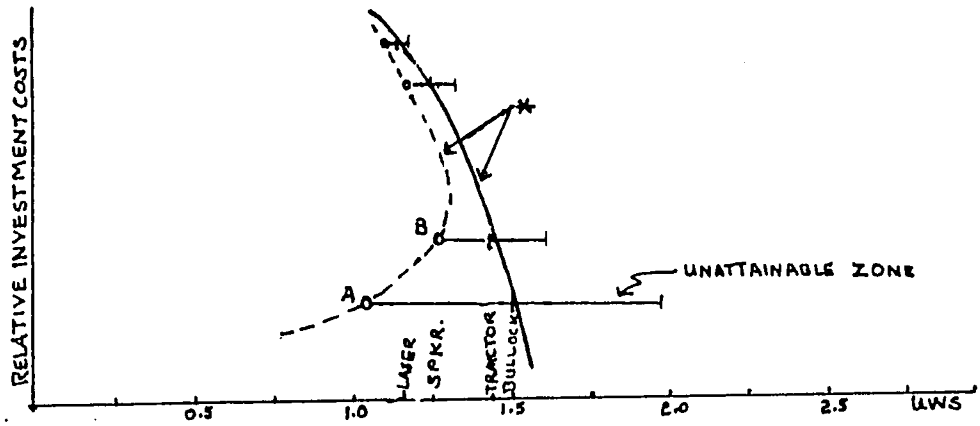
A farmer only has two options for reducing the labor costs of doing efficient on-farm irrigation: he has to make an investment in either land leveling or in different technology.

We have seen that in a traditional agriculture deficit water situation it might not be profitable for a farmer to invest in achieving higher water application uniformity (on a larger share of his land). However, this result depends on the specifics of the available technical options and their benefit/cost ratios. Experience in North America has shown that the combination of being able to utilize the same amount of water on more land, or less water more effectively, has made investment attractive, either by means of switching techniques (sprinklers) or, nowadays, via laser leveling.

If a farmer expects a low unit water supply (say, 0.5) he will not invest anything. With assurance of somewhat more water he may be willing to consider an investment in leveling if the expectation can be matched with some appropriate technique. As the expected unit water supply moves toward 1.5, 1.4, 1.3 or 1.0, he has to invest more and more in one or another technique to make use of the associated optimum amount. For example, if the available UWS is never expected to rise above 1.0 for his total land area, he will not devote the human and animal energy to level all of it, because he knows that he will need at least UWS = 1.5 for that technique.

Figure 7 shows the hypothetical investment in land leveling required to operate within a range of a given unit water supply. The small circles represent the initial investment cost of leveling in each case. In general, only the UWS zone < 1.5 is of much interest. This is because if water is not "priced" and farmers are operating in the excess water zone (UWS 2.0, say), they will not have much incentive (and possibly no social need) to invest private resources that would compliment society's sunk costs.

In the diagram, we imagine that investment (A) in crude leveling using hand methods will only be able to bring the individual farmer as close to UWS=1.5 as 1.0 (2.0). A greater investment (B), involving combinations of bullocks/tractors and scrapers, moves a farmer in the direction of 1.5, only now his target may be UWS = 1.4 because, as explained in Annex A, the coefficient of uniformity linking the experimental production function to the field production function is different for each leveling or other water application technique. For example, this link brings the desired UWS ratio associated with laser leveling to about 1.15. Of course, intra-seasonal labor and other costs are still a factor, even if technique changes. Thus, the investment in animal/tractor leveling still will not permit subsequent water management right at UWS = 1.4. The farmer only will be able to get relatively closer to 1.4 than



*Locus of movement of production function potential vs. investment in technique

Fig. 7 Hypothetical upper limit on expenditures to strive to obtain uniform water application in upland systems

he could to 1.5 . In other words, the "unattainable" production area shrinks according to level of investment, so that in the case of sprinklers, it might be possible, in terms of O&M and labor costs, to operate virtually at the associated optimum UWS (say, 1.25). The same would be true for laser leveling.

The locus of agronomically optimum unit water supplies has been drawn to move from approximately 1.5 to 1.0, according to irrigation technique employed. This shows the relationship between technique and relative water requirement to achieve exactly the same maximum crop output. Annex A contains a discription of how the various production functions are estimated. Possibly the cost rankings are not represented very well, because we know that some intra-seasonal water handling and management costs must also be borne by a farmer. Generally, however, these additional costs are inversely related to the caliber of leveling technique: they are higher for hand leveling, less for tractor/scraper, and least for laser. (Sprinklers can be quite expensive to manage.) In fact, it is interesting to speculate that it would be cheaper to get close to the uniformity required at 1.0 by laser leveling, than by any amount of other effort and expense involving leveling.

3.4.2.1 Pre investment long-run variable costs

Figure 8 shows the expected long-run average cost prior to investment in leveling with bullocks/tractor and scraper. Data for wheat production in Maharashtra State in India are plotted in this figure. Short-run (intra-seasonal) O&M, labor, water charge and gross profit curves are shown. In this example, at the time of planning the investment, a water charge does not exist. A description of the data sources and computations are given in Annex B.

The diagram illustrates a data set arranged so that it could be used to decide between investing in bullock or tractor leveling. As mentioned, the expected UWS level or knowledge of its availability at a price will have an influence on the final investment decision. Here we only assume that to begin with the farmer predicts long-run variable costs for various levels of UWS. Allowance for a unit water charge can be brought in later.

The key function is the estimate of the amounts of necessary fixed investment required according to various levels of UWS. In order to operate closer to UWS = 1.5 subsequent to the investment, it is necessary to move up from bullock to tractor (Af). Of course, if water is free at the time the investment planning is in motion, there would be little need to invest as much if the levels of UWS can be expected to be higher than 2.0. Thus, the long-run fixed cost function would have a hump as shown. (Compare the dotted line linking points A and B in Figure 7--tractor/bullock are the only techniques in the figure that can be so linked.)

A water charge can be represented by a ray from the origin (W). The sum of the expected long-run average cost components are shown without and with water charges (T and Tc). The results of subtracting T and Tc from the gross profits function in Figure 8 indicate the expected long-run profits from the various scales of investment.

The wheat data suggest that if bullock/tractor investment were to be made, it would be more profitable to stay away from the most agronomically efficient water use zone. However, in this data, the level of information available is not sensitive enough to distinguish any particular profit point--a wide range of UWS values (if they were all attainable) would generate about the same seasonal profits.

An element missing in the wheat data are estimates of labor "saving" in water handling that might be achieved by moving well up the technology ladder. For example, plotting the projected annualized cost of a set of investments in various leveling technologies, along with the expected separate profits functions and labor costs, would result in more definitive long-run variable cost and return curves for investment planning.

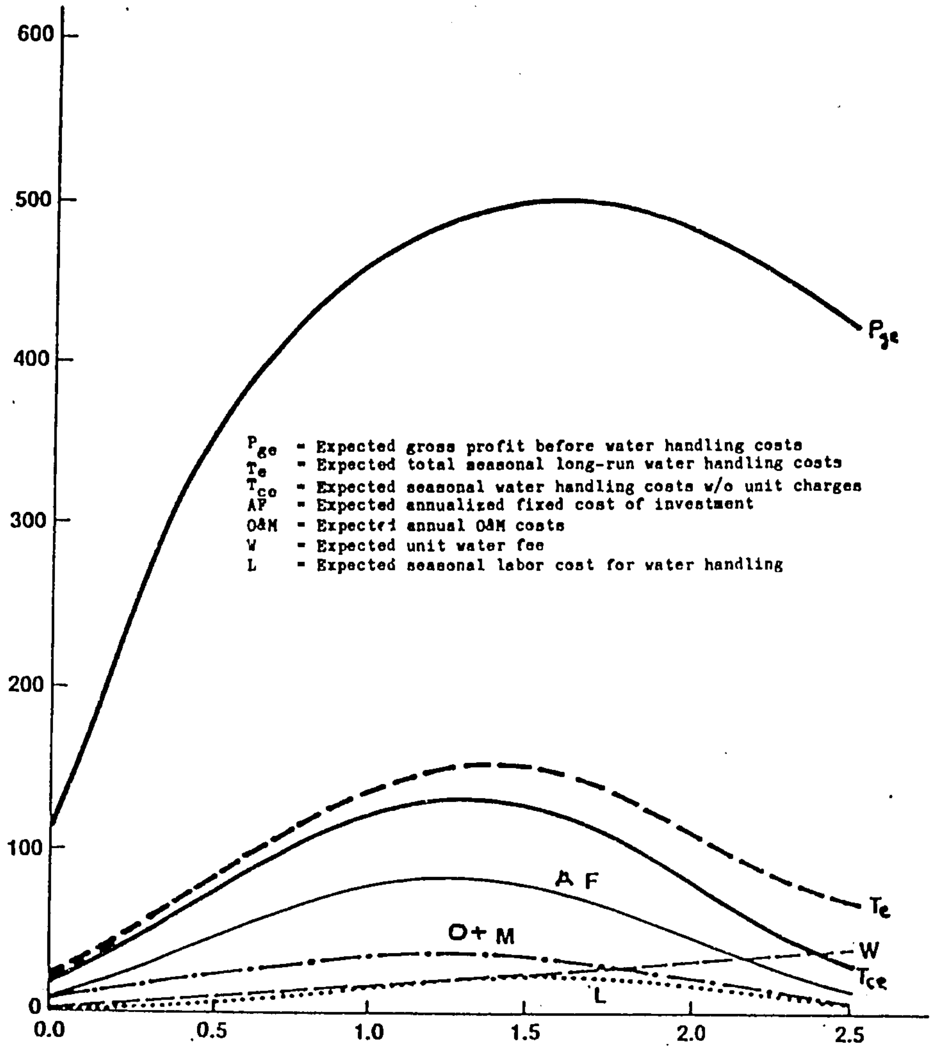
Already it is clear that we have a few problems: farmers are not going to go through the misery of making this type of investment decision, unless the risks are low; too much shaky information is involved.

Nevertheless, if all works out as planned, a farmer would operate at the unit water supply he programmed into his investment decision. "excess" water will not be used in any year if he thinks production might be adversely affected. If planned for water supplies do not materialize in a given year, he presumably will buy as much water as possible.

3.4.2.2 Post investment short-run costs

Once an investment has been made, the farmer must live with the sunk costs or overheads he has created. All might not work out as planned. Crop prices may change for better or worse, or his cost structure may change. Our interest, for present purposes, is in the farmer's response to imposition or increase in unit water fees.

If a farmer invests, presumably he will turn back any future water deliveries that bring UWS very much above the optimum associated with the he has chosen. Or, if he must pay, he will refuse to buy more water than he needs.



Source: Annex B, Annex Figure 2

Fig. 8 Investment planning information for bullock/tractor leveling wheat land: Maharashtra example

Due to this presumption, if a farmer invests, the short run labor cost curves will be as shown in Figure 9. That is, they will not exist in the excess UWS zone during normal supply years, and if sometimes there is extra water, labor costs will not be affected because the extra water will not be utilized. Annual farm O&M cost curves will be some function of the leveling method chosen, and might still have a "hump." Annual fixed costs of the investment chosen will of course be some horizontal constant cost value line (discontinuous in the regions of individual agronomic optimum), and will have no impact upon short-run water utilization decisions. Although not included, a unit water fee may be imagined. The functions are not shown in any particular hierarchy. Thus, except for the sums of money involved and the target UWS levels, there is no distinction between a particular leveling expenditure, installing sprinklers, or investing in some other more uniform application technology.

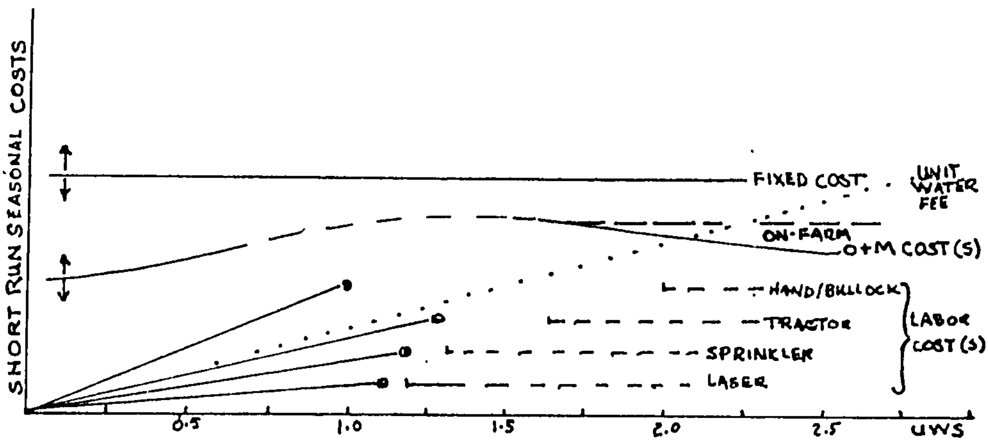
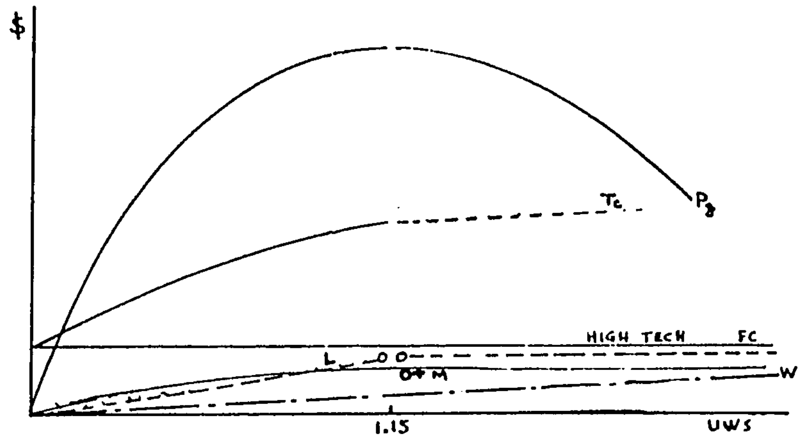


Fig. 9 Generalized post investment short-run labor costs for field irrigation in average season

The elements of the preceding argument are combined with a "gross" profit function (similar to Figure 4.) in Figure 10. This diagram is meant to represent the short-run costs and revenues following an investment in a technology such as sprinklers or laser leveling, both of which support farm operation close to the optimum UWS associated with the techniques. The short-run cost curves are more or less continuous. If water charges are increased at a time when a farmer is operating anywhere in the whole zone where UWS > than the amount required for an agronomic optimum for his chosen technique, he will be pushed toward greater efficiency in water use. How far towards the optimum he will go depends on the technology level chosen during the investment process (certain leveling methods may still leave a considerable "gap" on either side of of his UWS optimum). With laser and sprinkler technologies, for all practical purposes the farmer will be able to operate at the agronomic optimum, if it is profitable.

The farmer will have a short-run average fixed cost that is constant relative to UWS. In the whole zone where UWS = greater than his target UWS, important variable costs will also be more or less constant. If the unit water charges rate (W) is increased, the farmer will use less water. If fees are raised enough, utilization will continue to fall.



Source: Adapted from Annex B, Annex Figure 5

Fig. 10 Main econoomic variables in the short-run: high tecnology irrigation investment

A general rule of thumb is that the more advanced the technique, the the smaller an "unattainable" operating zone and, therefore, the greater the potential for affecting farm management decisions via unit water charges. This is a result opposite that for lower technique levels.

3.4.3 Summary of field irrigation analysis

This mini-analysis supports the conclusions in earlier sections of this paper. In tight water situations farmers will be efficient in the sense that they will not waste water. This is automatic and no water fees are necessary to bring the result about. However, to say that they will not waste, does not imply that they will try to operate (in a planning sense) as close to UWS = 1.5 (approximately the agronomic optimum for traditional gravity, furrow systems) as possible. It will not be profitable to do so. The only way that investment will be made in more efficient water handling methods is if the prospective annual labor savings and some intra-seasonal supply flexibility can be gained. No farmer is going to level up land he does not have water for--but something like sprinklers might have a place.

If the farmers' UWS values are > 1.5, they are pushed into the situation of maximizing returns to land as a fixed factor. Given excess water, in traditional furrow agriculture a farmer has little incentive to invest in efficient water handling methods. In the opposite case, if water supplies are tight, an example of actual data suggest that, in the India wheat case, the investment would not be made. In any event, the decision is complex and would require definitive data before any farmer would take a chance.

In the short-run, even if water charges are levied on a unit basis, the farmer will not move closer to an efficient irrigation position than his profit picture supports--he will hold at his best option and "eat the tax." If the unit fees are made high enough, a farmer will be driven out of the "excess" zone, and be forced to operate in the "deficit" zone. Society may or may not obtain productivity gains in the process; there is no clear-cut rule. All that seems clear is that the farmers' profit potentials and society's desire for crop output may not be in harmony.

If investment in better water handling is made, but the technique chosen is one that still restricts operation from being close to the optimum UWS, shifting water charges will have some direct utilization effects as just described. Only if the traditional farmer is able to invest in a high level technique will it be possible to operate at the optimum UWS level. In this case, alterations in a unit water charge would have a much better potential to bring desire for high output into harmony with farmers' profit goal. Therefore any scope for achieving "efficiency" benefits via unit water charges seems rather limited, even if a mechanism existed for imposing them.

4. ANNEXES

4.A Actual evapotranspiration and maximum yields (fol. Hargreaves & Samai)

In an input-output sense, neither conveyance facilities nor plants are 100% efficient. However, it is possible to speak of 100% water application efficiency if what is supplied to the plant equals transpiration. In practice this value is rarely achieved at the field level because of the expense. There is a difference between potential plant yield and actual yield (Y_a). Potential or maximum yield (Y_m) is a function of available energy and can be estimated as a linear function of Class A pan evaporation from a station inside an irrigated field. Pan evaporation is determined principally by air and solar radiation. Actual yields are influenced by fertilization, density and soil moisture availability. There is a similar relationship between evapotranspiration possible (ET_m) and what plants actually achieve (ET_a).

Various models have been developed linking crop production to evapotranspiration. For example, the the relation of actual to potential yield can be written:

$$\left(1-\frac{Y_a}{Y_m}\right) = k_y\left(1-\frac{ET_a}{ET_m}\right), \qquad (1)$$

where k_y = a yield response factor that relates the decline in Y_a to the unit decrease in ET_a.

Therefore in order to move the ratio Ya/Ym towards unity, ET_a must be moved to equal ET_m. The amount of irrigation necessary to achieve this equality is dependent on the efficiency and uniformity of water application available as precipitation plus other factors. As water application is adjusted to push ET_a into the range for high yields, it becomes increasingly difficult to maintain high efficiencies. [Ibid, p.345]

This discussion is related to the notion of Unit Water Supply as used in the main text as follows: Unit water supply (UWS) is the ratio of total water supplied at the field gate to the net amount of irrigation water required to produce Ymax, i.e.

$$UWS = \frac{\text{Depth of irrigation water at field gate}}{\text{ETmax} - R},$$

where R = effective rain + antecedent stored soil moisture.

4.B Interplay of technical and economic factors in traditional farmers' on-farm water management decisions (fol. Keller, et al.)

Water application techniques other than furrow irrigation would have higher peak efficiencies. As a consequence the basic production function, when combined with exactly the same economic information about unit selling prices and production costs per unit would result in a different gross benefits curve. Annex Figure B.1 shows that a basic production function from some crop computed from experimental data must be transformed into a production function associated with a particular irrigation technique via the relevant "coefficient of uniformity" associated with the technique. The general differences in particular coefficients according to water supply levels is clear: the sigmoid shape is flatter for low efficiency techniques and steeper for higher efficiencies.

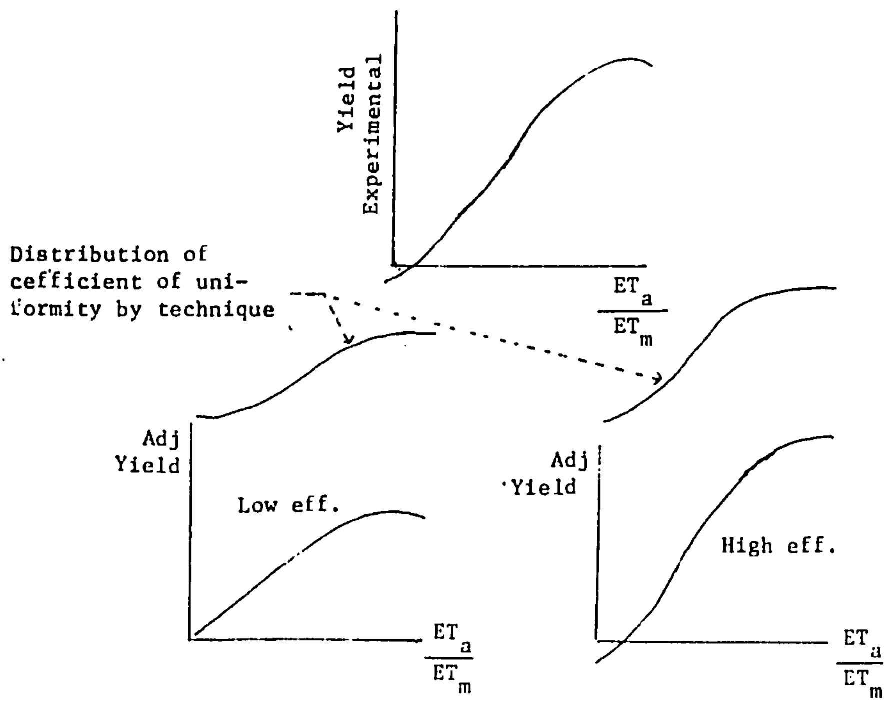


Figure B.1 Effect of coefficient of uniformity on basic production function

4.B.1 Benefits from irrigation

For our study we have taken wheat during the winter season in the central portions of the state of Maharashtra, India. We used a water production function taken from Solomon (1983) in the form of:

$$y = \sum_{i=0}^{4} a_i \, (aw)^i \qquad (2)$$

where

a_i = constants from Solomon (1983)

aw_i = relative available water = $\frac{AW}{AWmax}$

AW = irrigation water applied

AWmax = AW at Ymax

Ymax = maximum yield

y = relative yield = $\frac{Yact}{Ymax}$

Yact = actual yield at AW

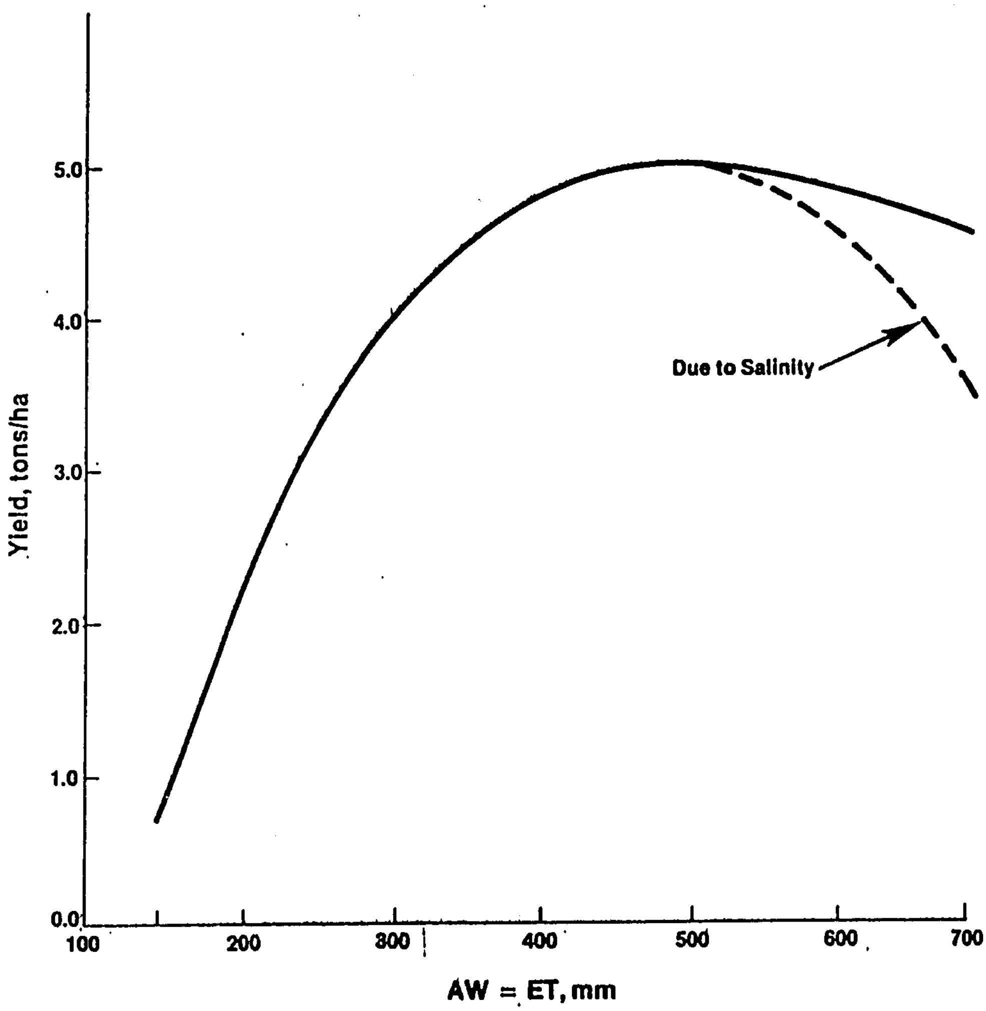
Based on the data from Gulati et al. (1979) and Mahatma Phule Agricultural University, Maharashtra, India (Anonymous, 1982b), following assumptions were made:

Ymax = 5.0 ton/ha, AWmax = 500 mm, R = 150 mm

Using constants, a_i, for the low sensitivity function, the yield curve for wheat is obtained as shown in Figure B.2.

The gross benefits to irrigated agriculture are equal to the gross returns from the sale of the wheat produced less the associated farming costs other than irrigation. For traditional and improved farming costs, we used data from Patil et al. (1978, 1980), Anonymous (1982a) and Anonymous (1982b) for both low and high tech irrigation.

Combining this data and the crop yield thus computed for various UWS for the traditional and sprinkle irrigation, the gross income to irrigation were obtained and tabulated in Annex Table B.1. Several possible uniformity are available (Soloman, 1983) and we adopted linear forms associated with traditional and improved irrigation techniques. The resulting function for traditional irrigation is shown in Annex Figure B.3.



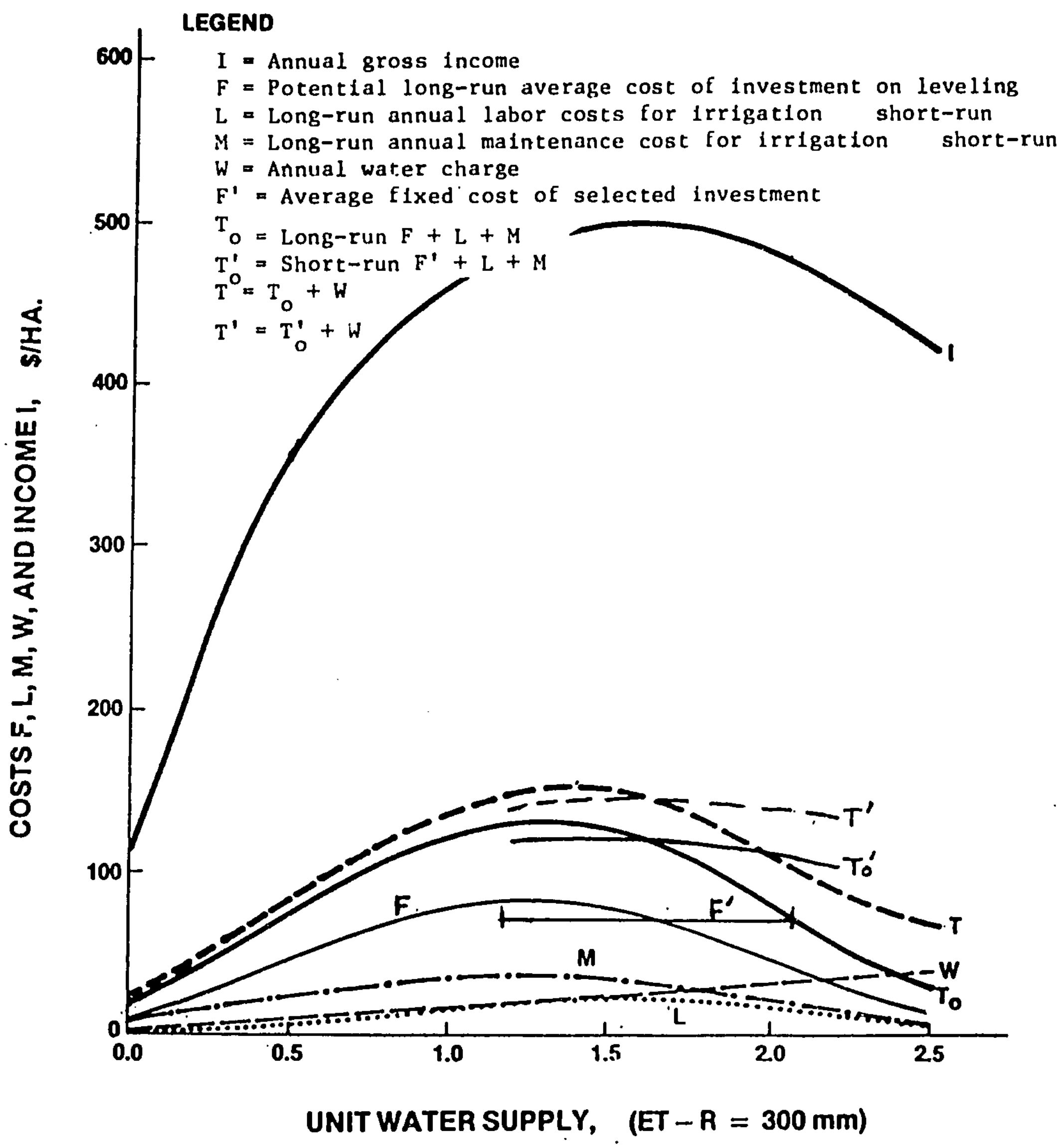
Source: Adapted from Keller, Sawant & Mulik

Figure B.2 Production function curve for wheat

Table B.1 Cost and Income per hectare From Irrigated Wheat from Traditional and Sprinkle Irrigation in Central Part of Maharashtra, India

UWS	Traditional Irrigation				Sprinkle Irrigation			
	Yield	Gross Income	Cost less IC	Gross BNF to IRG	Yield	Gross Income	Cost Less IC	Gross BNF to IRG
0.25	2.31	370	260	109	2.53	405	260	145
0.50	3.45	552	285	267	3.74	598	285	314
0.75	4.06	650	295	355	4.47	715	295	421
1.00	4.57	731	305	426	4.83	773	305	468
1.25	4.77	763	305	458	4.93	789	305	484
1.50	4.83	772	305	467	4.86	778	305	473
1.75	4.68	749	305	444	4.68	749	305	444
2.00	4.51	722	305	417	4.46	714	305	409
2.25	4.33	693	305	388	4.24	678	305	373
2.50	4.18	669	305	364	4.04	646	305	341

Source: Keller, Sawant & Mulik



Source: Adapted from Keller, Sawant & Mulik

Figure B.3 Relationship between unit water supply and annual income and irrigation costs of wheat with surface irrigation

4.B.2 Net benefits with traditional Irrigation

To determine the net benefits with irrigation, we must subtract the cost of irrigation from the gross benefit curve. These costs are estimated for Wheat irrigation by surface gravity system in Maharashtra State in Annex Figure B.3.

Elements of the cost of irrigation would include the sum of the initial preparation cost for leveling and putting in irrigation channels and facilities, the seasonal maintenance cost of laying out the bunds and small field channels, the labor cost of applying the individual irrigation, plus any water charges. Furthermore, if pumping was involved, the cost of maintenance and operation of the pumping plant would have to included. But we did not assume that pumping was necessary for a traditional irrigation system analysis. Actually, if pumping were involved, it would look very similar to an additional water charge.

Figure B.2 must be interpreted very carefully because information for both long and short run costs are combined. Curve F is a long run planning curve (L.R. variable costs) showing different levels of investment that would be required for furrow irrigation, given the available water supply. ONce an investment has been made, the seasonal fixed costs would be a constant (F') for an investment aimed at dealing with a range of supplies centered on a unit water supply of 1.5. The curves, W, M, and L are seasonal variable cost curve.

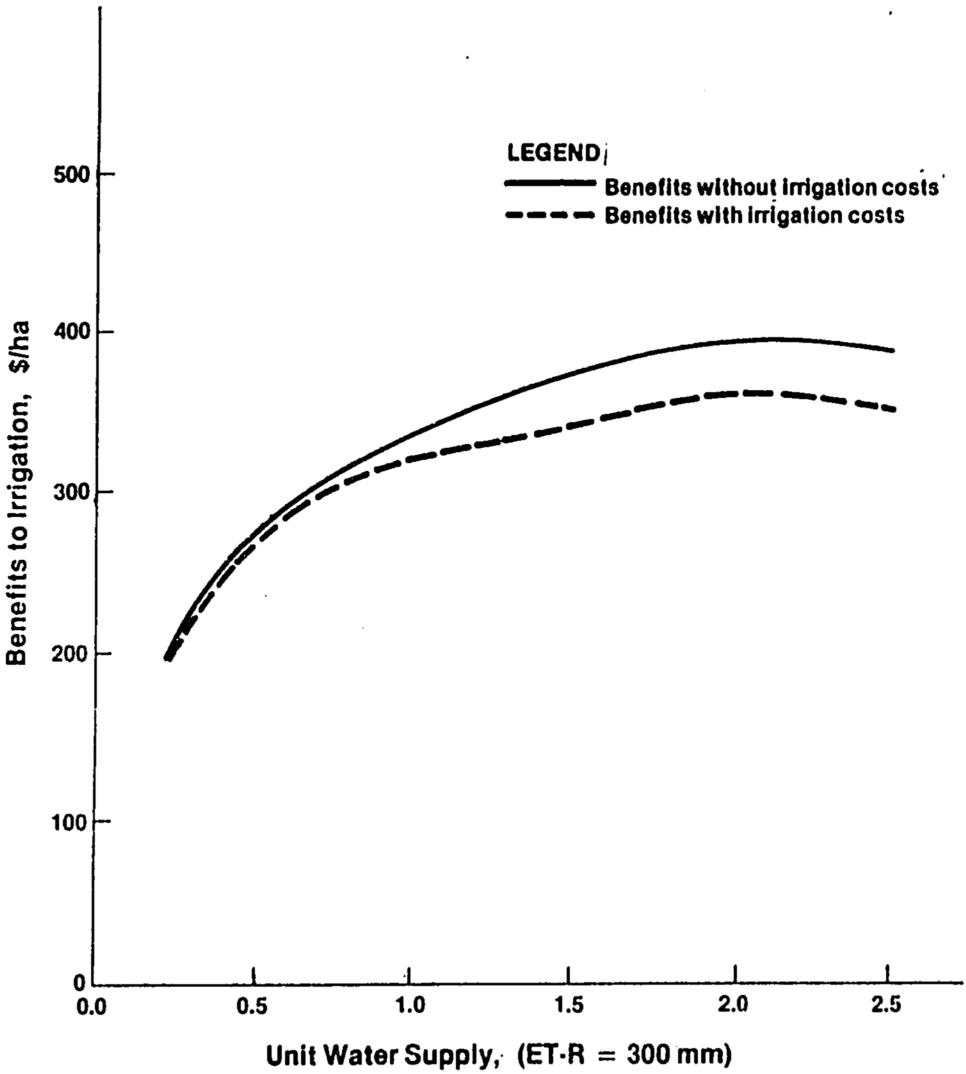
Thus, the summations represented by T_o and T are for planning purposes, they help define the most profitable level of investment. In this case, somewhat in the zone to the right of (x), assuming the water supply will be available. On a seasonal basis the total on-farm irrigation costs represented by T' and T_o'apply. The heavy lines T and T' represent the variable planning or seasonal costs (respectively) of irrigation with a water charge (w) of $0.5 per hundred cubic meters (Jain, 1981).

We based our initial investment on the reports by Agarwal (1979) and Anonymous (1982b) in preparing the land for irrigation at $800 per hectare for more or less precision traditional methods, and $120 per hectare for ordinary traditional methods. Using a capital recovery factor of 0.1, and assuming different degrees of system perfection for spreading the water with varying levels of water supply, we obtained the fixed cost.

Viewing the data from the standpoint of long-term investment in leveling impovement by the range of simple to more complex, but still traditional tractor methods, we may net out the long-run irrigation investment costs shown in Figure B.3 to create the expected net annual long-run profit curves shown in B.4. The difference between the curves is due to allowance for annuual water fees.

4.B.3 Net benefits with sprinkler technology

We have done a similar analysis for a hand-move hose-fed sprinkler system, again operated in the central portion of the state of Maharashtra. The production function was the same as for Figure B.1. Allowing for suitable adjustments for the expected coefficient of uniformaity, the production data shown in Table B.1 result in a gross benefits function as shown in Figure B.4. In this figure, the cost data we used for the fixed maintenance, pumping and labor are as follows.



Source: Adapted from Keller, Sawant & Mulik

Figure B.4 Relationship between unit water supply and net benefits with surface irrigation--long-run planning curves for wheat

Based on the note of the Irrigation Department, Government of Maharashtra (Anonymous, 1982c), the average fixed cost of hand-move hose-fed sprinkle system with electric motor (assuming 15 years life) would be $600/ha. The pumping cost with total pressure head of 30 m, pump efficiency 70 percent, motor efficiency 90 percent, assuming discharge of 10 ms/hr and electricity charges of $0.04/kw-hr, would be $0.05/ha-mm. Assuming 15 minutes to move a sprinkler irrigating 200 sq mt/set, applying 60 mm of gross water, and labor charges at the rate of $0.15/hr, the labor cost would be $0.03/ha-mm.

Operation and maintenance would involve fixed and variable costs. Assuming operation and maintenance of hose and sprinkler as $50/year, and that for electric motor and pump as $10/year, the total cost on O&M would be $60/year, out of which $30/year would be fixed and $0.03/ha-mm would be variable assuming 1,000 mm application. The water charges would be the same as assumed previously.

In Figure B.5, the investments in higher technique are assumed to already have been made, consequently only variable costs are shown. (The idea of a planning function in connection with selecting investment in a higher techniques is illustrated in Figure 9.) Figure B.4 itself may be compared with Figure 10 in the main text.

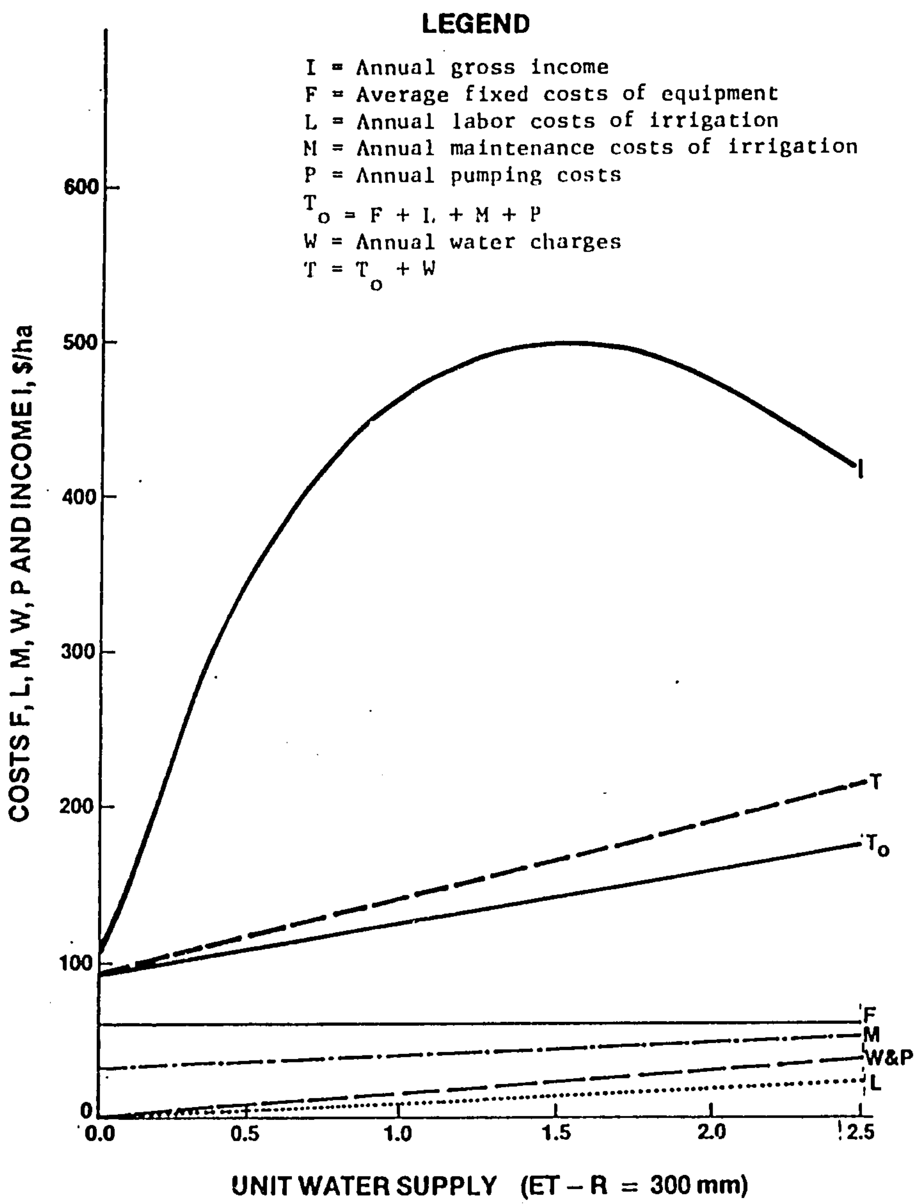
In the case of pressurized irrigation systems, the optimum income is obtained in the vicinity of high efficiency irrigation. It seems that this woild always be the case, but further investigation of a range of empirical results is warrented.

4.C Data for Figure 6

	UNIT WATER SUPPLY				
CURRENT	0.5	1.0	1.5	2.0	2.5
Profit/ha $	210	388	445	425	305
Ha Equiv.	1.0	0.5	0.333	0.25	0.20
Earnings	210	194	148	106	61

Source: Fig. 2

	UNIT WATER SUPPLY				
W/INVESTMENT	0.5	1.0	1.5	2.0	2.5
Profit/ha $	200	320	371	380	300
Ha. Equiv.	1.0	0.5	0.333	0.25	0.20
Earnings	200	160	123	95	60



Source: Adapted from Keller, Sawant & Mulik

Figure B.5 Relationship between unit water supply and income and irrigation costs for hand-move, hose-fed sprinkle irrigation on wheat

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OPERATION AND MAINTENANCE COSTS

by

Juan A. Sagardoy[1]

1. INTRODUCTION

In the irrigation sector, the 1980s have been characterized by a marked interest in the performance of existing irrigation schemes. Although in most of the evaluations the considerable contributions made by irrigation in economic terms and welfare obtained by the benefitted farmers are recognized, there is also a general concensus on the need for improving irrigation performance. Often, deficient operation and maintenance of the system are identified as a major reason for poor performance, and insufficient financial resources are given as a chief reason for the improper service provided.

Consequently, the notion seems to have spread that substantially increasing the water rates will automatically result in a better operation and maintenance service and thus the overall performance of the scheme will improve.

Although we recognize that suitable operation and maintenance services require considerably higher water rates than those existing in many instances, there is no guarantee that higher water rates will automatically improve the operation and maintenance and the overall performance. In other words, increased water rates are often necessary but must be accompanied by suitable institutional changes and improved management capabilities in order to upgrade the standards of the O&M Service.

A further consideration is that before attempting to increase water rate serious consideration must be given to the possibilities of reducing actual O&M costs. This is often a much more viable alternative. In order to visualize some of these possibilities the paper analyses the influence of the different components of the O&M costs and their corresponding weight in some selected cases.

The other point to be examined in detail is that the improvement of the O&M Service does not necessarily mean that the overall performance of the irrigation scheme will improve in a noticeable way. Again, a number of additional measures or services are often needed - particularly in the early years of the life of an irrigation scheme - to guarantee a proper functioning of the scheme. The financial implications of these additional services cannot be ignored.

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Finally, in order to have an insight into the possibilities for the farmers to pay water charges, their effect on the production costs of some selected crops is analysed.

However, before entering into the discussion of some of the mentioned issues it seems necessary to review certain concepts associated with operation and maintenance.

2. WHAT IS ACTUALLY MEANT BY OPERATION AND MAINTENANCE COSTS?

The concept of O&M costs is often used in a loose manner meaning the sum of all costs associated with the distribution of water and maintenance of the irrigation infrastructure. However, large differences exist among the irrigation/drainage infrastructures to be covered by O&M activities in different projects and also in the activities which are considered as O&M by the management of the scheme. These two factors alone are already responsible for wide variations in O&M costs among irrigation schemes even within a given country. These factors are reviewed below.

2.1 Physical Systems of an Irrigation Project Needing O&M Activities

An irrigation project may include several or all of the following systems:

a. Water distribution system, made up of several or all of the following elements: (i) dam; (ii) diversion dam; (iii) pumping stations; (iv) main canal or conduit; (v) secondary canals or pipes; (vi) tertiary canals (watercourses); (vii) well and pumping units.

b. A drainage system, comprising some/all of the following elements: (i) farm drains (pipes or canals); (ii) secondary drains (pipes or canals); (iii) primary drains (canals); (iv) collectors; and (v) pumping stations.

c. A road system, for servicing the water distribution and drainage systems and facilitating access to farms.

d. Buildings (offices, stores, workshops, etc.) necessary to undertake the activities regarding the functioning of the above mentioned systems.

The question arising here is **whether O&M costs should cover the expenditures related to the 4 systems (water distribution, drainage, roads, buildings) or only those directly related to water distribution.** It is believed that most of the countries reporting on O&M expenditures refer to those arising from the water distribution system and the buildings. However, we feel that the drainage system is an inseparable component in the management of water and should also be included as part of the O&M costs.

As to the road system, the roads which are used specifically to service the canals should be maintained by the project, but those of multipurpose use should be excluded from the O&M costs.

The subject is further complicated by the fact that some of the elements of the water distribution system, like dams, can be of multipurpose use and the distribution of O&M costs among the different uses may be rather arbitrary.

2.2 O&M Activities

A number of activities are required to allow physical systems to perform their functions adequately and these are listed below:

(i)	Overall Management	-	Directing and supervising all activities
(ii)	Planning	-	Matching supply and demand (yearly crop plan)
		*	Matching financial resources and expenditures (annual budget)
(iii)	Implementation	*	Handling of structures to deliver water requirements
		*	Processing information to meet water needs
		*	Maintaining all the physical systems for which the O&M units are responsible
		-	Enforcing the rules and regulations of the system
(iv)	Monitoring	-	Recording water deliveries and effected maintenance
		-	Recording irrigated areas, crops, yields
(v)	Administrative Control	*	Financial control of revenues and expenditures
		*	Personnel management
		*	Purchasing of supplies
		-	Control of stocks (in stores)

The above list of activities should be undertaken in all cases but unfortunately this is more the exception than the rule. In most instances only the activities marked with an asterisk are carried out.

Assistance to farmers to improve farm irrigation is an activity sometimes carried out (Mexico, Spain, Cyprus), but in spite of its importance this is frequently not the case. Costs associated with this activity are not included as O&M but considered as training and are often not charged to farmers.

2.3 Working Resources

In order to carry out the activities, the management of the schemes needs the usual working resources:

- personnel (management, professional, technical, clerical, skilled labour, unskilled labour);
- materials and supplies;
- equipment (heavy, medium and light equipment);
- energy and public utilities (telephone, water);
- buildings (offices, stores, workshops, etc.);
- financial resources to cover other expenditures, like rentals, loans, indemnities, etc.

Some of the costs inherent to the working resources are fixed (independent of the volume of water supplies) and others are variable (depending of the amount supplied).

A breakdown of expenditures into fixed and variable is given below:

Personnel		Fixed	Variable
1.	Salaries and fringe benefits	X	
2.	Travel and subsistence	X	
Materials and supplies			
3.	Materials (wood, cement, office equip., etc.)	X	X
4.	Supplies (tyres, fuel, stationery, food, etc.)	X	X
Equipment			
5.	Depreciation cost	X	
6.	Spares	X	
7.	Repairs	X	X
8.	Hire of equipment		X
Energy and public utilities			
9.	Electricity/petrol for pumping stations		X
10.	Water (purchased)		X
11.	Telephone - head, light.	X	
Offices, stores, workshops and other buildings			
12.	Amortization cost	X	
13.	Repairs/maintenance	X	X
14.	Rents	X	

Others

15.	Indemnities	X	
16.	Payment of loans	X	
17.	Contributions	X	
18.	Emergency repairs		X

It is interesting to note that most of the expenditures belong to the fixed category - or at least those having a greater weight in the total expenditure. This is one of the reasons why a considerable reduction/increase in the water diverted is likely to have a reduced effect on the overall O&M costs, except in cases where the water is pumped and therefore the energy component is very important.

2.4 Functional Units

The activities, together with some of the working resources, are often grouped in functional units in order to have a better organization of the work to be done. The most common grouping is indicated below.

Operation and Maintenance Service	- Director/Manager's Office - Water Distribution Unit - Maintenance Unit - Administration Unit

For medium-sized irrigation schemes these units are not clearly differentiated and the staff of the O&M Service perform functions pertaining to both water distribution and maintenance.

Often, the irrigation schemes of a given area - generally within a river basin - are too small to justify such organization. In these cases a central O&M Service is established - often called "Irrigation District"[1] - which provides common services for all the irrigation schemes of the area (basin), although small water distribution units exist in every scheme. This type of "Irrigation District" not only carries out the functions that are inherent to the O&M Service but often it also performs some watershed conservation works in order to maintain favourable conditions for the off-the-river diversions. This type of work is sometimes considered part of the O&M expenditures. The corresponding organization appears quite suitable for small watersheds but it certainly implies higher expenditures than those which, strictly speaking, are considered as O&M costs.

The picture emerging from the former review of the elements integrating the O&M Costs is that of a great diversity of physical systems covered by this concept and a variable number of activities undertaken in some cases but not in all. Therefore **the need for some standardization in the concepts appears necessary, or at least the need for describing which system and activities are covered by the reported O&M costs**, so that their exact meaning can be understood.

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[1] This concept of an irrigation district is somewhat different from that commonly accepted in the USA where irrigation district might refer to an irrigation scheme inside a basin, certain selected schemes or only some sort of financing entity.

3. O&M COSTS AND WATER CHARGES

The working resources mentioned before, i.e. personnel, equipment, material and supplies, energy, transport and others, have some inherent costs, the determination of which is rather straightforward, except in the case of equipment. In this case, the annual costs, corresponding to the depreciation of the equipment or replacement costs, are rarely included; only those necessary for operation are considered. The implication of this policy is that at the end of the working life of the equipment there is no capital for replacement, and since governments are under financial constraints they cannot provide it either. At this time, the consequence is that the maintenance of the scheme is not effected properly, as most of the equipment is used for this purpose. **Here again the need for some standardization as to how to calculate tne costs of equipment appears useful.**

In principle, the O&M costs should be more or less equal to the corresponding part of the water charges[1] imposed on the farmers for this concept, but often there are large differences, the water charge being considerably lower than the actual costs (see Table 2). In particular, the salaries of government staff engaged in the O&M Service are often not charged. As farmers are mostly not charged for the personnel cost component, this represents a large subsidy. If they are eventually going to take up this responsibility they must be prepared to face a considerable rise in water charges by this mere fact.

In theory, the water charges corresponding to the O&M costs should be somewhat higher than the O&M costs, the reason being that this policy will allow the building up of a "reserve fund" to cover any expenses for unexpected failures/damages in the physical systems or to carry out some improvements.

Another factor contributing to the disparity between costs and charges arises from the fact that expenditures incurred in one given year are not recovered through water charges until the following year or the year after. In countries with substantial inflation this means a considerable reduction in revenues for the scheme. **Adjustment of the water rates to inflation is an issue that requires attention.**

There are other issues related to allocation of the costs to be charged to farmers, such as **which bases should be utilized for charging: command or irrigated area; hectare; amount of water diverted or delivered per cubic metre; a double (fixed and variable costs) or a simple charge (fixed + variable costs), but they belong more to the domain of other papers** to be presented at the Consultation.

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[1] Here the water charge is understood as the amount paid by the farmer to cover the recovery of the investments - although in most cases this is a small contribution or even non-existent - plus the O&M share.

4. WATER CHARGES OR SCHEME RUNNING CHARGES?

With the present concern for water charges, the notion seems to spread that if proper funding is available for O&M activities the overall performance of the scheme will automatically improve and farmers will utilize the water better and increase their production. Although we do not deny that this may be the case in areas where farmers have great experience with irrigation water, there are many other instances - particularly in relation to new schemes - where this is not the case. In fact, even projects with a long life, when evaluated, prove that they have been suffering chronically from deficiencies which require major changes in the organizational structure and have substantial implication in the costs of running the scheme.

This may be better illustrated by the example of the Pisque Irrigation Scheme of Ecuador where a substantial effort has been made to prove that **it is necessary to coordinate a large number of activities which go far beyond the operation and maintenance of the scheme in order to produce an authentic agricultural development** in the project. In fact, in addition to strengthening the O&M Service the project has implemented the following services: (a) three workshops on mechanization, metalwork and woodwork; (b) a social department for implementing and encouraging the establishment of water users' associations; (c) an agriculture development department aimed at providing advice to farmers on irrigated agriculture; (d) a mechanization unit to rent services to farmers; (e) a revolving fund for fertilizers; (f) a fruit nursery; and (g) a reforestation service (the area is affected by serious erosion problems). The services for mechanization, fertilizers, the fruit nursery and reforestation have an autonomous management but all are coordinated within the "overall management of the scheme" where each of these units/departments is represented.

The total investment costs necessary to develop these services and to rehabilitate the irrigation system were US$ 1 087 per irrigated hectare (see Table 1) but 90 percent of these costs were invested in the rehabilitation of the irrigation scheme and only 10 percent in the facilities/equipment needed for the above described services. This indicates the importance of taking an integrated approach when attempting rehabilitation of an irrigation network, since the basis for suitable agricultural development can be established with relatively small additional investments.

Table 1 also describes the foreseen average annual expenses for a five-year period (1983-87) of each of the services provided and the expected revenues at the rates prevailing in 1983 and illustrates that some services are nearly self-financed (mechanization, fertilizers, fruit nursery, O&M) but others have large deficits, as they do not generate a visible income. The expected total deficit (12.1 million sucres) represents an increase of about 100 percent over the existing payments but amounts only to US$ 52/ha (at values of 1986). This increase in the rate permits the small deficit of the autonomous services to be absorbed, the financing of some rehabilitation works and the financing of those services which are necessary but do not generate direct income.

The government had two alternatives, either to subsidize this deficit or increase the water charges to make up the difference. In this latter case, the water charge is no longer a charge for water but for running the scheme and providing some services which are indispensable to produce the expected agricultural development. This is particularly relevant when considering that more than 50 percent of the farmers have less than 1 hectare and therefore a reduced capacity to invest and improve their productivity.

The question raised here is **whether it is more important to have "running of the scheme charges" or "water charges" when the overall final objective is to improve the performance on the entire scheme.** The advantage of such rates is that a redistribution of the income takes place within the scheme, as all the farmers (small and large) pay for the services but the ones benefiting more directly should be small ones. Another advantage is the considerable employment generated (3 timea more than for O&M activities, see Table 1), of people requiring a certain degree of technical specialization.

As to the farmers' capacity to pay for these additional services, the analysis of the margin (gross income less direct cost) indicated that the increase of the rate will only reduce the margin by 4 to 2 percent for the tomatoes and avocados and by 10 to 8 percent in the case of potatoes, maize and beans, which are the predominant crops of the scheme, and therefore the implementation of the suggested charge appears quite feasible.

5. RELATIVE IMPORTANCE OF THE WORKING RESOURCES IN THE AGGREGATION OF O&M COST

In order to analyse the possibilities for reducing O&M costs it is necessary to have a clear notion of the corresponding weight of the working resources in the aggregation of O&M costs. For this purpose their importance is analysed in the light of two examples (Tables 2 and 3) corresponding to the experience of selected irrigation schemes in Jamaica and the USA respectively.

5.1 Personnel Costs

For **gravity irrigation schemes** (RCIW[1] in Jamaica and all of them in the USA), this component is by far the largest, ranging in value from 63 to 71 percent of total expenditures[2]. Our experience from other countries is consistent with these figures and rarely goes below 50 percent of costs.

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[1] RCIW = Rio Cobre Irrigation Works.

[2] Much lower values are given for the Tulare and Lower Tule irrigation projects in Table 3 but these values are distorted by the high value of the "others" component under which large amounts of water have been purchased from other districts.

It is interesting to note that there is not much difference between the figures for developing and developed countries. Apparently the greater efficiency in the use of personnel in a developed country is offset by the greater salaries and travel costs.

As personnel is the largest component of the costs, the greater opportunity for reducing the O&M expenditures is in this item. Therefore particular attention should be paid to using staff in the most efficient manner. **This indicates the importance of dedicating greater effort to determine manpower requirements for the major O&M activities so that overstaffing and related deficiencies can be more easily identified.**

The other interesting implication is that personnel is a fixed cost (not depending on the amount of water used) and therefore greater or smaller efficiency in water distribution is bound to have a limited effect on the overall O&M costs. In other words, the water distribution efficiency is less important than the efficient use of the staff as far as costs are concerned in gravity irrigation systems. However, there are other technical considerations (shortage of water resources) which can invalidate or reverse this argument.

For irrigation schemes requiring pumping of all the water used the personnel component immediately loses its primary importance. In fact, Table 2 illustrates that in pumping schemes (SDIS, MCIA and HIA[1]) the personnel component is down to percentages that range between 13 and 23. This fact is analysed in more detail in the next section.

5.2 Energy Costs for Pump Projects

The importance of energy costs in the total O&M expenditure is highly dependent on the total lift and the volume of water pumped. Therefore great variations in costs can be found. In the case of Jamaica, where the lift ranges between 15 and 35 metres and the amounts pumped are very large (see Table 2), the energy cost ranges from 61 to 73 percent of the total. Of course, the type of energy used (electricity or fuel oil) and the respective prices have a significant impact on the energy cost.

Not only do the energy costs represent an important component but they tend to increase the overall O&M costs. In the case of Jamaica, the O&M cost for the pumping schemes is more than 10 times that of gravity (RCIW). This may be an exaggerated difference due to some inefficiencies but costs are considerably higher.

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[1] SDIS = St. Dorothy Irrigation Authority
MCIA = Mid Claredon Irrigation Authority
HIA = Hounslow Irrigation Authority

As energy usage is highly dependent on the volume of water pumped, the most immediate way to reduce them is to minimize the water pumped. This can be achieved by maximizing the efficiency of the water distribution system as well as that of the water used on the farm. Contrary to what happens in gravity systems, the efficiency of the water distribution and use becomes the highest priority, if costs are to be reduced. Increasing the overall efficiency may require some efforts in terms of investment to improve the irrigation infrastructure as well as in farmers' training to reduce water use at farm levels. **The trade-offs between these investments and the saving on energy costs need to be analyzed in each case.**

5.3 Materials and Supplies

The weight of this component in the total O&M cost ranges from 10 to 22 percent for the surface irrigation schemes of Tables 2 and 3 (exceptions are made of Tulare and Lower Tule in which values are distorted by the "other" component). It is much smaller (4 to 8 percent) in pumping schemes. Therefore their impact on the overall O&M is in any case limited and savings/reductions made in this component are liable to have a limited effect as far as costs are concerned.

However, in some developing countries it may be important to use local materials and national supplies rather than imported ones, which are often not easily available or their importation requires long periods. These delays may have a more detrimental effect on the undertaking of certain activities than the greater or smaller cost of the item.

5.4 Equipment

The cost of equipment is made up of several components: depreciation, operating costs and repairs. The first item, as mentioned earlier, is rarely considered when reporting about equipment costs. In any case, the weight of this component appears surprisingly small for the two cases analysed, with values below 4 percent in most cases for gravity schemes. It is somewhat higher (9-12 percent) in the case of pumping schemes, which is logical as the amount of equipment (particularly pump-sets) is considerably larger.

If the above pattern is a generalized one it could be concluded that equipment has little impact on the overall costs and therefore offers little room for reducing costs. However, this apparent conclusion will need a more in-depth analysis to be generalized. To add complexity to this component, one has to realize that labour is often used to undertake some works that could be effected by equipment. The costs inherent to this labour may appear under "personnel", further distorting the relative weight of the two components.

5.5 Others

This is often a very small component but there are a few cases (Table 3, Tulare and Lower Tule scheme) when it can assume large values (over 50 percent of the total). This corresponds to the fact that sometimes a project has to buy water from another project where there is a surplus. As this water is often acquired at a high cost, the opportunity for reducing this purchase should be carefully studied.

6. RELATIVE IMPORTANCE OF O&M ACTIVITIES IN THE TOTAL O&M EXPENDITURE

Another way to look for possibilities of reducing O&M costs is to break down the total costs into major activities and analyse their weight in the total costs. This has been attempted in Table 4 and the following average distribution can be observed:

Operation	45%
Maintenance	24%
Monitoring/Supervision	6%
Administration	12%
Others	13%

Basically all the expenditures made for Operation correspond to personnel emoluments, therefore the remarks made earlier apply here.

The question can be raised here if the operation costs can be reduced by implementing an automatic system of water distribution (on demand). Although this appears possible, experience with "on demand" irrigation systems in developing countries has proved quite troublesome and perhaps the reduction in the operation cost has been largely compensated by an increase in repairs and the need for maintenance.

With regard to **maintenance** costs, the **issue arises as to what extent it is worthwhile to line canals in order to reduce maintenance costs.** To illustrate this, Table 5 shows that maintenance of lined canals or pipes is 34 percent cheaper than that of unlined canals. However, this lower cost has sometimes no apparent effect on the total maintenance costs. The Tulare scheme has a maintenance cost of US$ 20/ha (see Table 4) and 88 percent of the total length of the irrigation network (467 km) comprises unlined canals, while the San Joaquin scheme has 94 percent of the total length (560 km), is made of lined canals or pipes and has a maintenance cost of 23 US$/ha. On the other hand the Merced System has a lot of unlined canals and yet the maintenance cost is 35 US$/ha. These indicate that lining of canals tend to produce lower maintenance cost but there are other factors that may alter this conclusion.

Another important issue is the trade-offs between maintenance machinery and labour with particular reference to developing countries. Questions like what type of maintenance works can be more effectively carried out by labour or machinery have not been satisfactorily answered.

Monitoring and supervision costs are only 6 percent of the total but represent a very important activity. Rather than reducing this cost, efforts should be undertaken to make it really effective.

The **administration** cost is made up essentially of personnel. The reduction of this cost can be obtained by using simple operative procedures which will eventually require less staff. Complex administrative procedures and lack of automation of offices produce unnecessarily heavy administration costs. The use of personal computers with their reduced price could really help to reduce administration costs.

Finally, the question arises whether the above-mentioned distribution would be entirely different in a developing country. We have little information on this issue but indications are that the distribution is rather consistent, with a tendency to have greater values for O&M and much lower for the remaining components. This may be clarified by the country reports presented at the Consultation.

7. DELEGATING TO FARMERS THE RESPONSIBILITY FOR OPERATING SOME PARTS OF THE SYSTEM

If the governments of the developing world are forced to reduce public expenditures, it is likely that their contributions to O&M expenditures will be reduced in the future. In practice, this means that either the farmers will take over the entire responsibility for managing the irrigation, and this will certainly imply much higher water rates, or the farmers will take responsibility for only some parts of the water distribution system while governments keep the remaining part. This latter alternative seems to be logically preferred as delegating the responsibility for running a large scheme to farmers is not only a financial question but also a matter of having people suitably prepared to take up this difficult and complex burden.

In fact, in several Asian countries the operation and maintenance of tertiary and quaternary canals have already been transferred to farmers, as for example in Indonesia. **What is the financial implication of this transfer of responsibility?** Very little information is available on the topic but in order to have a first approximation of the cost involved, a theoretical calculation has been made in Annex 1 to evaluate the O&M costs of a tertiary canal under the Indonesian conditions.

The O&M costs for a tertiary canal irrigating 150 ha are distributed as follows:

	Rp	%
Operation	81 000	9
Maintenance	735 000	80
Others	100 000	11
Total	916 000	100

The total expenditure represents a cost of Rp 6 106/ha (US$ 5.47/ha). This value is about 50 percent of the total government allocation for the O&M activities in the period 1984/85 (Rp 11 512/ha). This illustrates the importance of delegating the management of this part of the system to farmers under the Indonesian conditions. Another way to visualize this importance is that the mentioned cost per hectare is equivalent to 8/9 mandays/ha/year.

Indeed, a major effort is needed for evaluation under other conditions so as to see the consistency of these results. It is, however, interesting to note that in developed countries the tertiary canals are often lined or replaced by pipes requiring very little maintenance. Under these circumstances the transfer of this responsibility does not appear economically significant.

If farmers can operate tertiary canals satisfactorily, the question arises why not secondary, primary and eventually the whole water distribution system. This involves two sets of questions: one is the technical capability to do the work and the other is the economic advantage of doing so.

Experience elsewhere (Spain, Korea, Italy, USA, etc.) proves that farmers can run very large irrigation schemes but often long periods are needed for this complex activity to be fully transferred to them.

The economic advantage of this transfer to the farmers is not so clear, as for large irrigation systems a considerable number of professional and technical people are always needed and cannot be replaced by farmers. The advantage may be that these people, being responsible to farmers, are likely to perform more efficiently than the public servants but on the other hand in government-run schemes there are hidden subsidies for which the farmers do not pay. In our opinion the economic advantage is more for the government which divests itself of a heavy annual expenditure. The farmers gain is more in terms of self-reliance and independence to solve their own problems within a fully democratic system.

8. HOW TO INCREASE REVENUES TO FINANCE O&M COSTS?

In the former sections of this paper, we have been particularly concerned with the possibilities of reducing O&M costs but is there any chance of increasing revenues which can be utilized to finance these costs? Here are some ideas:

a. The irrigation water can be utilized for other purposes which can generate important revenues. In Thailand, for example, the small dams are utilized for fish production with considerable success. The revenues arising from this activity are distributed among the benefitting community and cover some costs of the O&M.

b. Maintenance machinery is often underutilized as it is dedicated only to the maintenance activities of the scheme. In some cases (Peru) the establishment of a machinery pool that also provides services to private people outside the system has proved a highly viable enterprise, reducing maintenance costs.

c. Can the irrigation system generate part of its energy requirements? Burning some agricultural residues (rice husks, straw, etc.) has proved a viable alternative in some cases. Some of the canals occasionally offer good conditions for mini-hydropower stations.

d. Why should farmers pay for all the irrigation costs when a much larger community benefits from the irrigation system? It is conceivable that any person trading with the irrigation scheme could pay a sort of "value added tax" that would be reverted to the scheme.

e. The value of irrigated land is much higher than the non-irrigated and, in many parts of the world, farmers do not reimburse irrigation investment costs. Therefore, when it becomes irrigable because of new irrigation systems and this land is later sold, the seller makes a large profit (since he has not returned the investment). It would be fair in such cases to impose a tax on the seller that could be reinvested/reused in the irrigation system.

There are certainly other possibilities but too little attention has been dedicated to them. It would be important to analyse and collect at least the existing successful experiences.

9. IMPACT OF IRRIGATION COSTS ON THE FARMER'S INCOME

It seems socially and economically correct that farmers pay for the services associated with the distribution of water, provided that these services are effective and there are no substantial mistakes in the design of the system which can take a heavy toll on the O&M costs. Nevertheless, this sound policy cannot be implemented in an indiscriminate manner, as there are many instances in which some of the farmers of a given irrigation system may not have the capacity to pay for the real O&M costs. **Therefore it is always important to check the farmers' repayment capacity** - particularly of those having smaller financial capacity - **before proceeding to the implementation of water rates.**

In order to better visualize the effect of irrigation costs on the income generated by crops, an example has been worked out in Table 6. All the data are taken from a detailed study of the crop production costs undertaken by the FAO/UNDP project "Development of Irrigated Agriculture Production" (PAN/81/011). The data correspond to the Herrera Region where average precipitation is 514 mm/year and temperature throughout the year is 26°C. Two different seasons can be differenciated: the wet season from May to November concentrates 95 percent of the rainfall and the dry season (December to April) the rest. Crop production is possible in both seasons provided the water requirements can be satisfied.

Three scenarios have been elaborated in order to see the effect of different water charges policies. The first scenario corresponds to a water charge of US$ 0.01/m³ which is considered a "fair charge" and includes a partial recovery of the investments. The second is considered as a "high price" (US$ 0.02/m³) and corresponds to the total recovery of investments in addition to O&M costs. Lastly, a flat rate per hectare and season of US$ 30 has been applied, which represents the present rate paid in some schemes. The conclusions for each scenario are discussed below.

i. <u>First scenario (US$ 0.01/m³)</u>

a. All the wet season (WS) crops have a higher income than the same crops grown in the dry season (DS). This appears logical as the DS crops have much higher irrigation requirements than the WS crops. This indicates that the O&M costs together with the labour irrigation costs heavily penalize the DS crops.

b. The impact of total irrigation cost on net income or on total production costs is very important for rice and maize while it is negligible for horticultural crops. This indicates that horticultural crops are only marginally affected by irrigation costs and therefore farmers using water for these crops are not likely to react to moderate changes in the charges for water. This raises the question of why to charge water per m³ in the case of horticultural crops if farmers are not financially motivated to save water.

c. Table 6 shows that the labour irrigation cost[1] is a very small component of the total costs. Therefore, the opportunity for replacing labour by some modern irrigation

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[1] This refers to the cost of labour utilized for applying the irrigation water on the farm.

methods (localized, sprinkler, etc.) is very small. This is particularly relevant in developing countries where the cost corresponding to amortization of the equipment is likely to be higher than the labour irrigation costs. However, there may be other important reasons (limited water supply, unavailability of labour, reduction of effort, etc.) which may lead to the adoption of modern irrigation techniques.

ii. Second scenario (US$ 0.02/m^3)

a. The application of this water charge implies that DS rice is uneconomical (negative net income) and DS maize generates a net income of only US$ 84/ha. The practical implication is that rice and maize cannot be grown economically during the dry season. The problem of what to grow instead becomes a serious one, since soils used for rice cannot be utilized for many other crops. Therefore a change in the water charge should not be implemented without carefully studying its effect on the crop pattern of the irrigation scheme.

b. This scenario stresses some of the conclusions (a and b) already described in the first scenario. It is interesting to note that at this price, there is no point in trying to become more efficient in the use of water for rice: a reduction of 40 percent of the irrigation requirements would still give a negative income.

iii. Third scenario (US$ 30/ha/season)

a. Under this hypothesis the total irrigation costs tend to augment for the wet season crops and decrease for the dry season crops. The result is that the net income of the wet season crops tends to be smaller (compared with the first scenario) while that of the dry season crops increases substantially. In fact, this alternative has some equilibrating effect on the irrigation costs between the wet and dry season crops, and also among the crops with high and low water requirements.

b. Under this alternative the dry season rice and maize again become profitable, while the income from horticultural crops is hardly affected. If the government policy is to produce rice and maize - as it was in the past in Panama - this water charge represents a viable alternative to increase, or at least not to reduce, the areas dedicated to their production.

This last scenario points out an interesting solution to **the problem** mentioned earlier of **some farmers not having enough payment capacity to afford the real O&M cost.** It would be conceivable that these farmers pay a much lower water charge than other farmers being in a better financial position. In a way this solution implies that the "better-off" farmers to some extent subsidize the irrigation expenditures of the poorer farmers. For this purpose a flat rate per hectare appears a more useful tool than payment per cubic metre.

Although the above conclusions apply to a particular region of a given country, it is believed that similar important conclusions can be derived from the study of the production and irrigation costs of the different irrigated crops in other countries. This information would be extremely valuable when trying to determine suitable water charges.

TABLE 1

INVESTMENTS AND RUNNING COSTS OF THE PISQUE IRRIGATION PROJECT (ECUADOR)

	Investment Rehabilitation & Improvement	Average annual expenditure (1983/87)	Average annual revenue (1983/87)	Financial Deficit	Number of persons employed
	....	1 000 Sucres	....		
General Administration	4 240	2 225	-	2 225	11
Topographical Surveys Unit	445	463	-	463	4
Workshop	2 981	1 753	-	1 753	13
Social Department	393	325	-	325	2
O&M of Irrigation Network	225 621	5 229	4 803	426	35
Agriculture Development Dept.	4 185	2 983	105	2 878	17
Agriculture Mechanization Dept.	4 491	1 393	1 168	225	6
Revolving Fund for Fertilizers	2 473	2 391	2 391	-	-
Fruit Development Programme	1 291	470	394	76	5
Reforestation Programme	5 539	4 261	2 882	1 379	18
Rehabilitation of canals (investment)	-	2 205	-	2 205	n.a.
Purchasing of land for nursery (investment)	-	190	-	190	n.a.
TOTAL	251 669	23 888	11 743	12 145	111
Average total cost per ha (Sucres)[1]	47 937	4 550	2 237	2 313	
Average total cost per ha (US$)[2]	1 087	103	51	52	
Actualized average cost per ha (US$)[3]	1 380	131	64	67	

Source: Nagant D "Organización y significación económica de un proyecto de riego - caso del proyecto Pisque Tropicultura, 1984, 2, 2, 60-66.

[1] Irrigated area: 5 250 ha
[2] At a rate of 1 US$ = 44,1 Sucres prevailing in 1983
[3] Actualized to 1983 with the US Bureau of Reclamation Index (1.27)

TABLE 2

O&M COSTS FROM SELECTED IRRIGATION SCHEMES
(JAMAICA)

	Unit	RCIW 1/	SDIA 1/	MCIA 1/	HIA 1/
Irrigable area	ha	14 200	1 900	4 500	800
Irrigated area	ha	9 400	1 130	2 830	670
Total water diverted/pumped	10 m³	111	20	75	7
Average water use	m³/ha	11 808	17 785	26 501	11 046
O&M Cost per Irrig. hectare:					
1. Personnel 4/	US$/ha,(%)	17 (71)	42 (13)	64 (16)	87 (23)
2. Material & supplies	US$/ha,(%)	4 (17)	15 (4)	31 (8)	16 (4)
3. Energy	US$/ha,(%)	1.5 (6)	230 (73)	281 (70)	233 (61)
4. Maint. of equipment	US$/ha,(%)	1 (4)	28 (9)	25 (6)	44 (12)
5. Others	US$/ha,(%)	0.5 (2)	-	4 (1)	-
6. Total O&M costs/ha	US$/ha	24	315	405	380
7. Total O&M costs/m³	US$/m³	0.2	1.8	1.5	3.6
Present water charge 3/	US$/m³	0.03	0.08	0.13	0.13

Source: Irrigation Water Pricing Policy and Tariffs, FAO, Oct. 1985 (ULG Consultants, Report)

1/ RCIW = Río Cobre Irrigation Works
SDIA = St. Dorothy Irrigation Authority
MCIA = Mid Claredon Irrigation Authority
HIA = Hounslow Irrigation Authority

2/ 1 US$ = 5.78 J$

3/ Irrigation water is sold by yd³/hour at following pices (1983 rates, still apply):
Río Cobre: 12J$/hour
Opens canals: 30 J$/hour
Pressure pipes: 50 J$/hour

4/ Includes travel and subsistence allowances.

TABLE 3

BREAKDOWN OF ANNUAL EXPENSES BY WORKING MEANS IN
SELECTED IRRIGATION SCHEMES
(USA)

	South San Joaquin		Merced		Tulare		Lower Tule	
	US$	%	US$	%	US%	%	US$	%
Personnel[1]	722 000	63	1 457 000	71	371 000	37	300 000	29
Materials	251 000	22	204 000	9,9	80 000	8,2	53 000	5,2
Equipment	10 000	0,8	46 000	2,2	17 000	1,7	91 000	9
Energy	49 000	4,3	188 000	9,2	0	0	0	0
Others	101 000	8,9	151 000	7,4	511 000[2]	52	567 000[2]	56
TOTALS	1 133 000		2 046 000		2 011 000		1 011 000	

Source: Operation, Maintenance and Repair of Selected Irrigation Systems, WB, AGR, Technical Note No.1, 1977

[1] Includes fringe benefits
[2] Includes costs of purchasing water from other districts

TABLE 4

OPERATION AND MAINTENANCE COSTS FROM SELECTED IRRIGATION SCHEMES
(USA)

	(1)	(2)		(3)		(4)		(5)		(6)		(7)	(8)	(9)	(10)
	Irrigated	O&M Costs per irrigated hectare											Water	Water	O&M Cost
	Area	Op.[1]		Maint.		Sup. Eng.		Adm.		Others		TOTAL	Diverted	Use/ha	per m³
	(ha)	$	%	$	%	$	%	$	%	$	%	$	(10 m³)	m³	(US$/m³)
South San Joaquin	26 308	46	46	23	23	12	12	20	20	-	-	100	394	15 000	0.7
Merced	46 676	27	26	35	34	5	5	9	9	25	25	102	849	18 200	0.6
Tulare	25 253	49	54	20	22	3	3	6	7	12	13	90	286	11 300	0.8
Lower Tule	35 490	42	64	12	18	2	3	8	12	3	2	66	331	9 300	0.7
TOTAL	133 727														
Mean Value	33 431	41	45	22	24	6	6	11	12	14	13	90	-	13 450	0.7

Source: Operation , Maintenance and Repair of Selected Irrigation Systems, WB, ACR, Technical Note No.1, 1979.

Notes

- Column (2): includes costs for water development (Pumping), purchased water and transmission and distribution.
- Original values were updated using the O&M index cost (1975 to 1986 = 2.33)

TABLE 5

MAINTENANCE COSTS OF SPECIAL WORKS

	(1) San Joaquin		(2) Merced		(3) Tulare		(4) Lower Tule		(5) Size Range	(6) Mean Value
	Km[1]	$/Km	Km	$/Km	Km	$/Km	Km	$/Km	m^3/s	US$/Km
Maintenance of unlined canals	32	1 085	812	1 113	411	1 361	326	1 511	1.5-28.0	1 267
Maintenance of lined canals	64	724	222	954	-		-		0.4-2.6	839
Maintenance of pipelines	464	897	171	894	56	642	-		0.2-0.7	811
Total lengh of canals/ pipes (Km)	560		1 195		467		326			
Total assets[2]/km	24 526		19 425		4 817		7 039			

Source: Operation, Maintenance and Repair of Selected Irrigation Schemes, WB, AGR, Technical Note No.1, 1979. Figures updated to 1986 using O&M index (2.33)

[1] Km refers to total length of canal/pipelines.
[2] Values of 1975

TABLE 6

IMPACT OF IRRIGATION COSTS ON TOTAL PRODUCTION COSTS AND INCOME
(Selected crops, per hectare, Panama)[3]

	Rice		Maize		Horticulture Crops					
					Water melon		Peppers		Industrial tomato	
	W[1]	D[1]	W	D	W	D	W	D	W	D
First Scenario										
Water charge = 0.01 US$/m³										
1. Irrigation labour costs	31	90	15	53	16	53	5	42	7	44
2. Water charge	44	128	22	78	22	77	8	61	10	63
3. Total irrigation costs	75	218	37	161	38	130	13	103	17	107
4. Irrigation requirements	4 417	12 759	2 221	7 763	2 228	7 646	777	6 049	999	6 281
5. Total Production costs	986	1 129	520	644	1 558	1 636	3 226	3 316	2 631	2 721
6. Gross income	1 208	1 208	775	775	2 862	2 862	6 360	6 360	3 710	3 710
7. Net income	222	79	255	131	1 304	1 226	3 134	3 044	1 079	989
8. Total Irrig. costs/Tot. Prod. Costs (%)	8	19	7	25	2	8	1	3	1	4
9. Total Irrig. costs/Net income (%)	34	(-275)	15	(-123)	3	11	1	3	2	11
Second Scenario[2]										
Water charge = 0.02 US$/m³										
3. Total irrigation costs	119	345	59	208	60	206	21	163	27	170
5. Total production costs	1 030	1 256	542	691	1 580	1 712	3 234	3 376	2 641	2 784
7. Net income	178	(-122)	234	84	1 281	1 150	3 126	2 983	1 068	926
8. Tot. Irrig. Costs/Tot Prod. Costs (%)	12	27	11	30	4	12	1	5	1	6
9. Tot. Irrig. Costs/Net income (%)	67	(-283)	25	(-247)	5	18	1	5	3	19
Third Scenario[2]										
Water charge = 30 US$/ha/season										
3. Total irrigation costs	61	120	45	83	46	83	35	72	37	74
5. Total production costs	972	1 031	528	566	1 566	1 589	3 248	3 285	2 651	2 688
7. Net income	236	177	247	272	1 296	1 273	3 112	3 075	1 059	1 022
8. Tot Irrig. Costs/ Tot prod. Costs (%)	8	12	9	15	3	5	1	2	1	3
9. Tot. Irrig. Costs/Net income (%)	34	68	18	31	5	7	1	2	3	7

Source: Banco de Datos de Cuentas Normativas de Actividades Agropecuarias (Programa P.A.C.C.A.), Documento Técnico No.9. Proyecto de Desarrollo de la Agricultura bajo Riego (FAO/UNDP/PAN/81/011), Marzo 1985, Panamá.

[1] W = Wet Season; D = Dry Season
[2] For the second and third Scenario only horizontal lines that are different from the first scenario are reported
[3] All data from Herrera Region, Panama

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ANNEX I

ESTIMATED O&M COSTS FOR A TERTIARY CANAL
(Indcnesia)

1. DESCRIPTION

The total length of the tertiary canal is 2.5 km and that of the quaternary canals (field canals) is 12.5 km. The area served is 150 ha distributed in 175 farms. The average trapezoidial section of the tertiary canal is 0.7 m^2 capable of carrying a maximum flow of 0.5 m^3/s. The average section of the quaternary canals is 0.05 m^2 and they carry flows in the order of 20 l/s.

2. OPERATION COSTS

One ditchrider ("ulu-ulu") together with one helper can manage the water distribution within the area as it has suitable operating structures. The related annual cost is:

	Rupees
1 ditchrider	
(120 kg rice x 150 Rps/kg x 3 seasons)=	54 000
1 helper	
(60 kg rice x 150 Rps/kg x 3 seasons)=	27 000
	81 000

3. MAINTENANCE COSTS

The tertiary canal needs weed clearance every three months to keep it in proper working order. One man can clean 25 m/day of one side of the canal; therefore the labour required for one cleaning is:

$$\frac{2\ 500}{25} \times 2 = 200 \text{ mandays; for 4 times/year} = 800 \text{ mandays}$$

Quaternary canals also need four weedings per year and one worker can undertake 200-250 m/day. Therefore the labour requirements are:

$$\frac{12\ 500}{200} = 62.5 \text{ mandays/weeding; for 4 times/year} = 250 \text{ mandays}$$

The estimated maintenance cost is therefore:

1 050 mandays x 700 Rs/day = 735 000 Rps/year

4. OTHER COSTS

The undertaking of the above-mentioned O&M activities requires the existence of a water users' organization which has some costs in terms of supplies and material. Theses are estimated at 100 000 Rps per year.

5. TOTAL O&M COSTS

Operation:	81 000
Maintenance	735 000
Others	100 000
Total	916 000

This represents a cost per hectare of 6 106 Rps. (5.47 US$/ha) or approximately 8/9 mandays per hectare.

The allocation for O&M activities from the central government for the period 1984/85 was 11 512 Rps/ha, therefore the O&M costs of tertiary canals represent an important part (35%) of the total expenditure (176/8 Rps/ha).

WATER CHARGES: A TOOL FOR IMPROVING IRRIGATION PERFORMANCE?

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SUMMARY

Policies for financing irrigation services have the potential to affect the management and performance of irrigation systems. For this to happen, however, appropriate institutional arrangements are needed with respect to establishing responsibility and authority for four key processes: allocating resources to irrigation, implementing irrigation services, collecting resources from beneficiaries, and controlling the resources collected.

If water charges are to have the potential to improve system performance through providing more funding and encouraging better management, a degree of financial autonomy is needed to create a link between the provision of irrigation services and the collection of and control over resources from water users. Likewise, for a financing mechanism to have the potential of improving system performance by encouraging active cooperation and involvement of water users, a degree of financial autonomy is needed to give them a sense of ownership of the irrigation system. Improvement of investment decisions is also possible with financial autonomy, although this is not likely to occur unless the financially autonomous agency also has a voice in the investment decision process. Because water charges seldom involve water pricing, they have much less potential to encourage increased efficiency of water use by the farmers than is frequently assumed.

In the absence of any significant degree of financial autonomy for the agencies that provide irrigation services, water charges may be justified on fiscal or income distribution grounds; however, it is unlikely that they will have any significant positive effect on irrigation performance.

Although the benefits of financial autonomy appear substantial, it is not a simple matter to introduce the institutional changes necessary to create financial autonomy in situations where it has not existed. An attempt to create these institutional changes is likely to result in a transitional stage in which many organizational and financial problems will be encountered. But there is a continuum between absolute financial dependence and complete financial autonomy. Movements in the direction of financial autonomy, where possible, seem desirable.

One argument sometimes given for not encouraging financial autonomy is that farmers cannot afford to pay the water charges that would be necessary to cover the costs of O&M. In light of the large amounts which farmers operating with non-government irrigation facilities frequently pay for water, this argument needs to be examined very critically. If the irrigation services provided by public irrigation systems are of such poor quality that the farmers cannot pay for the costs of O&M from the incremental income they receive from irrigation,

then something is seriously wrong with the irrigation system or with its management. And if water charges are a key link in a chain of events needed to improve irrigation performance, then charging farmers for irrigation may ultimately turn out to be a way of increasing their incomes.

1. INTRODUCTION

Over the past several decades, governments in many countries have made large investments to build, rehabilitate, and upgrade irrigation facilities. Concomitant with the increase in irrigated area has been a rise in the magnitude of the recurrent costs for operation and maintenance (O&M) of the irrigation facilities. Many governments have found the resulting budgetary demands burdensome, particularly in light of the economic and budgetary pressures facing them in the 1980's. One response has been to reduce the funding for O&M to levels that are likely to lead to a gradual deterioration of the irrigation infrastructure.

Not surprisingly, this recurrent cost problem has received considerable attention in recent years (see e.g., ADB/IIMI, forthcoming; Devres, Inc. 1985; Easter 1985; Small et al 1986; Westgate 1985). All too often, however, the problem is viewed from a narrow perspective of "how to increase cost recovery from farmers," perhaps combined with a concern about "how to get farmers to be more efficient in their use of water." But more important, in my view, is the role that financing policies could play in improving the quality of irrigation services provided to the farmers, while at the same time reducing the government's fiscal burden. In this paper, I address the questions of in what ways, and under what circumstances, policies towards water charges may create the potential for improvements in public sector irrigation performance.

Before we can proceed with an examination of these questions, however, we need to clear away some verbal debris that both reflects and encourages confusion and a lack of clarity and precision in our thinking on these matters.

First, we need to clarify the difference between cost recovery and irrigation financing in the context of public sector irrigation. I suggest that the following definitions may be helpful:

> Irrigation Financing: The internal (domestic) generation of funds or other resources which are used to pay for the costs of providing irrigation services.
>
> Cost Recovery: The internal generation of funds which flow to public agencies as a result of the government's provision of irrigation services.

Although the above definition of irrigation financing excludes the mobilization of external funds for irrigation, the term is still a very broad one, encompassing all approaches to the acquisition of domestic resources to be allocated for irrigation construction or O&M. Some, but by no means all, of these approaches would involve cost recovery. Funds flowing to the government as a result of cost recovery, on the other hand, need not -- and indeed frequently are not -- used for irrigation financing. The common assumption that increased cost recovery means improved funding for irrigation O&M is often incorrect.

It is also useful to distinguish between direct and indirect methods of financing and of cost recovery.

Indirect Methods: Methods of financing or of cost recovery which do not involve payments by the water users specifically for irrigation services.

Direct Methods: Methods of financing or of cost recovery which involve payments by water users specifically for irrigation services. These payments may be termed "water charges.[1]

Many indirect methods of irrigation cost recovery exist (such as land taxes, domestic marketing taxes, export and import taxes and trade restrictions); however, these cost recovery mechanisms generally have no inherent potential to improve irrigation performance, and so are not considered further in this paper. Indirect financing mechanisms (such as funding irrigation O&M from general taxation or from the receipts of economic activities not directly connected with irrigation) are also largely excluded from consideration in this paper, except where they have clear linkages to water charges.

Finally, it is important to make a distinction between two types of water charges, namely water prices and area-based fees.

Water Prices: Charges for irrigation services which vary in accordance with decisions of water users regarding the amount of water to use.

Area-Based Fees: Charges for irrigation services which vary in accordance with decisions of water users regarding the area and type of crop to irrigate, but not in accordance with decisions regarding the amount of water to use.

It is frequently asserted that water charges will enhance the farmer's efficiency of water use. But only water pricing -- a relatively rarely used mechanism -- has the potential to do this, because it is the only type of charge that links a user's total cost of water to his water-use decisions. Area-based fees, if they are differentiated by type of crop, may influence water use through their effect on a farmer's cropping decisions. But the importance of such an effect on the total efficiency of water use is likely to be negligible unless the differential is much greater than is possible with the present structure of water charges in most Asian countries. The common assumption that water charges will lead to more efficient use of water is thus often incorrect.

2. POTENTIAL EFFECTS OF WATER CHARGES ON IRRIGATION PERFORMANCE

Water charges may create conditions favorable to enhancing irrigation performance through their effects on (a) the availability of funds for O&M, (b) the accountability of system managers; (c) the extent of cooperation and involvement of the water users in O&M; (d) the efficiency of water use by farmers (if the charges take the form of water prices); and (e) the quality of investment decisions.

2.1 Availability of Funds for O&M

The efficient operation of irrigation facilities is frequently hindered by low funding levels for routine O&M. If funds are allocated through a government budgetary process, it is likely -- especially during periods of general fiscal austerity -- that the amounts provided for O&M will be inadequate for satisfactory performance. Alternatively, funding for O&M may be based on charges paid by water users, so that the level of funding for O&M can be made independent of general government budgetary constraints. If this results in increased funding for O&M, a significant improvement may be possible in the performance of existing irrigation facilities.

2.2 Accountability of System Managers

Financing policies based on water charges create the possibility of increasing the degree to which irrigation managers are accountable to water users, not only for financial and managerial decisions regarding O&M, but also for the overall performance of the irrigation system. If an irrigation agency receives a sizeable portion of its funds from the farmers to whom it is providing water, the agency's managers are more likely to be concerned about the quality of irrigation services provided in order to enhance their ability to collect the water charges.

2.3 Cooperation and Involvement of Water Users in O&M

Water users may cooperate more actively in O&M if financial policies cause them to feel that they, rather than some remote government agency, own the irrigation facilities. To encourage this, a government might provide a mechanism whereby, prior to any new government investment in irrigation development or rehabilitation, agreement is obtained from the water users to accept a clearly defined financial responsibility for a portion of the capital costs. For this to be effective, the potential water users would need to be involved in the planning and design process. Cooperation of the water users in O&M may also be enhanced if a system of water charges is structured such that the amount of payment required can be reduced if the users take direct responsibility for certain components of O&M.

2.4 Efficiency of Water Use by Farmers

If water charges are to result in more efficient use of water by farmers, they must be in the form of water prices, rather than area-based fees. But systems of water pricing generally require the ability to measure water volumetrically, although in some situations water pricing might be based on the length of time that water is delivered (if rates of flow are generally not subject to large and unpredictable fluctuations) or on the number of irrigations (if the amount of water received during each irrigation is relatively stable). Because of technical and administrative difficulties associated with controlling and measuring water, pricing in gravity irrigation systems characterized by large numbers of small farmers growing irrigated rice is generally economically infeasible, and is seldom attempted.[2] Furthermore, even if water pricing were possible, its benefit in terms of increased water use efficiency by farmers would be much less than is sometimes suggested. Much of the current "wastage" of water can be attributed to poor supply control rather than to excessive demand in the absence of water prices. But effective supply control -- itself a pre-requisite for a system of water pricing -- can be expected to greatly reduce the amount of water "wastage," thereby reducing the additional gains that could be expected from any subsequent attempt to introduce water pricing.

2.5 Quality of Investment Decisions

Improving the quality of investment decisions can increase the performance of irrigation both by resulting in project designs which are more consistent with the needs of the water users, and by avoiding the construction of projects of dubious economic viability. Water charges can affect the quality of investment decisions, but only if there is an institutional linkage between the investment decision process and the financial status of the individuals or agencies making the decisions. If water users know that they are expected to pay a water charge which will include a component for the capital cost of the irrigation facilities, and if they have a voice in the investment decision, this linkage exists at the level of the individual water user. Such a situation typically prevails in the case of farmer-managed ("village" or "communal") irrigation systems. For this linkage to exist at the level of the irrigation agency, two conditions must be fulfilled. First, the officials of the agency must know both that the agency is responsible for repaying a portion of the capital costs and that these funds must be obtained from water charges to be collected from the farmers. Second, the agency must be involved in the process by which the investment decisions are made.

3. THE IMPORTANCE OF INSTITUTIONAL ARRANGEMENTS

The likelihood that the potential effects of water charges identified in the previous section will actually be realized depends on the institutional arrangements establishing responsibilities for four processes: allocating resources to irrigation; utilizing these resources to implement irrigation services; obtaining resources from irrigation beneficiaries; and controlling the resources so obtained. The key distinction is between situations characterized by full or partial financial autonomy and those characterized by financial dependence. With financial autonomy, an irrigation agency has at least partial responsibility for all four processes. In particular, it has control over resources which it obtains from water users, and thereby also controls the allocation of all or most of the resources devoted to irrigation O&M. Financial autonomy can exist in varying degrees, and is almost always partial, particularly when the cost of irrigation development is considered in addition to the O&M costs. Therefore, the term "financial autonomy" does not imply total financial self-sufficiency. With financial dependence, on the other hand, an irrigation agency has no control over any funds collected from the water users, and is thus primarily dependent on resources allocated to it through the general government budgetary process.

The importance of the institutional distinction between financial autonomy and financial dependence is highlighted in Table 1. With the unimportant exception of water pricing in the case of financial dependence, none of the potential benefits of water charges on irrigation performance can be expected to occur in the context of financial dependence. While it cannot be asserted that these benefits will necessarily occur when financial autonomy prevails (because of other intervening factors which may exist), the institutional arrangement of financial autonomy creates the potential for their realization.

Financial dependence prevails in many Asian countries, including Bangladesh, India, Indonesia, Malaysia, Nepal, Pakistan and Thailand. Financing policy in Sri Lanka has also been one of financial dependence; however, recent policy changes with respect to water charges -- including the implementation of a water charge with the provision that funds collected in a given project are to be used for O&M in that project -- represent a potential move in the direction of financial autonomy.

Financial autonomy prevails in a number of other Asian countries, including China, Japan, the Philippines, South Korea, Taiwan and Vietnam. It also exists at the level of the tertiary irrigation facilities in Indonesia. In addition, financially autonomous irrigation agencies are found in other parts of the world, including France, Greece, Mexico and the United States of America.

Table 1 POTENTIAL CONSEQUENCES OF WATER CHARGES, BY INSTITUTIONAL CONTEXT AND TYPE OF CHARGE

Type of Consequence	Institutional Context and Type of Charge			
	Financial Autonomy		Financial Dependence	
	Area-based Fees	Water Prices	Area-based Fees	Water Prices
Improved Funding for O&M	yes	yes	no	no
Improved Accountability	yes	yes	no	no
Improved Involvement of Users	yes	yes	no	no
More Efficient Water Use				
-Better water use decisions	no	yes	no	yes
-Better cropping decisions	yes	yes	yes	yes
Improved Investment Decisions	yes	yes	no	no

Financial autonomy usually involves decentralized responsibility for irrigation services, which may be provided through local irrigation or land improvement districts or associations, as in China (Nickum 1982), Japan (Kimura 1977; Kelly 1982; Okamoto et al 1985), Korea (Small et al 1986; Wade 1982), Mexico (World Bank 1983), Taiwan (Abel 1976; Bottrall 1978]), and the USA (Adams 1952; U.S. Congress 1983); through irrigation companies, as in France (Pelissier

1968; Bergmann 1984) and the USA (Revesz and Marks 1981); or through irrigation cooperatives, as in Greece (Bergmann 1984).

An exception to this pattern of decentralized authority under financial autonomy occurs in the Philippines, where a semi-governmental corporation, the National Irrigation Administration (NIA), is responsible for constructing and operating national irrigation systems throughout the country. Although in the past the NIA received much of its funds from annual budgetary allocations from the Government of the Philippines, a few years ago this financial support for O&M was reduced and then terminated. Thus the NIA has increasingly been forced to conduct its operations within the budget constraints of revenues earned from its corporate activities. This has caused the NIA to place much greater emphasis on the collection of water charges from the farmers than had previously been the case.

Financially autonomous irrigation organizations generally impose direct water charges on the users of irrigation water. But they frequently also rely on indirect financing, in the form of secondary income, to reduce the level of the direct water charges which they must impose. Secondary income of an irrigation agency results from a variety of economic activities in which the agency engages, or from assets which it owns.

Many examples can be cited of the use of secondary income to supplement the water charges levied by financially autonomous irrigation agencies. In China, irrigation agencies are encouraged to undertake a variety of miscellaneous enterprises such as fishing, livestock production, and processing of agricultural products (Ye and Dong 1986; Nickum 1982, p 4). In Taiwan, some irrigation associations in urbanizing areas have found that the conversion of previously irrigated land into non-agricultural urban uses has made part of the canal network unnecessary. These associations have sold the land on which these canals were located and have invested the proceeds to generate income for the association. In the Philippines, part of the funds used to finance O&M activities for the NIA come from secondary income earned from equipment rental, funds on deposit, and a fee charged for managing the construction of new irrigation projects. In Korea, secondary income from interest earnings, sale of water for non-irrigation purposes, and rental of assets provides, on the average, about one-fourth of the total income of the irrigation associations (Small et al 1986). In the United States, the formation of water users' organizations was encouraged by a government policy that gave the associations rights to certain types of secondary income, such as the revenues from grazing permits and from the sale of power generated by hydropower facilities associated with irrigation reservoirs (Thompson 1985). In Indonesia, some water users' organizations have rights to income from specified parcels of land. Officials of the organizations are allowed to cultivate these parcels and retain the income as compensation for their services in lieu of direct payment by the water users.

As noted above, one of the potential advantages of financial autonomy is that it establishes an environment favorable to the creation of financial accountability linkages between irrigation managers and water users. Reports from China provide some indication that this increased accountability does occur. For example, Nickum (1982, p 22) reported that irrigation districts in China, unlike most economic enterprises in the state sector, were not over-staffed, due to the fact that revenues to cover a significant portion of the district's expenditures had to be raised by water charges on the users. There is also some evidence that water users in China use the threat of non-payment of water fees as a leverage over management (Ibid., p 38). In Vietnam it has been reported that prior to an irrigation season, financially autonomous irrigation agencies sign contracts with the irrigation team of the each cooperative regarding the number of irrigations to be given and the area to be irrigated. After each irrigation, there is an inspection to ascertain whether the results have been satisfactory. If the provisions of the contract have not been met, the water charge to be paid by the cooperative is reduced (Le and Ninh 1986). Accountability of irrigation managers is also encouraged in Vietnam by structuring the water charge so that the amount paid per ha depends on the yield obtained (Ibid.). This gives the irrigation agency a financial stake in the agricultural outcome of the irrigation services they provide -- something which often occurs in cases of private-sector irrigation, but is seldom attempted in the public sector.

Some of the effects of changing to a system of financial autonomy can be observed in the case of the Philippines. The NIA's increased financial autonomy has led to changes in the financial procedures for O&M. On the one hand, efforts have been made to reduce the costs of O&M, in part by turning over certain responsibilities and authority to the farmers. On the other hand, more attention is now given to collecting fees from water users than was the case in the past, and systems of incentives have been established to increase the rates of fee collection. One consequence of these changes appears to be increased recognition of the importance of improving the quality of irrigation services provided to farmers, in order to enhance their willingness to pay the water charges.

4. FINANCIAL AUTONOMY: CAN FARMERS AFFORD IT?

As noted in the previous section, financially autonomous irrigation agencies generally impose water charges on the farmers they serve, although the level of the fees is frequently reduced because the agency also has sources of secondary income. This raises the question of what level of charges farmers can reasonably be expected to pay. Or, to phrase the question in terms of the concerns of those responsible for providing the irrigation services, can farmers pay enough to provide the resources needed to continue to operate and maintain the irrigation infrastructure in a satisfactory manner?

Information on communal and private irrigation systems in various countries in Asia -- which are, by their very nature, financially autonomous-- shows that even very poor farmers often pay quite large amounts for good quality irrigation services. In Bangladesh, it is not uncommon for a farmer to agree to pay 25 percent of his dry season irrigated rice crop to the owner of a nearby tubewell who supplies the water. Studies of farmer-managed irrigation systems in Nepal have revealed large amounts of cash and labor paid by farmers (Martin 1986).

Two conclusions logically flow from these observations. First, although the payments are large, the benefits that farmers perceive they are receiving from the irrigation services must be significantly greater than these payments. Thus, even if they are very poor in an absolute sense, they have the ability to pay and be better off than if they did not have access to irrigation. Second, the farmers are willing to pay these amounts because they know that the alternative is to have no access to irrigation. In the case of communal systems, it is also likely that because the farmers own and control the system, they have enough confidence in the quality of the irrigation services to make them willing to make these payments.

For larger irrigation projects with more direct government involvement, the institutional arrangement of financial autonomy can foster a willingness on the part of farmers to pay water charges because it helps establish the conditions whereby farmers know -- at least as a group -- that unless they pay, they will have no access to irrigation. The magnitude of the farmers' ability to pay fees in such projects depends on the quality of the irrigation services provided. In a recent study of five Asian countries, it was concluded that as long as irrigation facilities were performing in a reasonably satisfactory fashion, the direct benefits accruing to the farmers would generally be large enough to enable the farmers to pay for the full cost of O&M (Small et al 1986). The estimated typical benefit recovery ratios (the proportion of the increase in net income attributable to irrigation which is needed to pay the water charges) that would occur if water charges were set at a level to cover the full O&M ranged from 7 to 36 percent for the five countries (Table 2). But the study also concluded that in most cases, the farmers could not realistically be expected to pay, in addition, for more than a small portion of the capital costs, because of the very high benefit recovery ratios implied (Table 2).

The institutional arrangement of financial autonomy provides the possibility of financing the recurrent cost of irrigation services not only from direct farmer payments, but also from secondary income. It may thus be possible to structure farmer payments for irrigation services to incorporate components for both recurrent and capital costs, while limiting the total payment to a level which is reasonable in light of the magnitude of the benefits received.

For example, irrigation service fees paid by farmers in Korea have clearly identified components for O&M and for capital costs, and the irrigation organizations are typically responsible for the full O&M costs plus repaying, to the central government, a specified small portion of the capital cost. But the average amount which farmers must pay is only about 93 percent of the average cost of O&M, with the difference between the amount paid by farmers and the expenditures of the organizations accounted for by secondary income (Table 3). This arrangement has the triple advantage of giving the autonomous agency responsibility for funding the recurrent costs of irrigation; giving it and its farmer members clear ownership rights to the irrigation facilities; and keeping the irrigation service fees at a reasonable level relative to the benefits of irrigation received by the farmers.

Another important factor affecting the level at which a financially autonomous agency must set the water charge is the rate of collection of the water charges. In the case of Korea cited above, rates of collection average over 98 percent, so that there is little difference between charges and collections. But in the case of the Philippines, for example, the NIA obtains

Table 2 ESTIMATED BENEFIT RECOVERY RATIOS UNDER ALTERNATIVE FINANCING POLICIES IN FIVE ASIAN COUNTRIES (PERCENT)

Country	Policy			
	Actual	Actual modified to Set Irrigation Service Fees Equal to O&M Costs	Actual modified to Set Irrigation Service Fees Equal to O&M plus Full Recovery of Capital Costs	
			Moderate Capital Costs	High Capital Costs
Indonesia				
low estimate[a]	8	10	56	114
high estimate[a]	21	27	154	313
Korea[b]				
low estimate[a]	26 (54)	27 (58)	141 (297)	203 (429)
high estimate[a]	33 (70)	36 (75)	183 (387)	264 (557)
Nepal	5	10	74	122
Philippines	10	7	43	98
Thailand[c]	9 (30)	31 (53)	155 (176)	279 (300)

[a] Low and high estimates result from alternative estimates of the net benefits of irrigation.

[b] Figures in parentheses represent the estimated benefit recovery ratios that would prevail if domestic prices of paddy were allowed to drop to a level consistent with 1983 world prices, while all other prices and input amounts remained constant.

[c] Figures in parentheses represent the values that would apply if the implicit tax on the farmgate price of paddy were 22 percent, as estimated for the late 1970's in World Bank, "Thailand: Case Study of Agricultural Input and Output Pricing" Staff Working Paper No.385, 1980, p.50.

Source: Small et al, 1986, vol 1.

Table 3 AVERAGE REVENUES EARNED OR COLLECTED PER HA BY IRRIGATION AGENCIES IN THREE ASIAN COUNTRIES (PERCENT OF O&M COSTS PER HA)

	Korea	Nepal	Philippines
1. Revenues from Water Charges			
a. Water charge levied	93	60	121
b. Approximate percent of charges which are collected	98	20	62
c. Total revenues collected[a]	91	10	75
2. Revenues from Secondary Income	28	0	257[b]
3. Total Revenues[c]	119	10	332[b]

[a]Line 1a times line 1b.

[b]Includes interest and management fees derived from and mostly utilized for new construction activities, amounting to 200 percent of O&M costs.

[c]Line 1c plus line 2.

Source: Small, et al, 1986, Vol 1, p 31.

only about 75 percent of the cost of O&M from water charges, even though the actual charge is set at approximately 121 percent of the cost of O&M (Table 3). This reflects the relatively low (62 percent) rate of collection of water charges which the NIA has been able to achieve.

As a final point, it should be noted that with financially autonomous irrigation agencies, the cash burden placed on the farmer to finance recurrent costs can often be reduced by provisions that allow direct contributions of labor for the maintenance of irrigation facilities. This type of "non-cash financing" is a common arrangement in communal or farmer-managed irrigation projects. For very poor farmers for whom cash is scarce, this may be an attractive alternative to a payment only in cash.

NOTES

[1]An alternative and more descriptive term for these payments is "irrigation service fees." This term is preferred by the Asian Development Bank because it emphasizes the idea that the charges represent payments for a specific service, rather than being a tax. It also implies that the fees are not limited to costs directly related to water, but include any type of costs which are incurred in the provision of irrigation services.

[2]It has recently been reported that water pricing is being successfully used in irrigation projects in China (Ye and Dong 1986). This contrasts sharply with the experience in other Asian countries, and bears further examination.

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IRRIGATION SYSTEM RECURRENT COST RECOVERY: A PRAGMATIC APPROACH

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1. INTRODUCTION

The economic and fiscal viability of public irrigation systems in developing countries is currently receiving intense scrutiny from a variety of observers, policy makers, and practitioners.[2] These topics have recently been the subject of a critical report by the U.S. General Accounting Office (GAO, 1983) and two subsequent studies on irrigation system O&M and associated recurrent costs commissioned by USAID (Carruthers, et al, 1985; Easter, 1985). Another major study on a similar set of topics has just been completed at the International Irrigation Management Institute (IIMI) with support from the Asian Development Bank (ADB, 1985). Recurrent costs have also been treated extensively in recent editions of the ODI newsletter and in a number of other papers and reports (ODI, 1985; PRC/CHECCI, 1985; DAI, 1984; Prasad and Rao, 1985; Rao, 1985).

Thus, although this is not a new set of issues (Michael Roberts (1980) has discussed similar problems existing a hundred years ago in the colonially-administered irrigation systems of Sri Lanka) the wealth of recent study and research offers a promising opportunity to reassess established thinking on the topic. Such a reassessment is particularly timely in the light of several recent trends. One of these is the apprehension felt in a number of Asian countries over increasingly stringent fiscal and balance of payment problems. This has led to a new concern with efficient operation and maintenance, and to reductions in, or even the elimination of, O&M subsidies from national treasuries.

In addition, many of the best sites for major irrigation system construction have been exploited, leaving more marginal sites as new project opportunities. For these more marginal sites to be economically viable, performance expectations have to be raised, which implies management that is more effective and efficient than the prevailing standard. This, in turn, implies higher O&M costs, exacerbating already stressed operational budgets.

Furthermore, a number of bilateral and multilateral donors are ideologically committed to increased fiscal responsibility and a reduction in government subsidies and "distortions" in the economies of countries which they assist. In the context of LDC irrigation sectors, one effect of this approach has been to focus particular attention on the fees generated by governments in exchange for the irrigation services they provide.

The purpose of this paper is to examine the means of meeting the recurring obligations entailed in operating and maintaining public irrigation systems from the point of view that a reasonably enlightened donor agency might employ. The recent studies and papers mentioned earlier comprise a primary source of information for this examination.

As used here, "cost recovery" refers only to the recurring costs of operating and maintaining existing systems and not to the original capital investment in them. This is a rather arbitrary definition of the issue, although it is noted that outside of East Asia developing countries do not generally make serious attempts to recover the capital costs of large-scale public irrigation systems from the direct beneficiaries and that change in this general policy is unlikely[3].

2. A PERFORMANCE PERSPECTIVE

A consideration of the recurring obligations involved in operating and maintaining an irrigation scheme, and the attendant recurrent cost obligations, leads straightaway to the question of the scheme's performance. Although an antiquarian's approach to the maintenance of a scheme's physical infrastructure is possible, it is not particularly useful. An irrigation scheme is a productive asset, and we are properly concerned principally with its output of agricultural goods, and possibly with other less tangible outputs such as increased levels of employment or regional economic growth. In short we expect it to **perform**--and effective O&M is essential to attaining expected levels of performance.

Unfortunately, "performance" is not as clear-cut a concept as we would like, especially when the famine-insurance objective of many of the "extensive" systems on the Indian subcontinent is included along with the production-maximizing goals that we are more familiar with in other parts of the world. Nevertheless, it is important not to stray too far from this fundamental (though broad) concern with "performance" in considering recurrent cost policies and collection procedures. It is all too easy to become preoccupied with interesting questions of pricing theory and marginal returns while losing sight of the larger purpose of the endeavor.

Certainly performance and cost recovery have economic dimensions as well as physical, institutional, and agronomic ones. But to treat these in isolation from the others, or to assign them primacy, is not terribly useful. Economic theory offers us tools for setting public policy that optimizes the performance of an economic system when certain conditions are met. But so many of the present difficulties with irrigation system operation and cost recovery lie in administrative, financial, organizational, political, and technical domains that a more pragmatic performance-oriented perspective seems to be a more useful one.

3. FEES FUNDING AND PERFORMANCE

Given that the performance of public irrigation systems is quite often disappointing, let us ask what impact policy decisions regarding irrigation service fees can have in making improvements. To set the stage, it is useful to focus on two rather important connections that are often assumed in the traditional chain of argument that leads from irrigation fee assessment to effective O&M.

3.1 Irrigation Fees and Efficiency

The first of these is the connection between the level of the irrigation fee charged to farmers and efficient resource (water) allocation. Nothing is closer to the heart of Western economic theory than the idea that prices broker supply and demand and, appropriately set, result in an efficient allocation of resources and an efficient economy. Thus a farmer will apply more urea at 1 Rupee a kilogram, than if it were 2 Rupees a kilogram, and, if the price of urea makes sense in the overall scheme of things, all farmers will make reasonably good decisions about how much urea to apply without being wasteful.

The following passage from Irrigation Age, an American trade magazine, illustrates this point well.

> Milas Russell, Jr. doesn't consider himself a pessimist. Realist is more like it....Water costs about $9.50 an acre foot from his Imperial Valley water district. Compare that with $150 an acre foot irrigators in San Diego County pay....
>
> Russell admits that he, and many other irrigators in the Valley, have wasted water in the past. The only real incentive to not waste water is the threat of a "triple-charge" fine. If drainage at the "waste box" exceeds 15% of the amount of water received at the headgate, and the irrigator is caught by the district, he has nine hours to fix the situation or he is subject to a fine two times the initial water charge.
>
> "But", said the Brawley, Calif. farmer, "that isn't too much of a worry for some of these guys who have 15,000 acres of high value crops." (Irrigation Age, 1986)

This simple notion has proved to be a remarkably powerful device both for understanding how the marketplace works and for making it work better. **We do economic theory grave injustice, though, when we expect it to perform this minor miracle on commodities that are not paid for on a per unit basis.**

All depends on a rational decisionmaker choosing to buy (and apply) more or less of an item (input) based on its cost and his return. If the price paid is divorced from decisions about how much to buy then it is unreasonable to expect "price" to perform a rational allocative function. In fact, the effect tends to be exactly the opposite of that intended. There is a good analogy with a 30-day rail or airline pass which allows unlimited travel within that period for a fixed payment.

The question we must ask then if we expect pricing mechanisms to promote efficient allocation of irrigation water, is "to what extent is irrigation water actually delivered and paid for on a per unit basis in practice?" To begin with, we observe that cases of true volumetric delivery of irrigation water by public agencies anywhere in the third world are vanishingly rare. On the other hand, it is also uncommon to find water delivered for a fee that is absolutely constant for all users.

In practice, pricing mechanisms fall on a continuum that ranges between metered and flat rate service but does not include the endpoints. The first adjustment to a hypothetical flat rate scheme that is usually made is for the area owned or irrigated. Subsequently, crop type, season. and source of water (e.g. pumped or surface) may be taken into account.[4] Additionally there may be special discounts or exemptions granted for crop failure or typhoon damage, or occasionally for such steps as the creation of a water user organization.

All of these adjustments attempt to distribute the charges levied more equitably among users. But as far as rational resource allocation among farmers is concerned, they **assume restraint rather than providing it**. There is nothing in any of these pricing contingencies which deters an individual farmer, acting rationally in his own self-interest, from taking as much water as he chooses, regardless of his need or that of neighboring farmers. Quite the contrary, having "contracted" to pay for water for 2 hectares of wheat during the dry season, it is perfectly rational for the farmer to attempt to obtain as much water as he can (without causing waterlogging damage) for that crop.

In actuality, almost all common pricing mechanisms implicitly assume that the **irrigation bureaucracy** will administratively allocate water to the cultivators in accordance with the contingencies determining the fee. The ultimate example of this approach is the Warabundi system of Northwestern India. But here, in the classic case, there is no room whatsoever for the incentive action of water pricing, since the rotation, once determined, is inviolate[5].

With the possible exception of the Indian Punjab, however, irrigation agencies seldom have the ability to control water to a degree even approaching the one hypothesized here. The far more common circumstance is for effective irrigation agency control to cease at some point well above the individual farm turnout. Within the community of users formed by this de facto transfer of control, water allocation patterns are generally governed far more by social relationships than by economic ones. Thus neither hypothetical economic incentives or administrative controls are effective at the tertiary level where water allocation among individual farmers takes place.

The upshot of all of this is that it is virtually impossible to construct a plausible scenario wherein the price that is set for irrigation water has some incentive effect on water use decisions at the tertiary or "on-farm" level **without** postulating significant changes in the way that water is generally measured and delivered or in the way that farmers and the irrigation agency are organized and interact with each other[6].

3.2 O&M Budgets and Performance

The second major connection I would like to examine is the one between the regular (non-developmental) budget provided to an irrigation agency and the agency's effectiveness in keeping the irrigation systems in its charge in good repair and highly productive. Unfortunately, this is another area where I fear we have a dearth of empirical data to support our conjectures. A study of irrigation agency budget allocations relative to various measures of managerial performance (possibly lagged) would be an extremely interesting one.

In the absence of this kind of information, we can but speculate. Given the stunning divergence between what irrigation agencies say (and perhaps think) they do to manage systems, and what empirical studies have shown to happen in practice, however, it is reasonable to assume that larger budgetary outlays to irrigation agencies from the central treasury would **not** result in commensurate improvements in system performance[7]. It is likely, instead, that agencies would simply undertake "more of the same" and multiply actions that are often out of touch with field reality and demonstrably ineffective.

This is not to say that budgetary allocations are always adequate. In many cases they clearly are not and must be increased if system performance is to improve. Rather, it is to argue that "structural" changes will usually be necessary if increased allocations are to be used effectively to improve system performance. These generally go beyond the commonplace remedy of more staff training and include (a) a clear-sighted look at how the systems are actually operating now, (b) a commitment to improved system performance and an incentive structure that supports that commitment, and (c) a recognition that agency control, in fact, often stops short of the nominal "transfer point" and that functional articulation with the farmer-managed end of the system is essential for effective overall management.

4. WHAT TO DO

Rather than flailing away again at the questions of how much higher we should raise irrigation fees and how we can get farmers to bear a larger share of the costs, it is time to take a more pragmatic and comprehensive approach to this issue. Such an approach has two fundamental thrusts, one of which involves devolution of certain responsibilities to farmers and the second a rethinking of our attempts to recover recurrent costs, including the reasons we do so and the methods we employ.

Beforehand, it is interesting to note two cases of major changes in the costs of providing O&M services. In Pakistan, Chaudhry (1985) reports the government subsidy to O&M services in Sind and the Punjab has nearly doubled, in real terms, in the 4 years between 1979/80 to 1983/84. Much of the increase is attributed to the increased expense of operating and maintaining public tubewells.

More generally, there is a strong tendency to extend governments' nominal responsibility for O&M ever further down into the system in response to perceived shortcomings in farmers' performance of these duties. Thus, in some states in India, the government's responsibility for water control and maintenance has recently gone from the 40 hectare level to the 8 hectare level and finally to the 2 hectare level.[8] This shift, if implemented seriously and in a widespread way, would hopelessly overextend the involved agencies and increase recurrent cost burdens to crushing proportions.

4.1 Devolve Responsibility[9]

In sharp contrast to this tendency toward increasing (nominal) central control, it seems far more sensible to explore the possibilities for a reduction in direct central authority. If one considers that the number of control points in a large irrigation system increases in rough geometric fashion as one moves down through the system, it becomes quickly apparent that the costs involved in extending control downward will compound very rapidly. Conversely, the benefits of moving irrigation department control up by one level (e.g. from the "minor" to the "distributary"), in terms of cost savings to the irrigation agency, are equally substantial. It is worthwhile to remember that there are vastly more farmers practicing irrigation management than there are civil servants.

The first part of a sound solution strategy involves devolving responsibility and control to farmers, to the maximum extent possible. As put by Coward and Uphoff (1985) in their excellent discussion of this topic, this involves "reducing certain direct costs to government by collaborative arrangements with water users so that the latter mobilize more of their own resources to implement specified O&M activities."

That this is a reasonable objective is demonstrated by three separate bodies of evidence, they argue. **First**, there are many irrigation systems that farmers successfully manage and maintain with little or no government assistance. These are usually small systems but some cover thousands of hectares. **Second**, there are also examples of farmer groups assuming a substantial role in O&M activities within large government-administered irrigation systems. **Third**, there are several innovative programs underway in Asia which increase farmer involvement in O&M activities. Preliminary indications from several of these programs are extremely encouraging, although problems remain to be solved.

It is critically important to distinguish this recommended devolution from past programs where "responsibilities" have simply been **assigned** to farmers or farmers' groups, whether or not there were any farmers' groups and whether or not (usually not) there was any perceived advantage in the deal from the **farmers' point of view**. It is imperative, if devolution is to be successful, that the program be based on a balanced package of benefits that is attractive to **both** farmers and irrigation agency officials.

Equally important is the need to treat the question of which responsibilities should be turned over to farmers as an **empirical** one and not simply accept the traditional "above and below the turnout" demarcation. Evidence assembled by Chambers (1984) suggests that farmers have both strong interests and useful contributions to make above the turnout. This determination has major implications relating both to how attractive the devolution will be to farmers and to the level of cost savings to the irrigation agency that will result. Likewise, both maintenance and operations must be included in the farmers' sphere of responsibility if the arrangement is to be acceptable and effective.

One extremely attractive aspect of a genuine two-tiered approach to irrigation system management--one involving both the government irrigation agency and organized farmers--is that it **would** permit the employment of irrigation fees as a tool for achieving more efficient allocation of the water resource, an effect that is virtually impossible to realize under current organizational modes. It would do this by permitting the irrigators' group to act as a bulk purchaser of measured volumes of water from the irrigation agency, which it would then retail to its members. In doing this, it would function in a role similar to that of irrigation districts or ditch companies in the American West.

4.2 Rethink Cost Recovery

Chaudhry (1985) in his discussion of irrigation water pricing policy in Pakistan, identifies three major objectives that can be addressed through pricing decisions. He defines these as **efficiency**--allocation of irrigation water according to equi-marginal principals, **equity**--reduction of the income distribution gap among different socioeconomic groups, and **financial**--recovery of (capital and) operational costs of the irrigation system. In practice, he acknowledges, it is difficult to reach all three objectives at the same time.

Arguments made earlier demonstrate the irrelevance of pricing to this first objective under methods of water measurement and delivery prevailing throughout virtually all of the developing world. A rational and pragmatic approach to the recurrent cost question over the short run would thus abandon rhetoric that attributes significant "efficiency" benefits to pricing decisions. Doing this simplifies the task of developing appropriate cost recovery policies and clarifies our thinking on the problem.

Equity considerations are less easy to dismiss so summarily. On the one hand, there are conceivable ways to address them with pricing decisions. On the other, such measures have not proven particularly effective in the past. Differential pricing schemes for the head and tail of systems, for example, could have an impact on income distribution among farmers served by the system. Implementing such a system, however, would tend to legitimize and institutionalize a system of unequal access to water within the irrigation scheme, which is certainly not a desirable longer-range outcome.

Moreover, water pricing is not a particularly powerful tool for achieving equity ends--not nearly so effective as land or tenurial reform, for example. Thus, although some interesting experiments are underway, some involving the assignment of water shares on bases other than land ownership, these are probably not generally applicable measures for large public irrigation systems at the present time.

It is the third objective, the financial one, that seems to be the most powerful, the most timely, and the most promising one to pursue at the present time. This is true for several reasons.

A number of Asian countries, e.g. Thailand, the Philippines, Pakistan, Sri Lanka, are expressing serious concern about the recurrent cost burdens they currently bear and some have already taken steps to reduce them.

More intensive management regimes, needed to maintain present rates of growth in agricultural production as the land frontier closes, will push these burdens still higher.

There are promising approaches available for addressing financial problems which have potential for gaining the favor of all three major participant groups--host country governments, farmers, and donor agencies.

There are potentially strong indirect linkages between revenue generation measures on the one hand and improved system performance on the other.

The immediate objective under such a strategy thus becomes bringing revenues and O&M expenditures more into line with one another. This can be done both by reducing the costs of O&M services--devolving responsibility for some O&M tasks to farmers and farmers' associations and rationalizing the tasks actually performed by irrigation agency personnel--and by increasing the budgets of the irrigation agencies. Pursuing these objectives simultaneously would probably be the most effective approach. An appropriate policy approach would involve a phased plan and a timetable for doing this.

But raising operating budgets is not an easy task. Accepting the strong recommendation in the Carruthers report (1985) that direct beneficiaries bear system O&M costs wherever possible, this task becomes, in part, one of increasing the revenues raised by the levy of irrigation fees.

It seems clear that in a great many cases, fees charged to farmers can and should be raised. It is equally clear, though, that simply raising fees is **not** the whole solution. A number of fundamental problems would remain to thwart most of the good that such a step could do.[10]

First, fee levels are not revenue levels. It is total collections that actually pay for O&M services and changes in collection rates, often low anyway, are likely to be inversely related to changes in fee levels.

Second, revenue collected and paid to the national treasury has no particular affinity for the agency which "generated" it. It may find its way back to support O&M, but it may not.

Third, if the irrigation agency is the collection agent and revenue is retained by the national treasury, there is little incentive for aggressive collection efforts. Quite the contrary, collection responsibilities will be regarded as a burdensome diversion from "real" duties.

Fourth, costs of collection must be considered, since net, not gross, revenue is the legitimate yield of the process.

Fifth, the irrigation agency is still at the mercy of the political budget-setting process, where O&M functions are often extremely vulnerable during any belt-tightening exercise.

Lastly, and perhaps most importantly, simply raising fees does not take advantage of the potential for linking users directly with the service-provider in a way that generates accountability--perhaps the most valuable attribute of an irrigation management system.

Some examples will help to illustrate each of these points.

4.2.1 Fees and revenues

(a) In the largest irrigation system in the Philippines, the Upper Pampanga River Integrated Irrigation System (UPRIIS), it was estimated in the late seventies that collection of 70% of the service fees due was necessary to cover O&M costs. Actual collections were only about half of that level. In part this resulted from a precipitous plunge in collection rates, from 64% to 27%, following a sharp increase in fee levels in 1975 (Cabanilla, 1984). (b) In Nepal, where water charge assessments are well below the level needed to cover adequate system O&M, actual collections are insignificant (Shrestha and Shrestha, 1984). (c) In Bihar in India, actual collection percentages have declined from around 28% in 1977-78 to only about 17% in 1981-82 (Prasad and Rao. 1985). (d) In Morocco, about 43% of amounts due are currently being collected (IBRD, 1986). Although there are exceptions to this pattern, it is a depressingly familiar one across much of the world.

4.2.2 Revenues and budgets

The interesting cases here are the exceptions to the general pattern of irrigation revenues disappearing into general national accounts. The Philippines offers an example. There the National Irrigation Administration (NIA) was constituted as a government-chartered corporation in 1964 and was charged with recovery of O&M costs and reimbursement of construction costs over a 25-year period. Revenues collected from farmers flow to a general account not specifically earmarked for O&M, but are retained within the agency. For major systems, no real attempt has been made to recover capital costs, however, the obligation to recover O&M costs has been taken seriously. And wnile collection percentages are not always high, they do comprise perhaps the single most important measure of system performance in the eyes of NIA personnel--affecting performance evaluations of technicians, water delivery priorities to villages, and ratings received by entire districts and systems (Svendsen and Lopez, 1980).

In Sri Lanka, where fees have been low or non-existent, a dramatic shift in policy has recently taken place. In 1984, an annual fee of Rs. 100 per acre of paddy land was imposed in major irrigation systems. This fee is planned to rise in annual increments until it reaches double that amount in 1989. During this inception phase, the difference between the estimated O&M cost of Rs. 200 per acre and the amount charged farmers in a given year will be made up by the government[11].

The most interesting feature of this arrangement is that the amounts raised from farmers, as well as supplementary government contributions, are to remain with the scheme in which they are collected and are to be earmarked specifically for operation and maintenance of that scheme. Furthermore, farmers are to have a voice in deciding how these funds are spent.

This is an exciting and innovative approach which eliminates some of the fundamental liabilities of traditional systems of O&M cost recovery. It also capitalizes on an observation by Small (1982) that farmers are more likely to pay specific fees for specific purposes than general water fees. Early results are mixed and, while collections are significantly higher that the less-than-two-percent rate prevailing prior to 1984, only two districts had collection rates greater than 15% during the first year of the new approach (Easter, 1985), and it is too early to tell how effective the program ultimately will be.

Perhaps the most promising version of this approach is found when it is combined with a system of strong farmer water user organizations. The large Gal Oya system in the southeastern part of Sri Lanka has recently been the site of an innovative and highly successful program of farmer organization. Irrigator associations of 15-25 farmers each have been constituted and a four-tiered structure of farmer organizations set up covering over 25,000 acres (Uphoff, 1985). These associations have taken on major responsibility for allocating water both among their members and among associations. They have also gained unprecedented representation on the District Agricultural Council--a powerful group that sets and coordinates agricultural policy for the district. Uphoff (1985) reports that in the Gal Oya area, collections under the new policy have now risen to 80%--the highest in the country. Moreover, budgets and plans for spending these receipts are being reviewed by farmers' representatives. If such performance continues, this combination of organized farmer groups and decentralized handling of funds earmarked specifically for O&M could provide an important and attractive model for replication elsewhere.

4.2.3 Incentives for collection

This issue is really a corollary of the preceding one. Logic suggests it is unrealistic to expect irrigation department employees, whose primary responsibility is to operate and maintain irrigation systems, to be diligent in collecting money from farmers for the national treasury. Peabody (1985) has concluded, following his participation in the earlier mentioned review of cost recovery programs led by Carruthers, that poor collection rates are more a function of irrigation departments' **unwillingness to collect** than of farmers' **unwillingness to pay.**

4.2.4 Costs of collection

Little data is available addressing this question, since an issue has not typically been framed in these terms. Scattered estimates of collection costs exist, however. Malhotra (1982) indicates that an unacceptable one-tenth of the total water revenue in agriculturally-rich Haryana state in India is being spent on the field establishment engaged in preparation of the water bill. This presumably does not include the actual costs of collection.

An even more striking picture is presented by Prasad and Rao (1985). Using figures for the Indian state of Bihar, they show that costs of collecting irrigation fees in that state, as a percentage of actual collections, increased from an already substantial 46% in 1977/78 to 84% in 1981/82. The net contribution of irrigation revenues to meeting O&M costs is thus virtually nil.

Another case from the Philippines emphasizes the importance of this factor. In an attempt to increase collections, policy was modified in 1978 to permit collection of fees in kind. This in effect borrowed a page from the book of one of the most successful collection agents in the rural Philippines--the village money-lender--by allowing the collection of fees in palay (paddy) in farmers' fields immediately following the harvest. This measure, while contributing to significantly increased collections, was later deemphasized because of the costs and problems associated with handling large quantities of grain. The practice of indexing the amount of fees paid in cash to measures of palay, in force since 1975, remains, however, and has provided an automatic and politically acceptable means of increasing fees over time.[12]

4.2.5 Budget cutting

It is almost axiomatic that funding for operations and maintenance are early casualties during times of financial stringency. This has happened recently in Peru and the Dominican Republic (Carruthers, et al., 1985).

A more extreme case is that of the National Irrigation Administration in the Philippines. While NIA has always had a mandate to recover costs from irrigators, in 1980, in the midst of serious national economic and financial problems, O&M subsidies from the national treasury were stopped altogether. The fact that around 90% of the total O&M cost is now made up of salaries and wages indicates that negligible amounts are being spent on equipment operation, essential for effective O&M (Sison and Guino, 1983). In the case of the Philippines, however, the results have not been entirely negative.

4.2.6 Accountability

Because NIA has been concerned with cost recovery since its inception and has experimented with a variety of methods for increasing its collections, it was in a position to respond in some positive ways to the financial stringency forced upon it. This response has followed the two fundamental approaches advocated in this paper--reducing costs (in part by devolving responsibility to farmers' associations) and increasing fee collections.

In attempting to reduce operating costs, NIA's strategy has included transferring complete responsibility for the smaller nationally-owned systems (those under 1000 hectares) to farmers, handing over responsibility for tertiary-level O&M to Farmers' Irrigator Associations (FIAs), and contracting out maintenance responsibilities for larger laterals and main canals to FIAs on a fee basis (Carruthers et al., 1985). All of this has allowed NIA to reduce field staff levels.

Other cost cutting measures have also been undertaken. In one system in Laguna province visited by the author in 1984, pumps purchased under an ADB credit and installed to augment water already delivered to the system by gravity flow have been idle since their installation several years earlier. NIA engineers indicate that operating the pumps would increase the average cost of water delivered in the system to a level well beyond what could be recovered from the users. They indicated also that staff members have been transferred out of their system to bring operating costs into line with revenues.

These measures have had a demonstrable effect. On a nation-wide basis, operating expenditures, which had risen from 107 M pesos in 1978 to 245 M pesos in 1981, had fallen back to 182 M pesos by 1983 (Carruthers et al., 1985).

The second thrust, that of increasing revenues from irrigation fee collections, has also relied heavily on the FIAs--in this case to serve as collection agents. Systems of collection incentives have been established to rebate a portion of the fees collected to the collecting FIA, with the fraction of the rebate increasing as the FIA's collection efficiency increases.

NIA also recognizes connections between collections and the quality of irrigation service provided to farmers, the physical condition of its systems, and the level of contact and amiability of the relationships between its personnel and farmers. Implications of this recognition are stress on system rehabilitation, a concern with farmer satisfaction, and an emphasis on more extensive contact between system officials and farmers. The impact of these measures on collection percentages is not clear at this time, although individual components of the approach have been shown to be effective in other situations.

Given the central role of the FIAs in both thrusts, it is important to realize that programs have been underway in the Philippines since 1975, aimed at learning to organize farmers into viable and self-reliant irrigator associations. Early efforts were carried out in small community-owned schemes and this work is among the most successful attempted anywhere in Asia. Efforts were later extended to larger national schemes with some modifications and with more mixed results. Work on both programs continues.

It would be a mistake to expect immediate results from a program such as this. In the Philippines, important elements have come together in a timely and fortuitous way, some of which began many years before the country's current financial difficulties began. Over the middle-range future, the prospect of establishing O&M on a self-sustaining basis is promising. It is an experience that bears close monitoring as it unfolds, both for its own sake and for the lessons it may have to offer other countries in the region and beyond.

5. CONCLUSION

An approach to the problem of satisfying the recurring obligations of irrigation system O&M has been outlined. It is empirical rather than deductive in nature and emphasizes system "performance" as a standard for judging our efforts. A fundamental problem is that we understand only poorly how such factors as rehabilitation, system operation, and maintenance affect system performance. Research is called for here. Still, if we are to justify, to farmers, to the planning ministry, or to the lending official the expenditures of increasing amounts of operating expense money, we must try to make such a case.

In the traditional chain of assumptions connecting increased irrigation fees to improved system performance, one prominent link appears to be broken and another unreliable. The first is the linkage between fee levels and their incentive effect on farmers to produce an efficient allocation of irrigation water. Given current patterns and practices of water delivery throughout the developing world, a convincing case for such a linkage simply cannot be made.

The second link is the one relating increased funding for a government irrigation agency and improved O&M (and improved system performance). There is reason to doubt the effectiveness of this relationship in many cases, and it is, at best, an unproven one. The implication is that while augmenting revenue flows to an irrigation organization, we must, at the same time, also analyze its functions and roles with respect to their effectiveness in increasing system output and extending its lifetime.

There are two fundamental approaches to the problem of imbalance between irrigation agency revenues and the costs of adequate O&M. These are (a) to reduce costs and (b) to raise revenues. For greatest effect, both should be undertaken together.

To accomplish the first of these, some form of farmer organization will be necessary in most cases. In the case of the second, simply increasing fees is not enough. It is necessary also to consider collection efficiencies and costs, the path that revenues take in reaching the irrigation agency, the presence or absence of supplemental subsidies from the national treasury, and a number of other factors.

If there is a simple vision of an ideal case, it might look a bit like a public utility for irrigation water. It would see itself as providing an irrigation **service**, would generate most of the revenue it needs directly from its users (in this case, probably user groups) and bear some accountability to the public in general and to its user groups in particular. We may be a long way from such a vision in most cases. However, in one country, the Philippines, a promising start had been made down just such a road before the recent economic and political difficulties. If will be interesting to see if that journey is now resumed.

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NOTES

1. At the time of writing, Senior Irrigation Management Specialist, Asia/Near East Bureau, AID/Washington. Presently, Research Fellow, International Food Policy Research Institute, Washington, DC. The views expressed are the author's.

2. The systems considered in this paper, as in most writing on the topic, are medium and large-scale government-owned systems where primary management responsibility rests with a government irrigation agency.

3. A case in point is the new (1984) cost recovery policy in Sri Lanka which is presented explicitly as a charge to farmers to pay for proper operation and maintenance of their system (ECL and DPCL, 1985).

4. ESCAP, 1981 reveals several other bases for assessing water-related fees, none of which contradict the argument being presented here.

5. The area where this type of water pricing scheme could have an incentive impact, assuming fees were high enough to be considered in the farmer's decision-making, is in the choice of crop, although the argument is seldom cast in those terms.

6. This, of course, assumes that farmers do feel some obligation to pay whatever fees are levied, which may be the case but often is not. If this obligation is not compelling, the entire discussion is moot.

7. It is arguable that increased budgets would have a stronger impact on levels of maintenance than improvements in operations. Because routine maintenance has a more indirect relationship with performance than does system operations, it is somewhat more difficult to deal with but is still very deserving of empirical study.

8. Interestingly, this has been, in large measure, a response to pressure from external donors.

9. This section draws heavily on Coward and Uphoff (1985), though ideas have been recast to some extent.

10. Many of these points were suggested by Carruthers (1985) and Easter (1985).

11. However, the amount of the government contribution not spent at the end of the year will return to the government's general revenue fund (Easter, 1985).

12. Although the real retail price of rice has declined by more than 40% since 1973 (Ferguson, 1986), irrigation fees, in nominal terms have increased.

COST RECOVERY IN IRRIGATION PROJECTS: PERCEPTIONS FROM WORLD BANK OPERATIONS EVALUATION

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INTRODUCTION

This paper derives from a recent report by the Operations Evaluation Department (OED) on cost recovery in World Bank financed irrigation projects.[2]/ The main chapters of this report (hereinafter referred to as the OED cost recovery study) are reproduced, with some slight editing, as Appendix I to the paper for ease of reference. They convey the important empirical findings about the extent to which costs of Bank-assisted irrigation projects have been financed or offset directly through payments by irrigation beneficiaries, and they provide an informative account of Bank policy on this subject. With this information as background, the paper does two things: first, it provides a summary and personal interpretation of the findings of the OED cost recovery study; and second, it seeks to offer several independent observations on cost recovery analytics and to identify fresh perspectives from which to examine selected cost recovery issues.

2. COST RECOVERY--AN INTERPRETATION

The OED cost recovery study is an important document for three reasons: first, it describes the Bank's evolving policy on cost recovery in irrigation projects; second, it reports on the extent of Borrower compliance with the Bank's loan conditions in respect of such cost recovery; and third, it lists a number of factors that have impeded this compliance. Nevertheless, its direct implications for policy are constrained by the project experiences actually examined. It is quite normal for irrigation investments to require seven years or more between project approval and completion, and more time still is required to evaluate project performance. Consequently, the accumulated irrigation project evaluations available to OED for study were limited in most cases to projects approved before the second half of the seventies. All 48 such projects reviewed were subject to the Bank policy regime in effect from 1971 to 1976.

Before 1976, Bank policy required recovery of operation and maintenance (O&M) costs as a minimum, and investment costs to the extent practicable, recovery being measured in terms of direct water-related charges collected from irrigators. The Bank's policy changed in 1976, stressing three objectives as the basis for cost recovery: economic efficiency, income distribution, and public savings. The new policy also favored water charges that could be levied progressively. In 1984 new policy directives were issued which strongly emphasized concerns about the financing of O&M (see Appendix II). The major empirical findings of the OED cost recovery study relate to the earlier, pre-1976 policy of the Bank and not to its more recent policy.

The study's findings show clearly that the levels of Borrower cost recovery in irrigation projects have fallen well short of what the Bank had desired or expected. In at least two-thirds of the projects reviewed the covenant requiring that cost recovery match the needs of O&M funding as a minimum had not been complied with. The proportion of O&M costs recovered was frequently between 15% and 45% only. There were very few cases where capital costs were recovered. The study also notes that operation and maintenance of irrigation systems was considered satisfactory at audit in only about one-half of the projects.

This limited adherence to covenants on cost recovery has had three main causes: lack of government commitment, unreliable water supply due to poor O&M of irrigation systems, and the often heavy burden of direct and indirect taxes already imposed by governments on the farming sector. The response of the Bank to non-compliance with cost recovery covenants has varied, ranging from the extreme of refusal to consider further financing of irrigation projects to no reaction at all.

There are several sets of lessons from this experience. First, concerning government commitment, the study observes that:

i. the Bank's stated cost recovery objectives are not in harmony with some Borrowers' policies on cost recovery. A clear example is India's policy of not expecting its irrigation projects to be self-sustaining, while the Bank continued to invoke in its legal documents the need for stronger recovery efforts;3/

ii. sound cost recovery policies are not easily implemented through covenants on a project-by-project basis; sector and policy-based lending operations may provide a better opportunity;

iii. inconsistencies between contemporary and historic policy goals (of lender and borrower) may explain in part the non-enforcement of covenants. With a progression of (Bank) policy regimes, it is difficult to determine which regime is applicable, and the Bank could well have undermined government commitment simply by changing its own policy.

Second, regarding irrigation system operation and maintenance, the study concludes that:

i. adequate O&M of irrigation investments is necessary for a reliable water supply, which in turn is a necessary though not a sufficient condition for profitable farming and hence, for cost recovery. In many instances farmers were unwilling to pay water charges because the amounts of irrigation water supplied to them were inadequate or unreliable. It is therefore much more important for the Bank to insist (generally through covenants) that adequate funding for O&M of primary and secondary canal systems be provided.

ii. only slow progress has been made in establishing water users' associations to look after tertiary systems. Thus, O&M of tertiaries has frequently been inadequate.

Third, concerning the burden of other taxes on the farming sector and the scope for direct irrigation cost recovery, the study observes that:

i. sometimes, other taxes are needed if there are fundamental Borrower objections to direct water charges; for example, religious traditions might proclaim water to be a free good, or political necessity might require that public irrigation services be financed from general revenue. Sometimes, the burden of other taxes limits farmers' willingness and capacity to pay direct charges. Bank policy should allow for such exceptions.

ii. any direct recovery system should be simple and understandable by farmers. By mixing cost recovery and income distribution objectives and focusing upon incremental incomes, the more recent Bank policy runs the risk of being too ambitious and of confusing Borrowers and farmers.

This brief summary of OED's cost recovery study is meant to encourage a full reading and perusal of Appendix I. Such a reading is highly recommended, as it will give the reader a better appreciation of the current dilemma that, in my opinion, so clearly confronts the Bank. This dilemma concerns what the Bank should do in the face of widespread non-compliance with these lending covenants. On the one hand, it would seem that such covenants are unenforceable and that, on these grounds alone, the Bank should abandon them. On the other hand, a devil's advocate can still argue that weak compliance is a result of weak enforcement and/or of an unconvincing, not-comprehensive-enough policy. The OED cost recovery study has provoked such challenging questions and the World Bank is currently trying to seek answers. As a contribution to that debate the next part of the paper reflects on several issues of cost recovery analytics which I believe could benefit from either different approaches, or different emphasis.

3. SOME PERCEPTIONS OF COST RECOVERY ISSUES

I would like to suggest that the problems of cost recovery that have been most persistent for Bank staff arise in three areas:

i. the linkage of O&M deficiencies to inadequate cost recovery;

ii. the notion of recovery through other than direct charges; and

iii. the linkage of irrigation finance with economic efficiency.

In addition, a fourth topic, concerning whether irrigation agencies might operate "better" as financially self-reliant public utilities, also needs to be discussed.

3.1 Linkage of O&M Deficiencies with Cost Recovery

It has always seemed incongruous that 1971-76 Bank policy insisted so firmly on a recovery equivalent to O&M costs as a minimum, when there were, in fact, no prevailing uniform institutional arrangements among borrowers to guarantee that such payments by direct beneficiaries would result in the actual funding of O&M.[4] The precise origin of this policy feature is obscure. The most plausible explanation is a fiscal one: namely, the concern that project O&M costs should not become a burden on the government recurrent budget. But there has always been the hint of an implicit behavioral assumption: namely, that irrigation project entities could be induced to behave like public utilities--e.g., electricity supply, port, and potable water supply authorities--which are commonly set up as autonomous agencies, reliant on their own generated commercial revenues. The idea that the public utility model was an inspiration for this policy feature derives from the (author's) perception that many Bank staff have regarded a minimum recovery of O&M costs as a contribution towards the "efficiency" objective of water charges, their notion being that adequate recovery would help support adequate O&M. Yet Borrowers' irrigation entities are invariably a part of regular Government departments and Ministries, without financial autonomy, and wholly dependent on the Government budget. Their very existence in such a form--accountable directly to a Government Minister--is a notable expression of Borrower desire to keep such agencies firmly within the political domain where there is maximum opportunity to exercise discretion and minimum constraint from the rules of commercial undertakings.

Such a notion--that irrigation finance can mimic the public utility model and obtain some of its benefits without the necessary institutional reform--has had three unfortunate consequences. First, it has delayed the proper (Bank) recognition and enforcement of stronger, more direct covenants that Borrowers should finance O&M properly, without regard to sources of revenue.[5] Second, it has obscured the need to interpret and apply Bank policy on overall recovery (concerning O&M and capital costs) according to the varying motives upon which Borrowers base both their support of public sector irrigation and their recovery of associated costs. And third, it has fostered a myth that inadequate O&M is somehow the fault of inadequate cost recovery.[6] Given the institutional arrangements that are typical for public irrigation, poor O&M reflects simply the low priority accorded by most Governments and their irrigation agencies to O&M relative to capital expenditures for new projects.[7] Obvious ways in which the Bank and other lending agencies can redress this imbalance are for them to offer persuasion in favor of more rational priorities, and to help finance O&M activities directly, learning from this experience also what other factors have given these activities their lowly status.

3.2 Should Irrigation Agencies be Organized as Public Utilities?

But there is also a school of thought which argues explicitly that irrigation agencies, in virtually all of their activities, should be public utilities. That argument requires that all or most aspects of public irrigation (to the extent they are not "privatized")--irrigation construction, operation and maintenance services--should be financed ultimately by voluntary, contractual obligations of direct beneficiaries to pay all costs. Under such a discipline, the very survival of public irrigation would depend on cost recovery of all capital and recurrent costs, in the same fashion as does the survival of private irrigation.

Advocates of this type of institutional reform [8] foresee many advantages. They favor the public utility solution because it:

i. avoids a drain on government budgets;

ii. provides a more certain guarantee (than does benefit-cost analysis) that irrigation investments are worthwhile;[9]

iii. reduces the political pressures that bias irrigation designs towards maximizing the number of beneficiaries, rather than efficient production; and

iv. affords more direct public accountability and control over public irrigation agencies and their staff.

There is no reason why this philosophy of irrigation finance should not sit well with the Bank...if it can find Borrowers who are also willing to try it. Naturally, such a method of finance will (continue to) draw opposition in Borrower countries from the special interest groups that profit from the irrigation subsidy arrangements that are now so common. This is also likely to block any early, broad adoption of such an approach as Bank policy. But the approach deserves support at least on an experimental basis to test its potential--especially for reaching smallholder farmers and for building political consensus on the viability of self-financing public irrigation.

3.3 The Notion of Indirect Recovery

However, in the real world, there is at present strong political pressures for public irrigation and weak government support for direct cost recovery. In this situation, the Bank has continually sought to interpret which government revenues should be counted as recovery. The basis for such determination has been some recognizable payment or transfer by direct beneficiaries, be it:

i. direct irrigation charges (including betterment levies),

ii. producer transfers to consumers as a result of low statutory domestic prices for commodities that, in the absence of Government intervention, would have enjoyed higher prices in domestic markets[10], or

iii. general taxes on land, commodity sales taxes, and taxes on agricultural exports.

The logic of this recognition process appears to have had its beginnings in the Bank's longstanding preference for direct charges, which had as their sole target, of course, direct beneficiaries. The other increased payments or transfers by these direct beneficiaries, comparing with- and without- project situations, for which they are liable on account of general (but specifically agricultural) taxes or price distortions attracted more recognition the more such payments or transfers seemed exclusive to direct beneficiaries. The pertinence of other, more general taxes/distortions was never ruled out; but the search for recovery instruments bearing visibly on direct beneficiaries meant that they were not explored systematically.

This logical process of recognition has had three flaws. First, the admission of general taxes and price distortions as indirect recovery instruments has resulted in undue prominence being given to those taxes and distortions bearing on agricultural output. A serious shortcoming of having limited this focus so has been the increased inequities that result for those producers who do not use public irrigation water: rainfed farmers and private irrigators. The merit of expanding the focus to more general revenues is that any inequities are spread more thinly around the economy. It would be more useful in future analyses to take 100% recovery as a truism and to focus speculation on the distribution of the public irrigation cost burden among direct beneficiaries and other relevant groups. For example, if the direct beneficiaries of public irrigation are rice growers and rice exports are taxed, the other relevant groups to consider might be: rice growers using private irrigation, other private irrigators, rainfed farmers, urban rice consumers, and the rest of the economy.

Second, the relevance of other subsidies (than for irrigation), mainly for rural inputs, especially fertilizer subsidies enjoyed by public water irrigators, has tended to be overlooked. These subsidies also need to be recovered, and they should be counted, along with offsetting taxes, in the same broader calculus of who bears the burden of public expenditures.

Third, the original purposes of existing taxes, which may have an entirely different logic (from irrigation cost recovery), has been largely ignored. It is extremely difficult, and certainly wasteful, to restrict the more general analysis of public cost recovery to irrigation only. The myopia that is evident in recognizing certain indirect taxes as recovering irrigation costs, when such taxes can also be viewed readily as recovering other public expenditures, for example rural road costs, testifies to this. Consequently, any analysis of the distribution of the burden of public irrigation costs should probably be carried out in concert with similar analyses of who is bearing the costs of other public services.

Summing up, I believe that our options for measuring irrigation cost recovery, when recovery is not mandated by institutional arrangements as it would be in the public utilities model, are rather polarized. They are limited to: (i) restricting the analysis to direct charges only; and (ii) expanding the analysis to include all sources of public revenues, and to differentiate the economy into a larger number of groups to see who is bearing irrigation (and other) public costs.

3.4 Linkage of Irrigation Finance with Economic Efficiency

The circumstances under which prices can be employed to solve public water distribution and other water use efficiency problems are extremely limited. The new type of public tubewells that the Bank has helped finance in India in recent years allows for the possibility of some elements of water price-induced efficiency of operation, because they offer close to an on-demand irrigation service, and metering of water supplies can be approximated. Even in this case, however, water supplies are typically rationed by roster, not by water charges. In the case of public sector gravity irrigation schemes, there are few practical working examples of efficiency pricing fit to study. Literature reviews offer examples of metering, negotiable water rights, and other means of encouraging trade in water across time and space. Yet the widespread practical use of these incentive systems for efficient water use is largely confined to economists' imaginations. Economists do not design such systems into public irrigation projects, partly because the client is not aware of their value, but ultimately because economists have not demonstrated their value under field conditions with the necessary research and development work. If there is indeed scope for employing such incentives, their realization will require the same kinds of experiments and demonstrations that have been recommended above for developing public irrigation utilities.

Cost recovery overlaps with general efficiency issues for irrigation in areas other than just water distribution and on-farm use. For example, the incentives for efficient O&M vary with the institutional arrangements for financing O&M. As discussed above (Section 3.1), however, there is no point yet in the Bank advocating as policy the public utility model for O&M, even implicitly, as was the case perhaps with its 1971-76 policy, because most Borrowers have already adopted institutional arrangements that put O&M at the mercy not of irrigation revenues but of the government budget. The same holds true for concerns about the efficiency with which capital budgets for new irrigation projects are determined. Institutional reform towards the discipline that self-financing irrigation requires ought to be tried, but the first requirement--even for experiment--is interested Governments.

Greater efforts are needed in differentiating Borrowers who have different levels of sympathy towards user charges (rather than general revenue) for financing irrigation. Because these varying sympathies are likely to correlate with political characteristics of Borrower economies, some prior research in this area could also be highly beneficial. In fact, it is surprising that past analyses of recovery performance across countries have produced so few insights into the influence of a political economy factor on what, after all, is a decidedly political issue.

1/ The author is a Senior Evaluation Officer in the Operations Evaluation Department (OED) of the World Bank. Many others contributed to this paper indirectly. Numerous colleagues toiled on OED Report No. 6283, the source of the material in Appendix I: principally Ernest Smerdon (counsultant), Christian Polti, Gottfried Ablasser, and Ian Carruthers (consultant); their Report also incorporates comments and insights from a large number of Bank staff. The balance of this paper has benefitted from valuable comments on an earlier draft by Gottfred Ablasser, Jose Olivares, and Robert van der Lugt, but the contents represent the views of the author alone. They do not represent the views of the Bank or OED.

2/ OED Report No. 6283, "World Bank Lending Conditionality: A Review of Cost Recovery in Irrigation Projects" June 25, 1986.

3/ See details in Appendix I, para 3.25.

4/ Bank Staff Working Paper No. 218, July 1975, "A Policy Framework for Irrigation Water Charges", by Paul Duane (paras. 1.34 - 1.37).

5/ There is evidence of such recognition in the March 1984 Policy note reproduced in Appendix II - see its paras. 27 and 29(a).

6/ The OED cost recovery study observes that 70% of the projects with data available for study "had the anticipated association between revenue performance and O&M standards." But it goes on to say: "It cannot be assumed that this is a causal relationship, nor, if so what is the direction of causality", Appendix I, para. 3.06.

The claim that a myth has been propagated is not too different from that made by Sfeir Younis, who described as one of planners' myths that water charges promote "good" O&M. A. Sfeir Younis, AGREP Division Working Paper No. 84, "Irrigation Water Charges and Cost Recovery Policies: A Policy Perspective", The World Bank, October 1983, para. 3.29.

7/ It can be further argued that this low priority is reinforced by external aid being limited to capital projects.

8/ A comprehensive statement in favor of this position is given by Robert Repetto in "The Role of Appropriate Incentives in Improving Irrigation Performance" World Resources Institute, Washington, August 1986.

9/ Repetto argues that much of the observed demand for public irrigation projects is generated by rational, rent-seeking behavior of potential beneficiaries, who recognize the value of, or rent from, obtaining something for less (often much less) than full cost. His principal examples of this kind of behavior, stretching over a long period, concern the lobbying for subsidized federal government water projects in the U.S.A.

10/ Note, in passing, that such transfers to consumers do not constitute government revenue.

WORLD BANK LENDING CONDITIONALITY: A REVIEW OF COST RECOVERY IN IRRIGATION PROJECTS 1/

I. BACKGROUND

1.01 Irrigation has been one of the largest components in Bank Group support for the agriculture sector. By late 1984, 278 irrigation projects, located in 52 countries, had received financing from the Bank. Total Bank lending for these projects, which together cost approximately US$26.0 billion,2/ amounted to US$10.9 billion.

1.02 The Bank has been concerned with the recovery of capital and recurrent costs in irrigation as these costs tend to be high compared with some other forms of agricultural investment and the opportunity cost of poor O&M continues to rise. It has been a constant Bank policy that irrigation investments should generate sufficient revenues to operate and maintain existing infrastructure and facilities, as well as to repay to the extent possible the irrigation investment cost.

1.03 The issue of cost recovery in irrigation projects is extremely complex for many reasons. As a case in point, the Bank favors the focussing of its loan programs on those population groups within developing countries that suffer the greatest poverty. To the extent, however, that irrigation projects are in areas where the people are very poor, the issue of the ability of these farmers to pay cost recovery charges constitutes a socio-political dilemma for the governments. However, for the most part irrigation farmers have a higher and more secure livelihood than other rural inhabitants and therefore an obligation to repay, at least in part, the public sector costs. Equity criteria are more and not less likely to require payment from farmers for irrigation services.

1.04 A second reason for the complexity of cost recovery is that the Bank's policy must apply to many different nations. This review showed clearly that each has different laws, customs and political attitudes toward cost recovery in investment projects-- particularly irrigation water charges. For example, there are cases where it is a fundamental belief that water should be free, and direct charges for the water, per se, may not be legal. However, there may not be any prohibition against charging for the services and facilities that are necessary for delivering water to the fields in a timely manner.

1/ Excerpts of OED Report No. 6233 dated June 25, 1986, Chapters I-III.

2/ Data on total project costs is available only for the period FY74-84, when Bank support comprised about 42% of total project costs. Using his same percentage for the period FY50-73, an aggregate figure of about US$26.0 billion is obtained for total irrigation project costs.

1.05 A third reason for the complexity of the issue is that farmers, governments and the Bank all have a different perception of, and somewhat conflicting views on cost recovery. Furthermore, the views of individuals and institutions change over time as policy shifts and new insights modify perceptions of key issues. In these circumstances only a clear, uncomplicated, indicative policy is likely to succeed.

A. Purpose and Scope of the Study

1.06 A study issued by the World Bank's Operations Evaluation Department (OED) in 1982 reviewed the experience with legal covenants associated with World Bank lending operations in general. It found that compliance with such covenants had not been good and offered recommendations for reducing the extent of covenant violation. The Bank had been aware even before that study was undertaken that covenant compliance related to cost recovery in irrigation projects was particularly poor.

1.07 The main purpose of the present OED Cost Recovery Study is to analyze past practices of the Bank regarding cost recovery in irrigation projects, and to draw lessons from experience with cost recovery in completed and evaluated projects. Specifically, it endeavors to explore ways by which the Bank can improve the formulation of irrigation cost recovery covenants and conditions, and Borrowers' compliance with them. The main text first presents a reflection on the evolution of the Bank's policy in this respect. The core of the study is the review and analysis of the experience with cost recovery in specific Bank-supported irrigation projects. Special emphasis has been given to the regional dimension, in the Bank's operational set-up, with respect to the fulfillment of covenant provisions and the Bank's reaction to noncompliance with covenants.

1.08 The principal source of information for the study are Project Performance Audit Reports (PPARs) for 48 completed irrigation projects, this being all the projects in the irrigation subsector which had been evaluated by OED up to 1984. Although this group of projects represents only about 17% of all irrigation projects approved by the Bank up to that time, it constitutes the majority of those completed. The PPARs have been systematically reviewed in order to gain an overview of the experience with cost recovery in the respective projects. Other documents, particularly an OED 1981 Water Management Study and OED Impact Evaluation Reports, where available, also have been reviewed, and Bank staff involved in relevant aspects of cost recovery have been consulted. The results of this in-house review have been supplemented by field investigations in India, Indonesia, Mexico and Turkey--countries in the four Regions where Bank support for irrigation development has been concentrated.

1.09 Full analysis of performance in relation to complex policy issues cannot rely solely on empirical analysis of PPAR's. An unprecedented response, in number and length of reply, from Bank staff to the draft of this report, elucidated valuable additional information. Three recent reports from USAID and the Asian Development Bank[3]/ also provided useful insight. This large and valuable response to the draft study of performance in an increasingly important investment category (more than ten percent of the Bank investment in the 1970's) has led to a more normative form of review than is usual in OED reports.

II. THE BANK'S COST RECOVERY POLICY

2.01 The policy of the Bank on cost recovery in irrigation projects has evolved from a relatively simple formulation to one that is now fairly complex. Although an attempt has been made to retain the flexibility which is essential when a policy is to be applied to varied conditions in many different countries, there are numerous complaints that the current Bank policy, set out in OPN 2.10 plus the 1984 addendum, is too complex and is not easily applied in the field.

A. Past Cost Recovery Approaches

2.02 Almost all the completed projects which have been included in this review were appraised prior to 1976, when Bank policy was substantially changed. At the time of negotiation, therefore, all were subject only to Operational Policy Memorandum (OPM) No.2.61, issued on March 31, 1971. That policy began with the statement: "The recovery of all project costs from beneficiaries is a normal aim for projects financed by the Bank. However, agricultural projects are sometimes exceptions." The policy further stated: "As a minimum, operational and maintenance (O&M) costs should be recovered completely."

2.03 This policy of recovering O&M costs as a minimum, with the secondary objective of recovering a significant portion of the capital costs, was the one generally used in Loan Agreements of irrigation projects until 1976. Presumably, the reason for stressing recovery of the O&M costs as a minimum

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3/ USAID, Irrigation Pricing and Management Report submitted by Devres Inc. to Office of Policy Development and Program Review, USAID Washington March 9, 1985.

USAID, Recurring Cost of Irrigation in Asia: Operation and Maintenance, K. William Easter, Water Management Synthesis II Project 1985.

ADB, Regional Study on Irrigation Service Fees: Final Report, Leslie E. Small, Manetta S. Adriano and Edward D. Martin. A report submitted by the International Irrigation Management Institute Sri Lanka, January 1986.

See also M. Svendson (1986) "An unofficial donor perspective on irrigation system recurrent cost" paper to Overseas Development Institute, London, February 1986.

stems from the keen awareness that failure to provide adequate O&M tends to limit the success and sustainability of the project, and oftentimes, necessitates premature rehabilitation. Apparently, it has been assumed that if sufficient funds for O&M are recovered these would be allocated to O&M--an assumption that in most cases is not justified.

2.04 The Bank policy on cost recovery in general provides for the beneficiaries to pay for the investment cost of projects. One aspect of implementing the cost recovery policy relates to determining fairly who are the beneficiaries. Most certainly the farmers are beneficiaries, but others often benefit as much or more.

B. The Present Policy

2.05 The cost recovery policy was significantly changed in 1976, when the Central Projects Memorandum (CPM) No.8.4 reinforced the income distribution aspects of the Bank guidelines. One of the major changes introduced under the new policy was that project beneficiaries were to be charged progressively, in proportion to the incremental incomes generated by the project. Therefore, Bank staff were required to (i) identify the project beneficiaries and classify them into a number of income groups; (ii) estimate incremental incomes for each group; and (iii) design a selective and progressive tax system. To facilitate evaluation of the recommended water charges and benefit taxes, so-called rent recovery indices were to be calculated by Bank staff, and presented separately for beneficiaries in the following different income classes:

(a) those with incomes below the critical consumption level (CCL);

(b) those with incomes between the CCL and the national average;

(c) those with incomes between the national average and twice the national average; and

(d) those with incomes above twice the national average.4/

2.06 CPM 8.4 instructed Bank staff to include information in appraisal reports and prepare related covenants on the following aspects:

(a) general principles to be followed in determining the appropriate levels and structure of water charges and benefit taxes;

4/ There are clearly operational problems with establishing incremental farm incomes. For example one can cite the difficulty of explaining the concept of rent to a farmer on a tubewell drainage project where the benefits consist of damage avoided. It would also be hard to justify progressive charges for water but proportional charges for fertilizer and other production inputs.

(b) the extent to which total (capital and O&M) public sector costs would be recovered, whether interest on the capital would be charged and, if so, the interest rate to be charged;

(c) the cost recovery period and the grace period;

(d) the submission to the Bank, for review and comment by a specified date, of the proposed schedule of water charges, benefit taxes or other assessments to be imposed and collected;

(e) the appropriate institutional and administrative arrangements for monitoring progress of the project, the flow of benefits and the extent of water charges and benefit taxes;

(f) the periodic review (at intervals not exceeding three to five years) by the Borrower and the Bank of the levels and nature of the schedule elements for cost recovery, taking account of changing price levels; and

(g) the separate accounting for the costs recovered by water charges, benefit taxes and other assessments from project beneficiaries, with annual reports on project costs and revenues to be submitted to the Bank for a period of 20 years or until the loan or credit is fully repaid, whichever is shorter.

2.07 In 1980, the cost recovery and irrigation water charge issue was again addressed in detail in Central Project Note (CPN) No.2.10, which was a reissue of CPM 8.4 with minor editorial revisions, providing flexibility in implementation. The three key elements forming the basis for cost recovery consideration were identified as:

- economic efficiency - the extent to which scarce water resources are optimally allocated among different uses;

- income distribution - the manner in which the benefits flowing from irrigation are shared among project beneficiaries; and

- public savings - the extent to which government captures part of the increased net benefits for future investment in agriculture and elsewhere.

2.08 CPN No.2.10 (now designated Operations Policy Note (OPN) 2.10) refers to many points that should be considered in applying the Bank's cost recovery procedure to any given project. It includes detailed guidelines for making calculations of the CCL and other indices involved in the procedure. However, one major complaint with this procedure is that the system used in the calculations is poorly understood by irrigation officials and difficult to apply. Ideally, volumetric measurements should be made, which are normally not possible. The calculation of rent and cost recovery indices requires estimates of the critical consumption level. To apply the economic efficiency objective assumes that irrigation water can be allocated according to market forces, which is generally not possible. The income distribution and public savings objectives are also difficult to apply in a prescribed format because so many judgment factors are involved. Although the principles embodied in the procedure are reasonable, the application to irrigation projects in developing countries is more difficult than the guidelines would suggest.

2.09 There is widespread recognition within the Bank of the difficulty of finding a simple and satisfactory solution to the irrigation cost recovery issue. In March 1984, a Policy Note entitled "Financing Operations and Maintenance in Irrigation" was circulated by the Vice President, Operations Policy, for filing with OPN 2.10 "Irrigation water charges, benefit taxes and cost recovery policies." Comments received from staff in response to the present OED draft report suggest that this note is not widely consulted. A copy is, for information, attached to this paper as Appendix 2. In summary the Policy Note concluded that:

(a) at the project appraisal stage, assurances will be required that sufficient funds are available for O&M;

(b) at the same time there has to be adequate recognition that the longer term objective is to have a system of resource mobilization that will recover capital costs so permitting replicability of investments;

(c) the mobilization of resources should include capturing rents from those who benefit directly from irrigation unless there are specified reasons, e.g., equity, why governments choose not to do so; and

(d) in any event, whatever the mode of resource mobilization, there has to be an analysis of how the fiscal system affects farmers' incentives.

The Policy Note does not change Bank policy as embodied in OPN 2.10, but rather proposes a modified approach to implementing these policy guidelines. For example, it elaborates on the many problems associated with cost recovery and emphasizes that the necessary institutional arrangements must be put in place to handle cost recovery. Important points such as assuring that funds for necessary O&M are available and that farmer incentives be provided are stressed.

III. EXPERIENCE WITH BANK-SUPPORTED IRRIGATION PROJECTS

3.01 A total of 48 Bank-supported irrigation projects in 29 countries had been subjected to performance audits by the Operations Evaluation Department (OED) by the time this review was conducted (1984). The Project Performance Audit Reports (PPARs) for these projects, which constituted the main source of published data for this study, are reviewed and the experience with cost recovery summarized in the following sections.

A. General Description of Cost Recovery Covenants

3.02 The essence of most covenants related to cost recovery in the projects reviewed was simply that the annual O&M costs were to be recovered. This directly followed the 1971 policy of the Bank as contained in OPM No. 2.61, which was in force when most of the loans/credits were negotiated. In several cases, the covenants also addressed the recovery of investment costs in general terms, such as indicating that such costs should be recovered to the extent that is practical. Costs were to be charged to farmers in different ways: through volumetric pricing (Morocco, Jordan), a charge per crop-hectare (Mexico) or as a general per hectare charge (most countries). Most charges were to be paid in cash, with a few exceptions providing for payment in kind (Philippines).

3.03 Frequently, the covenants required that a socio-economic study be undertaken to determine the ability of the farmers served by the project to pay water charges. These studies were to assist in providing data which could be used to determine the proper water charge rate for a given project considering all the factors of concern to the Borrower and the Bank, including equity.

B. The Fulfillment of Covenant Provisions

3.04 Based on the project performance audits, an assessment was made of the degree to which lending agreement provisions regarding water charges were fulfilled. Sometimes it could not be stated categorically that a cost recovery covenant had or had not been satisfied. For example, a covenant might not have been satisfied for a period of time before, eventually, substantial progress was made to meet its provisions. Conversely, initial compliance might have been subsequently reversed in effect, as for example when water charges were not indexed to inflation.

3.05 Recovery of O&M Costs. In at least two-thirds of the projects reviewed, the covenant requiring that cost recovery satisfy the O&M funding requirement was not fulfilled. In only about 15% of the cases were the covenant provisions fully satisfied. In general, about three-fourths of the cases were not in compliance with O&M-related cost recovery covenants.

3.06 The O&M was considered satisfactory at audit in only about half the projects. The question arises whether there is an association between the degree to which covenants were adhered to, in particular those relating to paying O&M costs, and the extent to which O&M was satisfactory. Of 36 PPAR's where this could be checked 16 had bad adherence and bad O&M and 7 had good adherence and good O&M. Although this showed two thirds of projects had evidence of association somewhat surprisingly nearly one third had bad compliance and good O&M. In effect more than 40 percent of all projects with good O&M and data on compliance had bad adherence to the covenants. A similar position emerges if simply revenue performance (up to O&M costs) and maintenance standards are compared. Seventy percent of the projects where data was available (37 projects) had the anticipated association between revenue performance and O&M standards. It cannot be assumed that this is a causal relationship, nor, if so what is the direction of causality.

Furthermore, the relationship needs cautions interpretations because for example "good O&M" is not precisely defined and each evaluator has personal criteria and subjective weighting and the issue is too polarised by the "good" and "bad" labels. Nevertheless it is worth noting that there were frequent reports that farmers were reluctant to pay when the irrigation service was not dependable.5/

3.07 Although, in the projects reviewed, poor cost recovery tended to be positively correlated with poor O&M and better cost recovery associated with good O&M, there were exceptions as noted, particularly in the Europe, Middle East and North Africa (EMENA) Region. A possible explanation for this finding is that the projects supported by the Bank in that region tended to have a higher level of technical sophistication with more lined canals and better control structures, making them more immune in the early years at least to some of the O&M problems that were frequently encountered elsewhere. If this assumption is correct, it highlights the importance of project design to good O&M. The substitution of capital for O&M expenditure (and management) is certainly possible in irrigation and in view of the evident problems with operation it is a topic that deserves more consideration.

3.08 Recovery of Investment Costs. Most of the covenants on investment cost recovery were quite general, with nearly half of them containing wording pertaining to recovery levels such as "as much as is practicable" or "a reasonable portion of capital costs." Some merely stated that a study should be undertaken to determine what should be done. There were very few cases where significant capital cost was recovered. Nonetheless, in view of the wording of covenants, it is not possible to state categorically that these covenants were violated.

3.09 Studies of Cost Recovery. In many cases, the lending agreements provided that the borrowing government would undertake a socio-economic study to determine the farmers' ability to pay irrigation water charges. Although the specifications for these studies were quite general, the principal objectives were to look at the question of equity and to determine the method for recovering costs that was most appropriate in a given country. A deadline for completing the studies usually was given.

3.10 In seven out of 13 cases, the studies were carried out, but in six cases their recommendations were only partly applied, or not applied at all because they were politically unacceptable to governments. In six other cases, the studies were not implemented, presumably because of governments' reluctance to change their existing policies. In only one case did the study conclude that no charge should be levied because of farmers' limited ability

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5/ Cases were reported in virtually every region of the world in which poor O&M was cited as providing a ready excuse to farmers for not willingly paying realistic charges. Moreover, when O&M is bad, government is weakened in attempts to enforce payment. Nevertheless in one sixth of the cases bad O&M was accompanied by good payment.

to pay. It might appear that, for both the Bank and for Governments, providing for studies in loan/credit documents often appears to have been an easy way to avoid addressing the difficult cost recovery issue in a timely manner. However, it is worth remembering that this issue is recognized to be extremely complex and extensive studies are often needed. Nevertheless, such studies should be completed before appraisal if the present policy relating to income distribution is to continue.

C. Bank Reaction to Non-compliance with Covenants

3.11 The reaction of the Bank to non-compliance with cost recovery covenants varied among different Bank regions. The most determined reaction occurred in Turkey, where the Bank in 1976 informed the Government that it would not consider further financing of irrigation projects until steps were taken to improve the cost recovery system. Another example in the EMENA Region was in Morocco, where the Bank took a firm stand and insisted on strong cost recovery provisions. An intensive dialogue between the Bank and Moroccan officials led to key issues being addressed forthrightly at an early stage.

3.12 In Mexico, the Bank made an effort to cover the cost recovery issue as part of a comprehensive irrigation subsector study. Mexico's Federal Water Act distinguished between charges to be collected for investment costs which were to accrue to the national treasury as it was the Federal Government which was responsible for financing the main works, while charges for O&M were to remain at the local level to supplement federal funds allocated for that purpose. The study showed that the portion of the full O&M cost of water covered by water charges in nine districts averaged only about 27% in 1982. This matter was subsequently addressed by Mexican officials at the insistence of the Bank.

3.13 The reaction of the Bank was more tolerant in other cases as is shown in the following section. In general, the Bank has been rather flexible in treating problems of low cost recovery from farmers. This may be due to the fact that the farmers served by irrigation often have been among the poorest in the country and the equity issue was considered. But evidence to support this view was not always produced. The Bank was particularly lenient with countries in South Asia and East Asia and the Pacific Regions in the sample, where covenants on cost recovery in irrigation were constantly breached without a strong reaction to non-compliance from the Bank.

D. Cost Recovery by Region

3.14 The PPARs from the six individual regions were analyzed to see if any regional differences emerged regarding the implementation of Bank policy on cost recovery. The recovery of costs by Region and in individual countries with different local conditions varied widely. Nonetheless, it is clear that in a large number of cases the water charges actually collected did not provide for the full O&M costs.

3.15 Equity considerations were often the basis for lack of remedial action by the Bank in cases of non-compliance. This is in line with current Bank policy which specifies "income distribution" as one of the basic factors in cost recovery considerations (para. 2.07). The following sections summarize the cost recovery performance in the present group of projects in different regions.

3.16 Eastern and Southern Africa. Only two irrigation projects in this region had been audited. In one, the Sudan Roseires Irrigation Project, there were no covenants on cost recovery. A 1980 OED impact evaluation study on this project revealed that water charges had not been collected up to that time. However, there was provision for the public sector to share in the net proceeds from cotton production. The sharing formula in effect in 1980 allocated only 47% of the proceeds to tenants and 2% to the Tenants Reserve Fund, while 36% went to the Sudanese Government and the remaining 15% to three other public sector entities. In the other project in the region, the Madagascar Lake Alaotra Irrigation Project, the covenants requiring project cost recovery from farmers were not fully applied. The audit indicates that the political situation was such that implementation of the covenants would have been impossible. During project implementation, the Bank did not address cost recovery issues in sufficient detail and with adequate force to help the Government resolve the serious dilemmas it faced. During this period and subsequently, the Bank's emphasis shifted to national cost recovery policies for irrigation which had been in disarray. Progress has been made in recent years, with passage of legislation and a start on implementation of a coherent and realistic cost recovery system.

3.17 Western Africa. Of the five audited irrigation projects in West Africa, only two had statements regarding cost recovery. For these, the Mopti Rice Project in Mali and River Polders Project in Senegal, cost recovery showed good progress. In Mali, the levy increased by a factor of 2.6 in the three-year period from 1974 to 1977. Collection rates were also high. Yet, the levies were sufficient to recover only 42% of O&M costs at the time the completion report was prepared in 1980. The Senegal River Polders Project had a covenant to recover costs through consolidated fees. The cost recovery was over 80% in 1977, an amount adequate to finance O&M costs. These funds were reportedly used for general support, however, rather than O&M, because of general budget shortfalls and as a result O&M was not adequate. Undoubtedly, such use of water charges revenue was in violation of the intended purpose of the covenant.

3.18 East Asia and the Pacific. The handling of cost recovery issues in the 12 projects in the East Asia and the Pacific Region was characterized by a considerable range in conditions. For instance, two examples of excellent progress in cost recovery occurred in this region. These were the Korea Pyongtaek-Kumgang Irrigation Project and the Korea Yong San Gang Irrigation Project, where collection rates were good and sometimes reached over 95% of assessments. Also in Korea, water charges were increased annually, assuring that inflation did not erode the progress toward planned cost recovery. Korea is a good example from which to learn because, after completion of irrigation systems, the Government generally transfers the responsibility for

O&M to the respective Farmland Improvement Associations (FLIA) in each project area. These farmers' groups are points of contact to assist in the collection of water charges, reflecting the political and socio-economic structure of rural Korea.

3.19 By contrast, the Malaysia Muda and Kemubu Irrigation Projects have had serious cost recovery problems. At the time of audit the water charges and land taxes remained far short of meeting O&M costs, and the audit report noted that prospects for improvement were not good. Although Malaysian Government officials accepted the proposition that beneficiaries pay O&M costs, they argued against the principle of recovering capital costs from beneficiaries. Nonetheless, the Bank insisted on following its normal approach.

3.20 The Government of Malaysia cited a number of problems in collecting water charges, including a heavy burden of the religious tithe (zakat) and a substantial sales tax collected from produce in the region. Other problems were mentioned such as continuing difficulties with the water distribution system. The audit report for these Malaysian projects recognized the zakat as well as the indirect return to the Government resulting from controlled prices on rice as alternative cost recovery mechanisms. It is noteworthy that these two Bank-supported projects were important in enabling Malaysia to reduce rice imports from 42% of its total requirements in 1967 to 17% in 1974. An FAO study showed the zakat to be capturing between 5% and 7% of gross farm income, considerably more than previously suspected. Based on the FAO figures, the audit concluded that Muda farmers' combined payment of water charges, land taxes and the production tithe covered all of O&M costs plus 20% of the projects' capital costs (at 10% annual interest). Taking these factors into account it could be argued that there was no real noncompliance.

3.21 In the Philippines, the irrigation service fee in the Aurora-Penaranda Irrigation Project was, in principle, more than adequate to meet O&M costs. However, the collection rate was not good although it appeared to be improving. The collection of water charges in that country has been by the National Irrigation Administration instead of the tax collection agency. The fee has been set in terms of the price equivalent of rice to compensate for inflation. In-kind payments, although unusual, were permissable. Keying the water charge rate to the price farmers receive for their products is a logical way of indexing water charges. However, problems can arise if real prices of key commodities fall compared to the general price index.

3.22 In Thailand, where authority to levy water charges exists under the Irrigation Act, no such charges had been collected under the projects reviewed. A study of farmers' ability to pay was undertaken by the Ministry of Agriculture and Cooperatives. The results showed that the project beneficiaries had very limited ability to pay charges. This matter was to be re-examined after the increase in income from the project had been realized by the farmers. Although Thai rice farmers did not pay water charges, they paid a tax (rice premium) on their marketable surplus which was a tax of some significance and as such presumably a suitable cost recovery method. In some projects in Thailand, poor O&M was mostly due to low construction standards and poor design of irrigation systems.

3.23 In some countries, such as Indonesia, water charges, per se, had not been acceptable in the past since water has been viewed as a "God-given" commodity. The Government for some time had objected to water charges as a condition of credit effectiveness, but now generally agrees with the concept of charges to recover O&M costs plus a "reasonable" proportion of capital costs. An impact evaluation study found that villagers made inadequate contributions to O&M. Water User Associations, set up under the first Indonesia Irrigation Rehabilitation Project, were not able to increase farmers' participation in rehabilitation of tertiary blocks or in their maintenance, and could not prevent a decrease in the proportion of farmers paying the village-level water retribution, which declined from 84% in 1976 to 67% in 1981.

3.24 South Asia. In the Bangladesh Chandpur II Irrigation Project, the covenant on recovery of O&M costs was breached. However, the Bank in 1977 took no action and instead concluded that the issue needed no further discussion. Also, the covenants were not fulfilled in the Bangladesh Northwest Tubewells Project and apparently no action was taken there either. In the Burma Irrigation I Project, instead of covenants on cost recovery there was a letter by the Government expressing the intention to recover maintenance costs of flood embankments from beneficiaries. Until recently, no such charges had been levied, although a betterment tax on irrigated land was introduced in 1981/82.

3.25 In India, the covenants on cost recovery had, in general, not been satisfied. The covenants often were vague and in several cases studies of water charge rates had been requested. For various reasons, the provisions of the covenants were not satisfied and the Bank let the covenants be ignored for several years without action. During the review of the India Chambal Command Area Development Project PPAR, the Borrower's failure to meet contractual obligations was addressed and it was noted that: "Good reasons are given, but it would seem that the Bank should specifically agree to waive compliance, rather than let the covenants be ignored for 5 to 6 years. By now the Bank should know what realistic goals can and should be achieved, and the covenants, dialogue, and performance should all be more compatible and respected than now seems to be the case." The Government of India in commenting on the OED Cost Recovery Study stated that, first, it did not expect irrigation projects to generate revenues or recover costs to ensure project sustainability after completion; irrigation projects were regarded as part of the Government's development program and were not supposed to be self-sustaining. Second, since most irrigation projects were targetted towards the rural poor, water charges were not intended for the purpose of recovering costs and were a function only of the farmer's capacity to pay. Third, recovery of water charges as a fee for services rather than as a tax was more a matter of semantics than of substance.

3.26 The experience in the Nepal Birganj Irrigation Project showed a drastic decline in water charge collection in surface irrigation schemes. Conversely, there had been good progress in improving collection of water charges for tubewells. Still, the provisions of the covenants were not met. This project offers a good example consistent with the view of the importance of reliability of water supply to the successful collection of water charges. The following table compares the collection rate in percent for the tubewell scheme and the surface scheme in the project for three years.

NEPAL: BIRGANJ IRRIGATION PROJECT

Assessment and Collection of Water Charges
('000 Rupees)

	Surface Scheme			Tubewell Scheme		
Year	Assessment	Collection	%	Assessment	Collection	%
1977/78	104.7	6.9	6.6	10.7	1.3	12.1
1978/79	334.9	3.7	1.1	15.3	6.0	39.2
1979/80	305.6	1.8	0.6	98.8	73.0	73.9

These data clearly show that the decline in collection performance for the surface scheme from 6.6% to 0.6% was in sharp contrast to the collection in the tubewell scheme which increased during the same three-year period from 12.1% to 73.9%. The audit reported that farmers did not feel pressed to pay water charges or to contribute to the maintenance of the irrigation system because they felt that doing so was unlikely to improve the quality of the services they received, including timely water supply. Adequate cost recovery reportedly was considered possible, but only if the farmers were provided with reliable water supply. It would be interesting to obtain current (1986) data, when reliability of tubewells may have been expected to decline, to see the impact of this on revenue performance.

3.27 In Sri Lanka, as in most countries in the South Asia Region, cost recovery covenants had not been complied with. Studies had been requested under the Mahaweli Ganga Development Project, but these did not achieve entirely satisfactory results. However, prior to 1978 the price of rice in Sri Lanka was controlled by the Government at about 30% below the world market level, so the farmers were paying a large implicit tax--a fact that was surely recognized by farmers.[6/] In connection with the Lift Irrigation Project, Government was reported to be reluctant to introduce water charges.

6/ Easter op cit reviewing an imaginative new policy in 1984 finds collection varies from 15 to 57% of O&M in Mahaweli but with most districts below 15% and 7 of the 17 Districts below 2%. There is a real danger that imagination will outrun practical politics.

With one minor exception, no water charges were collected since that project's inception despite a Government assurance that such charges would be introduced in 1979. A decision taken in 1981 requiring farmers to supply fuel and lubricants for the pumps still left Government with the burden of paying for maintenance and operating staff.

3.28 Europe, Middle East and North Africa. In most projects in the EMENA region, lending covenants required that O&M costs be recovered as a minimum. The attitude of the Bank in addressing non-compliance varied significantly within the region. The Turkey case presents one extreme where the Bank took the drastic action of curtailing further irrigation loans until the matter of non-compliance had been recognized and addressed. Nevertheless, despite various attempts to increase revenues from project beneficiaries, O&M recovery rates never exceeded 4% until 1981, and no attempts to recover investment costs had been made. The Bank attributed this poor performance to Government's agricultural sector policy rather than to sociological factors. A different case occurred in Yemen Arab Republic, where the Bank acknowledged that the original cost recovery covenant was fraught with difficulty and that a tax on gross production, similar to the zakat tax (tithe), was the only one that could be successfully administered under existing conditions. In that country, there had been a special study on cost recovery, but it was controversial and the results were never implemented. Therefore, the Bank accepted the compromise approach of levying a surcharge of one or two percent on gross production from irrigated land, following the centuries-old religious tithe system, which has the advantage of being simple and understandable.

3.29 In numerous cases in the EMENA region the Bank stressed equity considerations. Such considerations, along with early reluctance by the Turkish Government to implement the recommendations of a study on cost recovery, probably were factors in prompting the loan curtailment action in that country. Perhaps most critical was the fact that the beneficiaries in the project area had incomes well above the national average. The Government of Turkey has in recent years shown a willingness to take action to correct the problem, but there is still much to be accomplished.

3.30 Cost recovery in the projects in Morocco, in which the Bank stressed cost recovery issues, appeared to be relatively good. The proportion of invoices paid had increased and approached 90% in the Doukkala I Irrigation Project, for example. The volumetric charge rate of this project was increased significantly (86%) between 1969 and 1980. Pumping rates were indexed to the cost of energy. In all, the audit reported that the then existing level of water charges and the betterment levy were expected to recover 100% of O&M costs and 14% of investment costs. In Jordan, collection was high, approaching 100%, but cost recovery remained low (about 35% of O&M costs) because the charges had not been increased to compensate for inflation. A study was being undertaken in Jordan to determine the appropriate upward adjustment in charges considering farmers' ability to pay. Both Jordan and Morocco were applying volumetric water charges. However, because of its outmoded design, the North East Ghor Irrigation

Project in Jordan required ten times more staff for O&M than the Doukkala Project in Morocco, which had been designed as a capital intensive but modern, efficient and relatively low-cost system to operate. In Egypt, Cyprus and Iran the cost recovery covenants were not satisfied and there was no indication of firm action by the Bank in these projects.

3.31 Latin America and the Caribbean. In the Atlantico Irrigation Project in Colombia, the covenant on water charges was not complied with. A study of the farmers' capacity to pay was required under the loan agreement, but the study turned out to be useless because originally projected conditions could not be realized. A new study was subsequently requested by the Bank which accepted the fact that farmers could not pay for several reasons, including the fact that much of the project area could not be irrigated at the time of the audit. By 1982, water charges had been pegged at US$20/ha/year plus a volumetric charge of 4 cents/m3 (a drainage fee of US$6/ha/year was levied in the rainfed sector). However, cost recovery rates were only about 10% of amounts due because of farmers' reluctance to pay for irrigation and drainage services they considered inefficient. A similar situation occurred in Ecuador in the Milagro Irrigation Project where only small amounts in water charges could be collected before the water system was completed.

3.32 In the Tapakuma Irrigation Project in Guyana, the cost recovery covenant was not complied with in that only 10-15% of the O&M costs were recovered through water charges. A study reportedly was underway to determine a suitable system of water charges. Of importance in this project was the fact that the price of rice was controlled by the Government and had not kept pace with inflation. Farmers were thus paying a significant indirect tax.

3.33 In several projects in Mexico, the typical covenant provision of collecting water charges to meet O&M costs and some investment costs was violated, although in some projects water charges at one time fully covered O&M costs. However, rapid inflation eroded the real value of charge collections. In other projects, like Panuco, where annual rainfall is relatively high and irrigation tends to be supplemental, it was found that charges cannot be easily increased without creating a disincentive for irrigation, resulting in underutilization of the potential irrigation water supply. To increase water charges in cases like Panuco could be counterproductive in achieving the original purpose of the project.

3.34 In Peru, cost recovery under the San Lorenzo Irrigation and Land Settlement Project initially was quite low and, although progress had been made, the respective lending covenant had not been fully complied with. The issue of unreliable service providing an excuse not to pay was mentioned. Under a new system introduced in 1981, most of the funds recovered were to be allocated to the Water User Association under the assumption that such an arrangement would improve collection rates. Water rates were increased from US$6.0 per ha in 1978 to US$10.0 per ha in 1980, and were expected to be raised further in 1983 and thereafter to eventually cover the full O&M cost.

3.35 In general, in the Latin America and Caribbean region, there was no firm action taken by the Bank regarding non-compliance with cost recovery covenants. In each case on apparently valid reason was perceived (e.g., irrigation system not complete, low irrigation adoption rate or high inflation) for the covenant conditions to remain unsatisfied. In several cases the Bank called for studies searching for answers to some of the questions related to cost recovery.

E. Main PPAR Findings

3.36 The following section analyzes the poor cost recovery record in the 48 projects reviewed and presents some additional findings which may be relevant for future Bank policy.

3.37 The statement that cost recovery has not measured up to expectations arising from lending covenants is repeated often in the PPARs. A representative cost recovery rate for the audited projects could not be determined. Recovery rates through direct water charges spanned the range from zero to 100% of O&M costs, and a large number were in the range of 15 to 45%. In more than a third of the projects under review, reference was made to special studies on cost recovery and the farmers' ability to pay which were part of the lending agreements. In general, the results of the studies were not reported in the PPARs or their recommendations were not applied. It is worthwhile noting that all projects under review were formulated and implemented under the 1971 Bank policy, which was much less stringent and specific than that in force in the mid-1980s. Therefore, it can be reasonably deduced and discussion with field staff confirms that the prospects for compliance with the stricter cost recovery covenants in on-going irrigation projects are unlikely to be improving.

3.38 There are three main reasons why cost recovery covenants have been insufficiently observed: (i) lack of government commitment, (ii) poor operation and maintenance of the irrigation system, and (iii) the heavy burden of direct and indirect taxes collected by governments from farmers as a result of price distortions within the economy as a whole.

3.39 The lack of government commitment with respect to cost recovery was noted in a number of projects. Although officials repeatedly expressed recognition of the importance of improving cost recovery from beneficiaries, at project completion, the issue remained a very sensitive political matter. There has been a tendency for action to be repeatedly delayed. Many government agencies have neglected to pressure farmers on cost recovery because they count on government appropriations rather than water charges to finance their operational budget and hence have no direct financial incentives.

3.40 The issue of the quality of the irrigation service, including reliability and dependability of water supply, was stressed in many of the reports. It has been confirmed that farmers will not willingly pay high water charges for poor irrigation operations (not in many instances for a good irrigation supply). Good operation of the irrigation system may be a prerequisite for good cost recovery but it is not a sufficient condition. Certainly cases have been frequently reported where farmers willingly paid more for private well water than they would be willing to pay for public canal water. The reason often given was the superior dependability and timeliness of the private well water supply. However it often helped meet peak demands and thus enabled "free" canal water to be used for most of the season to increase cropping intensity and yields.

3.41 Projects in several countries illustrated the problem of poor operations, involving inequitable distribution of water and lack of responsibility on the part of irrigation engineers for delivering designed discharges to every outlet.

3.42 Maintenance is also critical because projects will deteriorate if maintenance is not adequate, and thus poor collection of water charges, and/or poor budget allocations, sometimes results in unnecessarily high O&M expenses and possibly higher charges to farmers. The PPARs tended to routinely relate the level of O&M to water charge collection. However, when the water charge collections go to the general revenue fund, such a direct correlation is not necessarily valid and seldom is justified. The relation between revenue and O&M standards is more likely to be positive when water charges are collected by the agency doing the maintenance, and an agency which has a clear institutional structure, appropriate responsibility and sufficient revenue. However, a number of irrigation agencies have been found not to be accountable either to the farmers they serve or to government financing authorities, resulting in overstaffing and low productivity.

3.43 Farmers' perception of the effect of increased cost recovery on the quality of O&M is very important. The data do indicate that when cost recovery is good, O&M tends to be better than when cost recovery is poor. However this cannot be proven with current information. It may well be that good O&M facilitates cost recovery rather than vice versa or a tenuous or even a spurious relationship may exist.

3.44 The issue of farmer incentives to utilize the irrigation supplies made available by the projects emerged time and again in the audits. In this context, policies on commodity prices, water charges and other input prices have to strike a delicate balance. On the one hand, they must provide producers with adequate incentives to ensure their participation in the project and, on the other hand, they must help keep the project on a sound financial basis.

3.45 There were several cases where farmers were paying a sizeable implicit tax (i.e., the difference between farmgate prices and the higher border price equivalent) by having to sell their products at low government controlled prices, although it is recognized that such a general tax not only compensates the public sector for the cost of irrigation water but for other important services as well. In the Malaysia Muda project, for example, farmgate prices for rice were projected below international prices for the period 1973-78, with a saving to the national treasury over this period of some US$500 million in 1974 constant value terms. The same issue of "fair farmgate prices" existed in Mexico where the price distortion amounted to an implicit tax of 20 to 50%, and in Sri Lanka, where the indirect taxes were up to 10 times higher than the water charges. A similar situation also existed in Guyana where controlled rice prices did not keep pace with inflation. These examples demonstrate that the Bank's emphasis on direct cost recovery, without proper consideration of implicit tax and indirect recovery mechanisms, was inappropriate.

3.46 Experience from this set of projects also provides some insights of general interest in future applications of Bank financial policy. These relate in particular to the need to employ several alternative cost recovery approaches; the problems in exposing farmers to the real cost of water; the benefits to be gained from farmer participation; ways in which low collection rates can be improved; the difficulty of pursuing cost recovery on a project rather than a national basis; and, finally, how studies can be made more useful.

3.47 The audits illustrate that alternative cost recovery approaches besides direct water charges are possible and in some cases may be better. These include taxes of various types. In some instances commodity price controls have a direct impact on cost recovery from the farmers. However, these aspects are often ignored. Bank staff have tended to implement Bank regulations and guidelines with insufficient regard to their timeliness, utility or applicability to country specific socio-economic conditions.

3.48 Some PPARs state clearly that ways must be found to expose farmers to the real economic cost of water from the start of water deliveries without discouraging irrigation. Projects which provide expensive water to farmers, who in many cases are new to irrigation, can seldom collect high water charges in initial years. Yet, when farmers have received the benefits of water without paying full costs, they are reluctant to accept the increased water charges at a future time. In addition, if the farmers are not exposed to the real cost of water they may choose crops which are financially attractive to them, but marginal or non-economic if the real cost of water is taken into account. Careful thought and negotiation is needed to obtain a reasonable balance between giving valid price signals to farmers yet understanding thoroughly their circumstance and perspectives.

3.49 The participatory role of the farmers in O&M was often emphasized. A number of irrigation projects appraised in the past years, particularly in East Asia, had been designed so as to give the water users full responsibility for O&M of tertiary systems. Bank experience with water user associations and groups is still recent and limited. The excellent cost recovery record in Korea is a good example of the role of water user associations, both in O&M and in improving cost recovery. Leaders of farmers' groups in Korea who are responsible for organizing O&M also act as points of contact for extension agents. This suggests that a link between extension and O&M activities may be desirable at the farm level. In the Philippines, communal farmers' organizations have been relatively successful in O&M of the tertiary and quaternary systems. The public sector financial crisis has forced withdrawal of some irrigation personnel from the field which has provided an opportunity for farmers to prove their capacity to operate and maintain systems efficiently. In Thailand, water users' groups exist mostly on paper and generally have not worked satisfactorily. There are exceptions, however, and some groups have been found successful when the canals were short enough to ensure small size and cohesiveness of the group, and in the traditional systems in the North of the country. In contrast to East Asian countries, little or no attempt to encourage farmers' participation in O&M was made in EMENA, although irrigation has been practiced for centuries in some countries in this region, and farmers have been use to operating, maintaining and repairing their traditional irrigation systems without government involvement. Reviving traditional participation of farmers appears highly desirable for irrigation systems in some EMENA countries. Participation of farmers in the operation of irrigation systems in LAC has helped ensure that cost minimization policies are pursued.

3.50 Even though low collection rates are frequently mentioned as a problem, penalties and dissuasive sanctions such as water supply suspension are reported to be rarely applied. In the event water charges are very low, the collection rate can be high while cost recovery rates remain very low. An efficient collection system, featuring water cut-off sanctions to non-paying farmers, was introduced in Jordan which achieved collection rates close to 100% (para. 3.30). Nonetheless, the recovery rate reached only about 35% of O&M cost because of low water charge rates. Jordan also provides an example that illustrates the effect of lack of indexation as the volumetric water charge rate in Jordan was not changed during the period 1974-1982 despite double figure inflation.

3.51 The audits further illustrate the difficulty of introducing cost recovery on a project rather than on a nationwide basis. This difficulty is particularly acute where the direct cost recovery required in Bank-supported projects significantly exeeds similar requirements in other projects in the same country. Such discrepancies may create an internal problem for government officials. Nevertheless the advantages of special new project charges or rehabilitaiton fees are potentially high and attempts to find viable methods should be maintained.

FINANCING OPERATION AND MAINTENANCE IN IRRIGATION

Agriculture and Rural Development Department
The World Bank

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TABLE OF CONTENTS

Financing Operation and Maintenance in Irrigation

The Problem

1. There has been growing concern, expressed at meetings of the Board by the Executive Directors when considering new irrigation projects, as well as among Bank staff and management, over the implementation of past irrigation investments. The major concern is that the efforts to recover the costs of investment and of operation and maintenance appear to be inadequate. A review was therefore undertaken of a sample of developing countries to assess the performance of different irrigation cost recovery systems. The review confirms that in many countries there is neither effective cost recovery nor adequate resource mobilization in irrigation schemes, although a few countries have been relatively successful on either or both counts. The manner in which countries implement irrigation projects, including the cost recovery policies related to them, varies a great deal. In general, this variance is an outgrowth of differing legislative frameworks, public finance policies, development objectives, and physical, social and ecological factors. The purpose of this note is to discuss the mechanisms for recovering costs and ensuring that operation and maintenance are carried out satisfactorily.

2. The most critical finding to emerge from the review is that government revenue-raising efforts for irrigation, from whatever sources, are typically very weak. The inability of irrigation project entities to obtain sufficient resources to maintain the existing irrigation systems properly (let alone provide for their replacement in due course) is jeopardizing investments in irrigation by most of our borrowers. The project justifications assume that operation and maintenance (O & M) will remain at standards which assure that benefit streams will be unaffected by deterioration of the project infrastructure, but with inadequate resources devoted to O & M that basic assumption does not hold in too many cases.

3. The problem is therefore one of ensuring that adequate resources are received in timely fashion by the authorities responsible for O & M in irrigation projects. It is important to underscore that this is both a resource mobilization and allocation problem, and not a cost recovery or water charges problem per se. Cost recovery (and water charges are among such recovery measures) is part of the resource mobilization process, and the criteria which apply to cost recovery measures include financial (public and private), efficiency and equity objectives. It is unlikely that efficiency and equity goals can be addressed without the financial needs of irrigation being met, either because insufficient revenues are raised or they are not allocated for irrigation financing purposes. However, a restatement of the approach to be taken in appraising irrigation projects is needed in order to clarify the relative contributions which different parts of the resource mobilization process can be expected to make.

Policy on Irrigation Cost Recovery

4. The existing World Bank policy concerning the recovery of costs in irrigation is embodied in OPN 2.10. This note proposes a modified approach to the implementation of these guidelines. Starting from the observation that irrigation water is a costly input and that development and recurrent O & M costs tend to be high, the OPN sets forth the approach by which recovery measures should be built into irrigation projects and irrigation components of rural development and other multi-purpose projects. This approach addresses three basic objectives:

(a) Economic efficiency — The economic efficiency of the project is to be promoted by levels and structures of prices for irrigation water which minimize wasteful use of water and maximize the project's net benefit to the economy. It is recognized that true efficiency pricing is rarely encountered in irrigation projects because it normally requires accurate measurement of volumes of water supplied, to a degree of accuracy that is difficult and excessively costly to attain. But even a nominal price for water is expected to offer incentives to reduce waste in water use. It is also recognized that even if it were possible to charge economic efficiency prices, these may not be compatible with other goals such as equity and public savings. Thus, modified cost recovery measures should be considered to address the equity question and to ensure adequate recovery of project costs.

(b) Income distribution — In order to achieve equity in capturing benefits from a project the OPN recommends progressive benefit charges which at the same time take into account the disincentives, the possibility of payment evasion and the costs of collection that are associated with some forms of benefit taxes. A major consideration would be that the base for computing benefit charges should be an accurate measure of the benefits provided by the project.

(c) Public savings — It is assumed that governments in most developing countries are short of fiscal resources for development, and that it is desirable to collect more revenues from beneficiaries than would result solely from efficiency pricing of irrigation water. The need to mobilize resources and to ensure adequate funds for investments, operation and maintenance may appear to conflict with equity considerations insofar as some project beneficiaries are "poor!" In practice, however, direct beneficiaries of irrigation development are likely to be much better off than those not receiving irrigation water, and equity and resource mobilization concerns should be mutually reinforcing.

5. The OPN identifies different kinds of policy measure which might be used to achieve the above objectives, and offers several guidelines on how to design benefit taxes, measures of cost and rent recovery, the norms of recovery and how to present these matters in appraisal reports.

Review of Experience

6. The review noted earlier was undertaken to sample a wide range of irrigation systems to see what experience has been with implementation of these guidelines and how cost recovery systems function in practice. Some of the major findings are summarized below.

7. Water Charges and Economic Efficiency. Markets for water are not as transparent as the markets for other commodities. Characteristics such as time, quality, location and security of supply generate multiple potential markets. Consequently, there could be a large number of efficiency prices across any one irrigation system and over time.

8. Because of these characteristics of water as a commodity, the demand schedule of farmers on individual irrigation systems, that will reflect their willingness to pay at any given point in time, has proven difficult to estimate in practice. It has seldom been feasible to meter consumption, due in large part to the existing technology of delivery systems and on-farm practices. Examples exist of successful metered systems, but the cost of the meters, recording and billing procedures and farmers' reactions thereto can be prohibitive relative to the benefits of such systems. Careful consideration of the economic costs and benefits must precede the introduction of such innovations. Moreover, the change to such efficient practice usually requires investments in modification of the delivery system.

9. It is very difficult to charge for water when the irrigation system is not fully reliable, e.g., during construction or when the system is not properly operated or maintained.

10. Some existing water distribution systems, (e.g., where water is allocated on rotation at fixed intervals of time), supply water to a farm unit at a particular point in time whether the farmer wants water then or not. Such a system responds to existing rules for allocating water but also to limits imposed by the technology for water distribution across farms. For water allocation among watercourses, the systems operate under similar constraints. These systems impose patterns of water rationing which do not take account of individual farm demands. This rigidity could be modified by improving the effectiveness of water distribution, but long-established water management practices are difficult to change. Attitudes toward water and irrigation are conditioned by a great many cultural considerations. Irrigation as an activity goes back well over 2000 years and attitudes toward it are ingrained and strongly held. Thus, in many countries water is considered to be a "God-given" commodity by both farmers and policy makers, and therefore free. Predictably, this view is not easily changed and, whenever attempts are made to charge for water, conflicts are created

11. Water Charges and Equity Objectives. Any pricing or taxation system has equity consequences that need to be assessed; this assessment of tax incidence can be technically difficult and costly. Water charges levied as a user fee have seldom been used to improve equity, although it is well understood that irrigation development generates significant economic rents for project beneficiaries and that different systems have different income distribution effects. In some cases, the water pricing structure changes the equity pattern indirectly, e.g., in cases where farmers pay more for water when cultivating cash crops than subsistence crops. This often involves an assumption that poorer farmers produce food crops and richer farmers produce cash crops—an assumption which may well be questionable.

12. Irrigation affects the economic rent which farmers receive, and this incremental rent can therefore serve as a measure of benefits received. Rents may be captured via new charges but there are limits on the extent to which it is possible to set up a system that will capture farmers' rents differentially. The limit is set by costs of estimation, collection and enforcement. In dealing with equity issues, countries tend to use one or more of the means of taxation at their disposal. For example, under certain conditions land taxes are a means for achieving equity. As irrigation is made available, land values and farmers' income are expected to go up, and consequently land taxes to increase. The progressivity or regressivity of this tax depends, however, on the tax structure prevailing in the system and the existing pattern of income distribution among beneficiaries.

13. Public Savings Efforts. Policy statements are often made to the effect that water charges will finance O & M costs; a few also include payments for capital costs. In practice, however, most cost recovery systems in existence today seeks to cover only O & M costs at most, and are not designed to collect full capital costs from direct project beneficiaries. Some governments are willing to use additional sources of national revenues, beyond direct user fees or taxes on benefits, to finance the needs of irrigation projects, but such policies encounter constraints at the national level given the competing demands for revenues.

14. Other Elements. In addition to the limitations noted above, there are several contributing factors to this generally unsatisfactory picture. For example, in many developing countries legislation does not exist specifically on water charges, nor on cost recovery generally. Even when it does exist, the laws need to be accompanied by the necessary codes and regulations which allow a cost recovery system to be put into operation.

15. Few public irrigation agencies have autonomy—defined as the capacity of the public agency to set, collect and allocate back to irrigation, funds for O & M and capital expenditures. Even in cases where autonomy appears to exist, it may be only nominal since changes in water charges can require a decision from a central agency of government. The absence of real autonomy may be an important reason why irrigation authorities lack incentives to collect charges or to improve organizational performance, (e.g., upgrading the billing system).

16. Many cost recovery systems, as they operate today, are shaped by institutional factors. Land tenure is one of these factors; if farmers generally are not owners of the land under irrigation, cost recovery is often sought by taxing output in cash or in kind. However, taxation of land could be both more efficient and more equitable in this situation, but this needs to be assessed. Better and less sophisticated institutional arrangements frequently need to be established in order to improve collection. The more sophisticated the irrigation water charge system becomes (e.g., encompassing both efficiency and equity objectives), the more expensive it is likely to be to implement—conceivably to a degree where the cost of collection may be higher than the total amount to be collected.

17. Enforcement of existing laws is often difficult and expensive, since appropriate institutional arrangements for collecting use charges do not exist, and because the sums of money owed by individual farmers are generally too small to justify court litigation by public agencies. Moreover, this mode of enforcement is not available to agencies which are not autonomous.

18. Cost recovery systems have rarely employed any kind of "indexation", although a form of indexing takes place when payments are made "in kind." The lack of indexing results in significant changes in equity, e.g., farmers located in "old" irrigation systems (where the cost at the time of construction was relatively low in nominal terms) often pay much less for the same type of service than those located in "new" irrigation systems (where construction and related costs have typically been higher in nominal terms). Further, in the absence of indexation, when in due course adjustments in water rates or taxes are made they often call for such large quantum changes in water rates or taxes (reflecting increases in of costs in nominal terms) that serious political problems are presented.

19. Summary of Experience. The review of experience in developing countries suggests a series of propositions:

(i) The benefits of and net returns on additional O & M expenditures in irrigation are often very high because of increased and more reliable crop production.

(ii) Cost recovery systems based on water charges and other recovery measures have been successfully implemented in some developing countries, and when they have, the financing of O & M activities has generally improved.

(iii) The organizational and practical aspects involved in O & M activities require much more attention if the effectiveness of irrigation systems is to be sustained.

(iv) Important considerations regarding cost recovery systems include: the need for greater simplicity in establishing collection systems, organizational autonomy, and the extent to which the irrigation technology used affects recovery options.

(v) Water charges are often difficult to implement because of strongly held traditional attitudes and values about water access which make water charges politically difficult to introduce or change.

(vi) Collection mechanisms for cost recovery have often been neglected, resulting in very low rates of cost recovery.

(vii) The importance and complexity of the micro and macro economic problems involved in cost recovery necessitate analysis at both the project <u>and</u> sector levels in order to devise viable recommendations.

Implications for Irrigation Policy

20. Irrigation lending constitutes the largest Bank subsector portfolio and represents more than one-third of all Bank lending in the agricultural sector. Similarly, such investments loom large in the activities of many developing countries, and are proportionately even greater in those countries with large irrigation potential. As a consequence, the economic and financial implications of irrigation are of major importance in a macro-economic context. In this respect, the longer term objective of cost recovery should be to have a system of resource mobilization that will finance capital costs, so permitting the replication of investments. Long term objectives should also include capturing rents from those who benefit directly from irrigation, unless there are specified reasons (e.g., equity or regional development goals), why governments choose not to do so.

21. However, an important short-term objective of irrigation policy should be to ensure that revenues provided to irrigation authorities are, at least, sufficient to meet O & M costs. There are various ways to achieve this objective--funds may be allocated from the central budget (derived from whatever revenue sources are used); funds may come from water charges or other charges imposed on the beneficiaries and paid directly to the irrigation authority; or some combination of cost recovery and general revenues may be employed. This objective is primarily important because of the benefits to be obtained from adequately financed O & M. But adopting this target should also provide an incentive for farmers to pay charges if they see that benefits actually accrue to them. The task is to design and put into place institutional mechanisms which will collect the funds necessary for adequate O & M, and to ensure that they are made available for that purpose. Whatever the mode of resource mobilization being considered, however, there has to be an analysis of how the fiscal system affects farmers incentives.

22. National, regional, state and local authorities may be appropriate vehicles for both revenue collection and the implementation of O&M. For all such institutions, rules and procedures should be designed to fit country-specific conditions and to provide appropriate institutional incentives for effective implementation.

23. In many instances the cost of implementing a system of water charges that could help to achieve full efficiency of water use may be greater than the expected economic benefits. Whenever this is the case, a simpler system of water charges may still be useful as a means of recovering costs (e.g., "area based charges, "or" flat rates").

24. When countries are unable to collect the full amount of O & M and capital costs through water charges assessed against farmers who directly benefit from the project, other means of taxation should be considered. As stated earlier, a comprehensive analysis should be carried out in each case of the impact on efficiency and equity. This analysis should take into account the incidence of other taxes on farmers since the tax burden from other sources may be such that additional taxation could be inequitable, excessive and therefore inadvisable.

25. Additional factors to be taken into account include:

(i) Simplicity: efforts should be made to keep collection efforts as simple as possible, because complex measures become difficult to enforce, and the costs of collection and billing can become self-defeating.

(ii) Autonomy: organizational autonomy has proven to be desirable. Experience shows there is little incentive to collect from farmers if the collection agency cannot retain the funds necessary to provide O & M services.

(iii) Technology of Irrigation: depending upon the costinvolved, projects financed by the Bank should attempt to incorporate technologies which enable planners and farmers to measure water use--as, for example, by a metering system.

(iv) Collection: in most cases more funds could be mobilized from those who benefit from irrigation, but the organization of proper collection systems has to be given careful attention.

(v) Indexing: the systems used to establish water rates must have an indexing procedure to reduce financial problems and inequities across irrigation projects.

26. Because water charges are one among the many prices, taxes and subsidies faced by farmers, careful attention must be given to examining the overall framework in which cost recovery fits. If change in the fiscal system is needed, this should be a major focus of attention in the Bank's dialogue with governments. The best vehicles for such a dialogue are probably through sector work and related structural adjustment lending and sector lending.

27. The thrust of the foregoing is that an important element in project justification of Bank support for irrigation development should be that, at the very least, countries be prepared to mobilize funds and make them available to project entities to the extent necessary to meet adequate O & M costs. Cost recovery is an important part of this effort, and the flexibility built into the Bank's cost recovery principles should be fully exploited in devising any new national program. Responsibility for ensuring, to the maximum extent practicable, the financing required for operation and maintenance requires a national commitment by the borrower.

28. The task of the appraisal team includes review of the means for providing a financial capability to maintain the project as a continuing productive investment. To the extent these means are derived from cost recovery measures in the project area, the existing cost recovery policy applies. In some cases guidance may be required on how to interpret the guidelines, and this type of support service should be provided by OPS as a matter of high priority. Specific attention should be paid at the early stage of the project, preferably well before appraisal, to the design of institutional arrangements for the collection and management of funds, as touched on briefly above, such that the proposed financial plan and the institutional arrangements associated with it can be fully elaborated in the project documents. Provision should also be made for monitoring and evaluating progress in the implementation of whatever program is proposed. Clearly, the rate of progress expected and the type of instruments used can and will vary from one country to another, and these variations should be reflected in the different approaches proposed.

29. In summary:

(a) At the project appraisal stage, assurances will be required that sufficient funds are available for O&M.

(b) At the same time there has to be adequate recognition that the longer term objective is to have a system of resource mobilization that will recover capital costs so permitting replicability of investments.

(c) The mobilization of resources should include capturing rents from those who benefit directly from irrigation unless there are specified reasons e.g. equity, why governments choose not to do so.

(d) In any event, whatever the mode of resource mobilization, there has to be an analysis of how the fiscal system affects farmers incentives.

THE AID APPROACH TO IRRIGATION RECURRENT COSTS: A MIX OF INSTITUTIONAL ALTERNATIVES

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SUMMARY

Over the past few years, the U.S. Agency for International Development (AID) has become increasingly concerned with the need to assure adequate coverage of the costs of operation and maintenance (O&M) in irrigation schemes to which the Agency lends its support. This paper briefly reviews the experience of early AID programs in support of irrigaton and the existing policy with regard to recurrent costs. It then presents an analysis of trends in the current irrigation portfolio in terms of the implementation of the evaluation results and the policy statement and, finally, summarizes the major findings of two recent studies commissioned for AID on this topic.

The review of earlier programs, as described in ex-post evaluations, indicates that improved water management has been an AID concern since the mid 1970s, and in some instances even earlier. The concern, however, was largely motivated by a desire to achieve greater economic efficiency on irrigation schemes. Considerable emphasis was also placed on farmer participation in design, operation and maintenance of irrigation systems as a means of achieving efficiencies.

The AID recurrent costs policy basically proscribes the financing of project recurrent costs unless four conditions are extant: 1) an acceptable host country policy framework; 2) analysis that shows recurrent costs support has a higher developmental impact than new investments; 3) host country inability to pay the recurrent costs at the outset; and 4) a plan for phasing in host country payment of recurrent costs while donor contributions decline.

*The views in this paper are those of the author and do not represent those of the United States Agency for International Development.

In the period since the recurrent costs policy was published, AID projects show an increased effort to address the sustainability problems of irrigation projects by directly dealing the the O&M issues. This coincides with a trend by host countries to make serious efforts to attend to O&M problems for reasons of both economic efficiency and financial constraint. The connection of water management to the ability of systems to be self-sustaining, both financially and otherwise, leads to AID's emphasis on institutional development and a variety of approaches to meeting recurrent costs, rather than a single instrument such as water charges.

The two studies commissioned by AID on irrigation recurrent costs reinforced the direction of the existing policy statement, and advised on refining AID's approach to implementation of the policy.

1. INTRODUCTION

In recent years the U.S. Agency for International Development (AID), along with other donor agencies and host countries, has become increasingly aware of the need to assure adequate coverage of the costs of operation and maintenance (O&M) in irrigation schemes. The reasons for this are several: to achieve and sustain high levels of agricultural productivity as efficiently as possible, to ensure that the benefits of such schemes are equitably distributed, and to provide for system sustainablity in times of increasing financial pressures, particularly upon the central governments of the less developed countries (LDCs).

The discussion in this paper is limited to cost recovery for recurrent costs, because AID does not insist on capital cost recovery, although it is encouraged. The decision to recover capital costs is dependent on, among other factors, the range of instruments at a country's disposal for recovering costs (e.g., direct or indirect taxation), on whether the funds are a grant or loan to the country and on the point in the system at which recovery is attempted. For example, many AID projects require cash or in-kind contributions from farmers toward local-level building or maintenance costs, but charges are not levied to defray the costs of main canal construction or rehabilitation.

The discussion is not limited to water charges, however, because, as the analysis will show, AID has used a variety of mechanisms and combinations of approaches to meeting recurrent costs. This is in part attributable to the emphasis the Agency places on institutional development, and in part to the conviction that the only means of bringing about sustainable improvement in system performance and maintenance is by trying to ensure that viable institutional capacity to address the problems is in place after the donor assistance has ended.

2. EVALUATION FINDINGS

In 1979, the AID Administrator initiated a set of ex-post evaluations designed to assess long-term project impacts. The impact evaluations were to be topical and to be produced in series that would have cross-regional comparability and findings that could be generalized. The series on irrigation was completed in 1983. The summary findings, as presented in

Irrigation and AID'S Experience: A Consideration Based on Evaluations[1/], made the following points related to the recurrent cost issue:

- The primary policy issue is who pays for irrigation. The principle of some cost recovery from beneficiaries should be encouraged. The traditional, community-based irrigation systems are often ignored in policy considerations, sometimes because they represent effective, local-level sources of power.

- Governments are having increasing difficulty supporting new construction, and are turning to rehabilitation of older works. Rehabilitation requires relatively less new capital and seeks to build on the sunk investments and earlier productivity of older schemes and farmers' previous experience in irrigation.

- Scale: Smaller, community-based systems take advantage of management that is aware of local issues and offer scope for innovative and user-oriented designs, while larger systems are almost invariably government-run or managed through a parastatal. The evidence regarding relative efficiency of large vs. small is mixed. Many of the larger systems have split or diffused management, delegating some decisions to locally-based public or private groups.

- Public vs. private: Community-based systems may be regulated by government or be part of larger governmental systems. Private management may be more effective when local knowledge is required, when decisions must be made frequently but not routinely, when quick responses are necessary and when changes in cultivation practices occur. Drainage seems more a public concern. The question of market forces operating for water charges and repayment of infrastructure has rarely worked in donor-supported systems.

- Lack of good management has been noted as the main cause of mediocre system performance. Water management is partially cultural, and is dependent on farmers' perceptions. The management aspect affects the allocation of sufficient water and therefore the relative equity of the system. Water management from the farmer's perspective is often based on pragmatic expectations of water availability rather than on scientific principles. Although irrigation is intended to overcome the unreliability of the natural environment, often the human element proves equally whimsical. There is little dispute that more farmer involvement in system planning will lead to better farmer management.

- There is a generally perceived need for water user associations (WUAs), but in some cases they have been difficult to form.[2/] In some societies, however, traditional, community-based groups have been very effective, although participation diminishes as the size of the groups expand. Primary functions of WUAs are adjudication of disputes, allocation of labor and allocation of maintenance costs. It is recommended that WUAs be formed before construction begins and that farmers be involved in the planning stage of construction or rehabilitation.

In reviewing the eleven individual impact evaluations included in the series (see Annex A for a list of evaluations reviewed), one notes that the problem of sustainability is prominent in all but two of the reports. Sustained benefits of investment in irrigation are closely linked to good water management, or lack thereof, at various levels in the system. However, only four of the reports mention any kind of direct charge levied on farmers to contribute toward operations and maintenance, and hence, management. In all four cases, the charge is not directly related to measured water usage, but is 1) an in-kind payment related to yield per unit of land (Philippines), 2) an arbitrarily set cash fee for the use of water (Peru), 3) a "partial" payment credited to each farmer's account upon the state sale of the regulated commodities produced on the scheme (Sudan) or 4) a cash or kind payment to cover both spare parts and pump maintenance (Senegal). In the latter case, irrigator groupements are also required to amortize the costs incurred by the parastatal in system development.

All but three of the evaluations examined projects with a participatory element, which to varying degrees implied the substitution of labor for capital, in its approach to system O&M. Of the eight that did, six were small-scale, community-based systems, but two were larger schemes with an element of government involvement in water management. The evaluation of the Pakistan project perhaps best expresses what has become a major theme in AID's approach to improved cost recovery for O&M.

> An immediate and very significant impact of implementation of the project, prior even to the attainment of any results from improved water management, was the impetus it provided to the Government of Pakistan to shift its development priorities from large infrastructure projects such as dams to water management -- a previously neglected function. . . . However, unit costs of watercourse improvement could have been reduced, or the project could have been spread further for the same overall cost if farmers had been required to share in the cost, which they repeatedly indicated willingness to do. . . . Increasing farmers' financial stake could have had the added benefit of improving the quality of work performed, as well as their interest in sustaining improvements through subsequent maintenance.[3/]

As noted in the evaluation of the Korean Irrigation Project, local participation is desirable, but is not a prerequisite to increasing farmers' financial stake. The Korean project was placed in a socioeconomic environment characterized by a high degree of bureaucratic centralism and hierarchical structures that did not allow for participation in decisionmaking. The government handled virtually all O&M, and its costs were covered by the very high national returns to rice and barley production, allowing foreign exchange savings by reducing imports, and eventually earning foreign exchange with agricultural exports.

The Korean evaluation also noted that to some extent equity, as well as efficiency, had been achieved by government subsidization of rice production. It pointed out that at the existing support price for rice, farmers could have afforded to pay for the use of water, and to amortize system construction, but smaller farmers would have had to diversify to other commodities such as vegetables, which was at that time illegal on government schemes.[4/] (This points to another issue that will be taken up later: the influence of macroeconomic and certain agricultural sector policies upon cost recovery in irrigation.)

The review of the impact evaluations indicates that improved water management has been an AID concern since the mid 1970s, and in some instances even earlier. The concern, though, was largely motivated by a desire to achieve greater economic efficiency on irrigation schemes, whether newly constructed or rehabilitated. No consistent thought was given in project design to the need for financial sustainability and therefore to water charges, or for that matter, to other means of meeting the recurrent cost requirements. Even at the time of the impact evaluation series, operation and maintenance concerns were still connected to the efficiency argument, and had not yet been raised as a financial viability question in formulating the analytical framework for the series. The financial rationale did emerge somewhat from the findings of the evaluations themselves, and were expressed obliquely in the summary report. The merits of water charges versus more indirect means of assessing beneficiaries were not explicitly addressed. However, considerable emphasis was placed on farmer participation in design, operation and maintenance of irrigation schemes, and this to some extent responded to efficiency, financial and equity concerns.

3. RECURRENT COSTS POLICY

In May 1982 AID published a policy statement[5/] governing its support for recurrent costs (those costs of development activities which recur) in its projects and programs. The statement was prompted by a growing awareness that many LDCs are not allocating adequate resources to finance the recurrent costs of their existing portfolio of development investments, causing these investments to become unproductive, and portending a similar problem with subsequent investments. The background statement pointed out that both host governments and donors have brought about this situation - host governments by inadequate revenue generation, misallocation of resources and inappropriate fiscal and monetary policies; and donors by refusing to fund recurrent costs while continuing to make new resources available for capital costs, thus overburdening the host country capacity to meet operating and replacement needs. The paper also pointed out that poor choice of development investment or poor project design may exacerbate the recurrent cost burden.

In view of the problems outlined in the paper, the policy guidance to AID field missions requires that an analysis of the recurrent costs situation in a country be conducted in formulating AID's country assistance strategy, so that the situation is well understood and AID's projects do not exacerbate the problem. This may result in a dialogue with the host country about its own revenue generation and resource allocation, and with other donors regarding allocation of donor resources for both new capital investment and recurrent cost support either to specific projects or as general budget support.

At the project level, the policy guidance is quite specific. First, AID is to work with the host government to design projects so as to assure that their recurrent cost components are consistent with economic feasibility, using realistic pricing; maximize the generation of revenues from services rendered; privatize public services to the extent possible and rely on local participation to mobilize local-level resources. If an AID mission chooses to finance recurrent costs as either general budget or specific project support, the following conditions must be fulfilled:

- The host country policy framework must be acceptable in terms of revenue generation, resource allocation and macroeconomic policies, or moving toward such a framework.

- An analysis must have been performed to assure that recurrent costs support has a higher development impact than new investments.

- The host country must be shown to be unable to undertake recurrent cost financing.

- A carefully phased plan must have been developed to shift the entire recurrent cost burden to the host government over time.

Finally, the policy notes that if a host government refuses to take sufficient action on project design and/or policy reform, AID should seriously consider reducing the level of assistance to the affected sector or country.

Other AID policies also have a bearing on the treatment of cost recovery for O&M. For example, the Agency's policy on food and agricultural development policy encourages the development of human and institutional capacity that permits a country to develop and apply food and agricultural science and technology toward sustained increases in food availability and improved food consumption. Similarly, the local organizations and cooperatives policy papers support the reliance on local, private sector groups to participate in all phases of a project. The local organizations policy paper specifically states that

> It has become increasingly clear that substantial and long-lasting development cannot be accomplished unless local resources are engaged not only to augment the efforts of government and donors, but also to engender interest in and commitment to a project. . . . A.I.D. planners who wish their programs to benefit through the commitment of local resources should include appropriate local groups in substantive project decision-making.6/

Local organizations are only one means by which AID's projects address the sustainability problem. Although other AID policy statements may have a bearing on the issue of cost recovery in irrigation, the most broadly applicable policy is that on recurrent costs. The next section will examine the extent to which the policy guidance and the findings of the impact evaluations have affected the design of irrigation projects so that there is a more systematic effort to address directly the recurrent cost problems.

4. ANALYSIS OF THE PROJECT PORTFOLIO

For the purposes of this paper, 40 AID project design documents (in AID terminology, Project Papers) were reviewed. (See Annex B for a list of projects reviewed.) The projects reviewed were designed between calendar years 1975 and 1986. They were reviewed specifically with regard to the designs' treatment of the O&M issue, and to determine if any trends over time could be observed. Of particular interest was the degree to which the 1982 policy statement on recurrent costs had had an impact on the project designs.

The table on the next page presents the results of the review of the 40 projects, of which 26 were written before 1982 and 14 were written between 1982 and 1986.

There appears to be a fairly clear trend toward an increased AID effort to address the sustainability problems of irrigation projects by directly dealing with the operations and maintenance issues in the period since the 1982 policy paper was published.7/ However, there was obviously a considerable amount of awareness of the problem prior to 1982, as over one third of the project papers did address the O&M issue through an action component, and more than two thirds recognized the problem but did not design into the project an approach to it.

The reason for the apparent lack of attention to the sustainability problem may have lain outside of AID's control. There may have been a reluctance on the part of the host governments to come to grips with the O&M question. Several of the analyses in the later project documents suggest that host countries have now begun serious efforts to attend to operations and maintenance problems for reasons both of efficiency and financial constraints. Perhaps the most salient example in the projects reviewed comes from four project papers from the same country. In the first three papers, two written in 1976 and one in 1979, almost identical language appears to the effect that

> There will be no direct cost recovery which can be directly attributed to the project because farmers do not pay a user charge for water. The Ministry of Irrigation has no present plan to institute such a charge, claiming that such a practice violates traditional practices. . . It should be noted that farmers contribute heavily to national revenues through the administrated [sic] prices for key agricultural products, which are considerably lower than international or true economic prices.

However, by 1980, when the next project was designed, the thinking had changed significantly.

> There is no provision for irrigation water user charges in this project. Historically [Country X] ha(s) rejected charges for water because it runs counter to . . . religious tradition. Nevertheless, it may be possible to gain acceptance of a distinction between charges for water use, which have been rejected, and charges for water delivery. These latter are in fact applied, albeit on a token scale to urban consumers, and are implicit in the present distribution system for water to farmers' fields.

The above example is perhaps the most dramatic, but not the only one. It is notable that in the sample reviewed, AID did not covenant with host governments prior to 1982 to require attention to O&M (usually by institution and effective collection of a water charge, but sometimes by earmarking revenues). Given the negative experience with covenants reported upon by the World Bank8/, it is doubtful that AID might have been any more effective at requiring governments to address the O&M issue until their own internal imperatives drove them to do so.

Table 1 PROJECT PAPER REVIEW

	Pre-1982[a/]	1982-1986[b/]
Number reviewed	26	14
Action addressing O&M	10 (38%)	9 (64%)
Analysis of O&M issues	15 (58%)	10 (71%)
Means of addressing O&M problem		
Water charges	10 (38%)	10 (71%)
In-kind payments	4 (15%)	4 (29%)
Special taxes	3 (11%)	2 (14%)
General tax revenues	1 (3%)	3 (21%)
Community management[c/]	13 (50%)	9 (64%)
Covenant[d/]	0	5 (35%)
Combination	8 (31%)	9 (64%)
Level to which institutional support directed		
National	8 (31%)	7 (50%)
Regional	4 (15%)	5 (35%)
Community	13 (50%)	9 (64%)
Combination	8 (31%)	4 (29%)

a/ All percentages in this column are of 26 pre-1982 projects reviewed.
b/ All percentages in this column are of 14 1982-1986 projects reviewed.
c/ May include water charge or other cash payment and in-kind payment, including labor.
d/ Condition mutually agreed upon by the donor and host country at the outset of a project. In this case, the covenants usually referred to the imposition of water charges or other fees/taxes, raising fees to more realistic rates and indexing them, earmarking revenues for O&M, establishing WUAs or similar measures.

On the other hand, there was some action on cost recovery underway before the publication of AID's recurrent cost policy paper. The data indicate that over one third of the projects which AID funded prior to 1982 included a water charge to the beneficiaries for purposes of O&M, and sometimes of partial capital cost recovery. The other technique relied upon was the formation of some sort of organization at the community level. In this analysis, such organizations shall be termed water users' associations (WUAs), but many were already extant groups, ranging from extended families to cooperatives, which were managing water use at the local level before AID began its activity. Half of the projects designed during the earlier period included reliance on WUAs for local management and maintenance. These trends have accelerated in the period since 1982, with 71 per cent of the newer projects including water charges, while WUAs are included in 64 per cent. It is also evident that more projects are combining means of meeting the recurrent costs, mostly through a mix of national or regional and local institutions. The reasons for this were well expressed in one of the project papers.

> Conceptually, the project defines the problems of irrigation efficiency in term(s) of those above the public outlet and those below although the workplan itself is integrated. When USAID undertook its first irrigation project in 1978, the widely shared belief was that irrigation efficiency could be increased by improving the design standards and construction practices for irrigation systems. This above-the-outlet approach dealt primarily with technical concerns or, more specifically, water delivery. . . . The problem has proved, however, to encompass more than water delivery and its associated design and construction.
>
> The assumption had been that once water was delivered to the outlet on a reliable and timely basis, the farmers and agencies that work with farmers would be capable of distributing water efficiently and equitably. It was also assumed that the knowledge and incentives required for the efficient application and utilization of water were or would soon be in place. Experience has shown these assumptions to be invalid. While [Country Y] and USAID continue to believe that well designed, well constructed schemes are critical to irrigation efficiency, we now recognize that addressing constraints below the outlet, such as water distribution, application and utilization is equally essential to irrigation efficiency and substantially more difficult.

Although not well reflected in a quantitative analysis, this view is widely shared by AID field missions and is implicit in the design of most irrigation projects started after 1981. In numerical terms, almost two thirds of the projects now include a community management component, compared to one half prior to 1982. These figures do not adequately indicate some of the nuances that one can note in the project narratives. Although almost all project designs are characterized by a recognition of the connection between improved water management and economic efficiency, the later papers also make an explicit connection between improved water management and coverage of the financial costs of system maintenance. Most often this connection is made by noting that beneficiaries are more likely to pay for water that is delivered in a timely and reliable manner, but there is also simply the matter of being able to measure water in order to impose charges. Even where indirect mechanisms such as land betterment taxes, or surcharges on crops are utilized, the benefits of improving management, such as less waterlogging, less salinity, better drainage and so forth, are taken to mean that productivity should improve and revenues rise.

This connection of water management to the ability of systems to be self-sustaining, both financially and otherwise, leads to AID's emphasis on institutional development and a variety of approaches, rather than a single instrument such as water charges. In order to break out of a cycle in which willingness to pay for services can only be expected of farmers if services are indeed rendered, and rendered properly, but doing that takes resources, which will not be forthcoming until performance improves, AID is, in effect, advancing the necessary resources to improve performance and demonstrate to farmers that it is worthwhile participating in the upkeep of the scheme. Where new water development is occurring, project designs attempt to stop the cycle before it starts by addressing questions of who should manage what, how maintenance should be performed, who should pay and in what form, and so on.

The approaches to institutional development operate at different levels, as indicated in the quantitative analysis. At the national level, it may take the form of training and technical assistance, often to bring about a reorientation toward more interaction with users, a greater degree of responsiveness and greater accountability in terms of agronomic and economic efficiency and financial management. There are a number of projects involving regional institutions or irrigation authorities. In some instances, those regional institutions already have a significant degree of autonomy, particularly with regard to raising and expending revenues, and in terms of decisionmaking authority, but their personnel may have the same needs for technical assistance, training and commodity support that the centralized systems required. In other instances, however, the AID project is strongly supporting a decentralization of authority for system management, again by improving regional capacity, but also by dialoguing with the central governments, or by placing certain covenants in the project agreements.

Finally, the support for water users' associations, and related community management has several objectives. First, it is a means of mobilizing local resources and relieving the financial burden on the central government. Second, it is a means of empowerment at the local level vis-a-vis higher levels, so that good performance can be demanded from the system, and resources can be withheld if service is not forthcoming. Third, it partially addresses the equity issue, as there are usually disparities among the water users in a system, and the group approach, in which head-enders are brought together with tail-enders, or the latter are simply empowered to deal with their better-off neighbors, has achieved some success.

It should be noted that there is considerable regional variation in AID's portfolio of irrigation projects, and therefore variation in the means of dealing with the financial and management sustainability concerns. In Asia, and in one country in the Near East, irrigation activities play a much larger part in the overall assistance program than in the other two regions. Asian systems tend to be large, and often AID's projects involve several of the institutional levels discussed above. Improvements in water management must come simultaneously at many levels. In Africa and Latin America, there are predominantly, though not exclusively, projects supporting small-scale, community-based systems, many of which supplement dryland agriculture. In the smaller community-based systems, attention to national irrigation institutions is not generally required, but the initial design of the system must be more carefully scrutinized to ensure the feasibility of local management, and then that the need to equip local institutions for the task is addressed at the same time as the physical infrastructure is being developed, rather than relying upon an assumption that the institutions would materialize after the construction was completed.

This analysis of the project designs must be viewed as a progress report, because many of the newer activities are only now beginning implementation. Some have had interim evaluations, but true impacts related to sustainability will not be measured for some time to come. Some trends are emerging, though, and do appear consistent with the lessons learned from evaluation and with AID's recurrent cost policy statement. More recent projects are systematically addressing the financial sustainability problem as well as the efficiency one through various project components, including policy dialogue with the host country, as evidenced by the inclusion of convenants regarding coverage of recurrent costs. More decentralization of the responsibility for O&M, and devolution of authority to mobilize and allocate local resources also appears to be taking place, albeit slowly. Perhaps equally important, the above project review indicates that AID as an agency, as well as the host governments with which it works, has thoroughly comprehended the need to address both efficiency and financial viability in its irrigation project designs. The record regarding equity is more mixed, with heavy reliance on community groups as the principal means of achieving this latter objective.

5. STUDIES OF RECURRENT COSTS IN IRRIGATION

Two AID-funded studies of the operation and maintenance problem, and the need to meet recurrent costs in irrigation have been completed in the past two years. These provide some additional insights, and will assist in shaping future policy dialogue and project designs and in implementing current projects. By examining country cases, the studies describe a range of alternatives, and bring to AID the experience of host countries and donors that lies beyond the rather narrow vista of AID's own experience. One study was supported by AID's Program and Policy Coordination Bureau, which examined the Peru, Dominican Republic, Morocco, Philippines and Indonesia cases and presented an analysis of the implications of direct and indirect charges in meeting recurrent costs, as well as the role of increased farmer participation in system management to defray such costs[9]. The second was commissioned by AID's Bureau for Asia and Near East, and included country studies of the Philippines, Nepal, Maharashtra State (India) and Sri Lanka and a cross-country analysis of the four cases that provides operational recommendations for donor and/or host country projects[10]. Although quite different in their objectives, the conclusions of the two studies are complementary.

The worldwide irrigation pricing and management study was policy-oriented in nature, and thus reached some conclusions on questions that should be answered prior to deciding how O&M requirements should be met in a given project. The principal conclusions of the study, very briefly summarized, were

i. All system planning should include a means for cost recovery and all beneficiaries, no matter how poor, should be asked to pay something toward O&M.

ii. Direct charges are preferable to indirect charges.

iii. Payment need not be in cash; in-kind payment is often better.

iv. Revenues generated should be directed back to O&M on a system-by-system basis as much as possible; they should not be returned to the general treasury.

v. Local-level control, of both resource mobilization and resource allocation (including labor) results in higher rates of participation and appears to result in improved O&M, although there are as yet very few cases in which responsibility has been thoroughly devolved.

The study of recurring costs in Asia pointed out seven alternatives in meeting those costs: "(a) increased investment by government; (b) collect more fees from users to invest in O&M; (c) turn systems or parts of the systems over to groups of farmers and let them do the O&M;. . .(d) have farmers contribute the labor part of O&M;" (e) turn O&M over to a third party (e.g., a private or state assisted enterprise; and (f) have donors provide a fund for O&M; or (g) establish a commissioning fund, in which donors set aside the first few years' O&M on a declining basis while the government increases its contribution over the same time period.[11/] The feasibility of each of these alternatives was discussed, pointing out that options increasing farmer participation have met with some success, that the third-party and commissioning approaches are largely untried, and that the experience with the other options has been negative.

The study concludes with conditions for increasing the collection of fees from farmers. The first four are necessary in all circumstances, and the fifth and sixth may be required in some instances. The six are:

i. a current information system on water recipients;

ii. dependable water delivery;

iii. efficient fee collection;

iv. actual application of funds collected to system O&M;

v. collections may have to start at the time that a project starts or a system is rehabilitated in order to take advantage of the economic surplus generated as well as to accustom farmers to fee paying;

vi. penalties for non-payment may need to be imposed.

The study also points out that there may be a lag time between improved system performance and willingness to pay fees, and that donors need to explore the alternatives and put in place a mechanism for meeting recurrent costs at the outset of an irrigation project.[12]

One other issue that emerged from both of the above studies, from the World Bank's study[13] and from AID's evaluation series, is the importance of carefully analyzing the impact of macroeconomic and sector policies on the ability of the beneficiaries to absorb more of the recurrent costs of irrigation. A number of country cases have been cited in which the implicit tax burden imposed upon farmers by controlled prices, controlled access to inputs or markets and the like severely limit the profitability of farming and the farmers' ability to pay direct water charges, special levies, betterment taxes or, for that matter, to contribute labor that is required elsewhere in order to supplement the farm income when returns to farming are administratively controlled. An inappropriate policy environment may also limit the foreign exchange available for necessary spare parts (as frequently happens in pump irrigation in Africa), or reduce the returns to farmers such that their interest in maintaining the system wanes.

6. CONCLUSION

In reviewing the impact evaluations and project papers, this analysis has concluded that a trend is emerging whereby AID is systematically addressing the need to meet recurrent costs in irrigation in order to achieve sustained benefits from its investments and those of the host country. The approaches used are diverse, but concentrate on financial and institutional viability simultaneously. A variety of means, including direct charges, indirect revenue generation, payment in kind, mobilization of labor and combinations of these elements, are used. Attention is given different institutional levels, from national to local, in whatever mix is appropriate. The linkage between system performance and willingness to pay has also become clear to AID, and many projects concentrate on improving water management, through institutional development as well as including a component for physical rehabilitation (or new construction). This is again a recognition of the importance of systems and procedures as well as trained personnel in the sustainability of irrigation systems. Insights from the analyses of country case studies are also being used to improve our understanding of the appropriate policy framework, host country and donor constraints in policy implementation and the different alternatives available to overcome those constraints. Although the record is far from perfect, the trends in comprehension of the problems in, and action interventions to improve, irrigation system operation and maintenance are encouraging from the perspective of at least one donor agency.

Notes

1/ Steinberg, David I. et al., Irrigation and AID's Experience: A Consideration Based on Evaluations, AID Program Evaluation Report No. 8 (Washington, D.C.:U.S. Agency for International Development, 1983), pp. iv-ix.

2/ Studies of local organizations in development show that group formation and mobilization to take on an unfamiliar development function are lengthy processes requiring intensive effort. The timing and level of effort are not always compatible with the short duration of many development projects, especially those involving the construction of physical infrastructure.

3/ Painter, James E. et al., The On-Farm Water Management Project in Pakistan, AID Project Impact Evaluation Report No. 35 (Washington, D.C.:U.S. Agency for International Development, 1982), pp. 22 & 27.

4/ Steinberg, David I. et al., Korean Irrigation, AID Project Impact Evaluation Report No. 12 (Washington, D.C.:U.S. Agency for International Development, 1980) pp. 6, 11 & 13.

5/ U.S. Agency for International Development, AID Policy Paper: Recurrent Costs (Washington, D.C.:U.S.A.I.D. 1982).

6/ U.S. Agency for International Development, AID Policy Paper: Local Organizations in Development (Washington, D.C.:U.S.A.I.D. 1984), p. 7.

7/ Of the five project designs that did not contain an action component on O&M, one project's analysis indicated that the regional authority was already recuperating sufficient funds to meet recurrent costs; one was a private voluntary organization initiative to which AID's policy cannot be stringently applied; one project was comprised entirely of technical assistance and training for irrigation management; one was a continuation of an earlier project and one was reviewed and approved at the field mission. Strictly speaking, only the last two should have been in compliance with the recurrent costs policy and were not.

8/ World Bank. World Bank Lending Conditionality: A Review of Cost Recovery in Irrigation Projects (Washington, D.C.:World Bank 1986).

9/ Carruthers, Ian et al., Irrigation Pricing and Management (Washington, D.C.:Devres, Inc. 1985).

10/ Easter, K. William, Recurring Cost of Irrigation in Asia: Operation and Maintenance (Ithaca, NY:Cornell University 1985).

11/ Ibid., pp. 46-48.

12/ Ibid., pp. 56-59.

13/ World Bank, op. cit.

ANNEX A

Impact Evaluations Reviewed

Development Management In Africa: The Case of the Bakel Small Irrigated Perimeters Project in Senegal. AID Evaluation Special Study No. 34 (Washington, D.C.: 1984).

Bangladesh Small-Scale Irrigation. AID Project Impact Evaluation Report No. 42 (Washington, D.C.: 1983).

Egypt: The Egyptian American Rural Improvement Service, A Point Four Project, 1952-63. AID Project Impact Evaluation Report No. 43 (Washington, D.C.: 1983).

Korean Irrigation. AID Project Impact Evaluation Report No. 12 (Washington, D.C.: 1980).

On-Farm Water Management In Aegean Turkey, 1968-1974. AID Project Impact Evaluation Report No. 50 (Washington, D.C.: 1983).

The On-Farm Water Management Project in Pakistan. AID Project Impact Evaluation Report No. 35 (Washington, D.C.: 1982).

Peru: Improved Water and Land Use in the Sierra. AID Project Impact Evaluation Report No. 54 (Washington, D.C.: 1984).

Philippines: Bicol Integrated Area Development. AID Project Impact Evaluation Report No. 28 (Washington, D.C.: 1982).

Philippine Small Scale Irrigation. AID Project Impact Evaluation Report No. 4 (Washington, D.C.: 1980)

Sederhana: Indonesia Small-Scale Irrigation. AID Project Impact Evaluation Report No. 29 (Washington, D.C.: 1982).

Sudan: The Rahad Irrigation Project. AID Project Impact Evaluation Report No. 31 (Washington, D.C.: 1982).

ANNEX B

Project Papers Reviewed1/

Country	Title
AFRICA	
Cape Verde	Tarrafal Water Resources Watershed Management and Soil Conservation
Chad	Irrigated Crop Production PVO Development Initiative
Mali	Action Ble
Mauritania	Small Irrigated Perimeters
Niger	Irrigated Agriculture
Senegal	Small Irrigated Perimeters
Somalia	Shebelle Water Management
ASIA AND NEAR EAST	
Egypt	Water Use and Management Canal Maintenance Irrigation Pumping Irrigation Management Systems
India	Gujarat Medium Irrigation Rajasthan Medium Irrigation Maharashtra Irrigation Technology and Management Irrigation Management and Training Hill Areas Land and Water Development Maharashtra Minor Irrigation
Indonesia	Sederhana Irrigation and Land Water Development II Small Scale Irrigation Management
Pakistan	On-Farm Water Management Irrigation Systems Management

Philippines	Small Scale Irrigation Bicol Integrated Area Development III Small Farmer Systems I
Sri Lanka	Mahaweli Ganga Water Management I
Thailand	Northeast Small Scale Irrigation
ANE Regional	Water Management Support

LATIN AMERICA AND CARIBBEAN

Bolivia	Disaster Recovery Project Village Devlopment Project
Dominican Republic	On-Farm Water Management
El Salvador	Small Farm Irrigation Systems Water Management
Guyana	Small Farm Development - Black Bush Region
Haiti	Water Resource Development Community Water System Development Integrated Agricultural Development
Honduras	Irrigation Development
Peru	Use of Treated Sewage for Irrigation Land and Water Resources Management Improved Water and Land Use in the Sierra

1/ Not all projects reviewed had an action irrigation component (e.g., construction, institutional development, etc.). Of the projects listed, only 40 proved amenable to analysis for treatment of irrigation recurrent costs. There are more projects in the AID irrigation portfolio than reviewed for the analysis, but documentation was not available in Washington, D.C. on the irrigation projects excluded from the sample.

References

Carruthers, Ian D. et al. Irrigation Pricing and Management. Washington, D.C.: Devres, Inc., 1985.

Easter, K. William. Recurring Cost of Irrigation in Asia: Operation and Maintenance. Ithaca, N.Y.:Cornell University, 1985.

Painter, James E. et al. The On-Farm Water Management Project in Pakistan. AID Project Impact Evaluation Report No. 35. Washington, D.C.: 1982.

Steinberg, David I., Cynthia Clapp-Wincek and Allen G. Turner. Irrigation and AID's Experience: A Consideration Based on Evaluations. AID Program Evaluation Report No. 8. Washington, D.C.: 1983.

Steinberg, David I. et al. Korean Irrigation. AID Project Impact Evaluation Report No. 12. Washington, D.C.: 1980.

Svendsen, Mark. An Unofficial Donor Perspective on Irrigation System Recurrent Cost Recovery. Mimeo, 1986.

U.S. Agency for International Development. AID Policy Paper: Food and Agricultural Development. Washington, D.C.: U.S. Agency for International Development, 1982.

U.S. Agency for International Development. AID Policy Paper: Local Organizations in Development. Washington, D.C.: U.S. Agency for International Development, 1984.

U.S. Agency for International Development. AID Policy Paper: Recurrent Costs. Washington, D.C.: U.S. Agency for International Development, 1982.

World Bank. World Bank Lending Conditionality: A Review of Cost Recovery in Irrigation Projects. Washington, D.C.:World Bank, 1986.

RESOURCE MOBILIZATION IN FARMER-MANAGED IRRIGATION SYSTEMS: NEEDS AND LESSONS

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1. BACKGROUND

There presently is widespread interest in the topic of appropriate government funding for irrigation development, including both the initial and continuing costs. In the past, even well endowed states have been miserly in assigning resources for O&M purposes. Now with restricted budgets, and a worldwide ethos of reduced government involvement in various sectors, there is increased interest in inducing the mobilization of irrigation development resources in the private sector.

In most instances concern with mobilizing resources for irrigation development has focused exclusively on that sector of irrigated agriculture served by the hydraulic works owned and operated by the State—what we might call State systems. As we have seen in the prior presentations, there are large concerns with both reducing the direct costs to government of building and operating these systems as well as concerns with increasing the charges made to the direct users of the irrigation facilities. There has been less attention to the matter of resources for the irrigation systems that lie outside the State sector and are managed by farmers themselves—what we call, herein, farmer-managed irrigation systems (FMIS). In a number of countries, FMIS serve a very significant portion of the national irrigated command.

This paper is primarily concerned with FMIS. It focuses on two sets of interlocked questions. The first is a somewhat novel one in the context of concern for financing irrigation development—it focuses squarely on the FMIS.

Question #1: What public policies regarding assistance to FMIS are needed to insure continued strong farmer commitment to mobilizing the resources required for operating and improving their systems?

As we will argue below, this is a critical question because many current policies significantly deter such continuing commitments. In fact, in many parts of the world, governments are actively involved in transferring FMIS, which are largely self-financing, into State systems. This process usually significantly disrupts and discontinues the resource mobilization activities of farmers.

The second query is one that many people have begun to explore—it focuses on the FMIS as a source of relevant experiences and ideas.

Question #2: What can be learned from an understanding of the processes of resource mobilization in FMIS that might be applied in the context of State systems so as to increase farmer contributions to system operation and development costs?

2. RESOURCE MOBILIZATION IN FMIS

Answers to the above questions should derive from a thorough understanding of the processes and experiences of resource mobilization in FMIS. In the last few years, several graduate students associated with the Cornell Irrigation Studies Group have examined this topic in their field research. A summary of the findings from several such studies is presented in the following paragraphs.[1] One should note that these studies have focused on systems in which the processes of resource mobilization are "alive and well." Thus, they give us some notion of what the upper limits of local resource mobilization might be—they tell us what is possible in some FMIS. But, of course, one should not expect that all FMIS either require, or are capable of, such sustained levels of resource mobilization activities. As a footnote, there is need for more research on the negative cases—for examination of systems in which local resource mobilization has fallen behind the needs or simply stopped functioning.

Many FMIS mobilize large amount of resources from their member farmers. Labor is the most common resource required from the farmers, but cash and materials are also contributed by farmers in some systems. Table 1 presents the annual labor mobilization for six hill systems in Nepal. The figures were taken from the written attendance records of the organizations.

Table 1 ANNUAL LABOR MOBILIZATION IN HILL SYSTEMS IN NEPAL

Organization	Number Years Labor Records	Man-days Labor Mobilized Per Year	Man-days/Ha.	Man-days/ Member
Thulo Kulo, Chherlung	3	2,440	70	23
Tallo Kulo, Chherlung	7	1,979	111	32
Raj Kulo, Argali	18	1,909	41	12
Kanchi Kulo, Argali	5	608	54	22
Saili Kulo, Argali	4	1,208	81	24
Maili Kulo, Argali	11	827	52	11

Source: Martin, 1986.

If the labor is valued at the daily wage rate of Rs. 10, the imputed value of the labor mobilized in these six systems ranges from Rs. 410 to Rs. 1,110 per ha and from Rs. 110 to Rs. 320 per member. At the 1983 exchange rate of Rs. 14.2 per US $1.00, the cost per ha ranged from $29 to $78. In contrast, the charge for water in government irrigation systems is Rs. 60 or Rs. 100 per ha per season for a maximum of Rs. 200 per ha per year.

In addition to labor, some systems in Nepal require significant cash payments by members. Cash is mainly used to purchase cement to repair and improve the system. Occasionally contracts are given to specially skilled laborers, such as masons or tunnel diggers, for special work on the system. Table 2 presents the cash assessments from members in the Thulo Kulo system of Chherlung for three years.

Table 2 CASH ASSESSMENTS, THULO KULO, CHHERLUNG

Year	Total (Rs.)	Rs./Ha (Rs.)	Rs./Member (Rs.)
1982	15,000	431	143
1983	34,800	1,000	331
1984	9,000	259	86
Average	19,600	563	187

Source: Martin, 1986.

If the value of the labor mobilized annually by the Thulo Kulo organization of Chherlung is added to these figures, the resource mobilization per hectare ranges from Rs. 959 to Rs. 1,700, and the per member contribution from Rs. 316 to Rs. 561. The average annual cost per ha for labor and cash mobilized in this system was $89.

Siy (1982) studied a federation of nine irrigation associations, termed **zanjeras**, in the Ilocos region of the Philippines. Approximately 500 ha are farmed by more than 400 farmers within the federation. Each year the farmers of the federation face a major task of repairing a brush weir which diverts water to the command area. An enormous amount of labor (and some other resources) must be mobilized for this. In 1980, Siy reports that nearly 16,000 man-days of labor were mobilized, an average of 32 man-days per ha or approximately 40 man-days per member farmer. At the 1980 local daily wage rate of Pesos 8 per day, the value of this labor was US $34 per ha or $43 per member. Siy estimates that an additional $11.25 per ha in food was expended by the federation for those who participate in the work, and that members provided materials valued at $1.19 per ha. Thus, the value of the resources mobilized annually for operation and maintenance is estimated to be $46.50 per ha.

A farmer-managed tank in Tamil Nadu, South India, studied by Meinzen-Dick (1983) carried out operation and management in a different manner. The farmers are responsible for the costs of operation and repair, but instead of contributing their labor they pay their own "staff" for maintenance and water distribution activities and contribute cash to a tank fund for other incidental expenses. In addition, they may be required to provide their own labor for some repair work. The estimated value of the total farmer contributions for operating and maintaining the tank system in the year of the study (1982-83) was US $35 per ha. Farmers cultivating the best double-cropped soils paid an additional fee to the association of $8 per ha.

Table 3 summarizes the data on the value of resources mobilized by farmers for operation and maintenance of farmer-managed systems.

Table 3 **VALUE OF RESOURCES MOBILIZED FOR O&M IN FARMER-MANAGED IRRIGATION SYSTEMS**

Country	Value of Resources Mobilized Annually/Ha
Nepal	$ 29 - 89
Philippines	47
India (Tamil Nadu)	35 - 43

The level of resources contributed by the farmers in these representative systems is significantly higher than the fees that are collected from farmers in most irrigation systems managed by government irrigation agencies. In a regional study on irrigation service fees, Small, Adriano, and Martin (1986) found considerably lower rates of irrigation charges in all of the countries studied, with the exception of South Korea. A summary of their findings is reported in Table 4.

Table 4 **O&M EXPENSE AND FARMER PAYMENTS IN AGENCY-MANAGED SYSTEMS ($/ha)**

Country	O&M Cost	Irrigation Service Fees Levied	Approximate Percent of Fees Which are Collected	Average Farmer Payments
Indonesia	22	NA	NA	15
Korea	211	196	98	192
Nepal	10	6	20	1
Philippines	14	17	62	10
Thailand	0	0	-	0

In addition to these figures, Palanisami and Easter (1983) report that the Public Works Department of Tamil Nadu expends only US $2.50 per ha on repairs. This is negligible compared to the $35-43 contributed by farmers in the farmer-managed tank studied by Meinzen-Dick (1984).

3. FACTORS RELATED TO RESOURCE MOBILIZATION IN FMIS

The above data show that farmers in FMIS contribute far more to operation and development of these systems than do counterparts in State systems. In many of the agency-managed systems which charge farmers for irrigation services, the fees are relatively low. The low collection rates in many countries result in an even lower rate of resource mobilization. Why is resource mobilization so effective in some FMIS?

While the reasons are both diverse and complex, for purposes of this discussion, we wish to highlight four points.

POINT #1. In FMIS, resource mobilization is done in the context of control of overall system operation. Farmers are asked to contribute resources to sustain and develop a system that they are in charge of—either directly or through selected leaders. There is thus a high degree of accountability between those who provide the resources and those who "spend" them. This usually creates a very direct relationship between resources provided and results observed. Payments do not disappear into a "black box" which is then controlled by resource managers who have little or no accountability to those who have provided the resources.

POINT #2. In FMIS, resources are usually mobilized for specific jobs to be done rather than for a general operations and improvement fund (Tan-kim-yong, 1983). This procedure has several important advantages. First, each cycle of resource mobilization requires the "planners" to engage farmers in decision-making and priority-setting since the farmers must be convinced of the significance of the purpose for which resources are being requested and the procedures by which they will be utilized.

POINT #3. In FMIS, resources are mobilized using principles and procedures that are judged locally as "fair." Often this fairness is achieved by assigning the responsibility for resource provision in proportion to the "water rights" held by individuals. Water rights may be conceptualized in a variety of ways—as specific volumes of water, proportions of the total flow, guarantees of sufficient water for a specific crop and so on—but here the point we wish to make is that the water rights are interlocked with responsibilities to provide resources for reproducing the system.

POINT #4. In FMIS, there is capacity to mobilize resources for quite different critical tasks—depending upon the local circumstances and needs. Thus, in the systems analyzed by Martin (1986) and Yoder (1986) in the hill regions of Nepal, a major system need is resources for repair of the system headworks and main conveyance canal during the wet season. In contrast, Duewel (1986) has analyzed systems in Central Java (Indonesia) in which the major purpose of resource mobilization is for improving the distribution of scarce water supplies in the dry season.

4. FMIS AS RECIPIENTS OF PUBLIC ASSISTANCE

FMIS have been receiving public assistance of various sorts for a long time.[2] In fact, it presently is difficult to find pristine FMIS that are completely without external assistance of one type or another. But, the nature of the assistance, the agency channeling it, and the implications of the aid for the future autonomy of the FMIS and the continued commitment to resource mobilization by local people are all quite varied.

The trend seems to be the following. In a number of countries, until a few years ago, much of the assistance provided to FMIS was delivered through nonirrigation agencies—departments of community development, local government, or sometimes agriculture. In many places, assistance by such agencies continues and is characterized by the following features: (1) usually the amount of assistance per system is quite small, (2) typically, the agency has only limited technical engineering capacity, and (3) the FMIS remain in farmer control following the assistance intervention—largely because the assisting department has no program of actually operating and managing irrigation systems.

In more recent years, irrigation departments have begun assisting FMIS and displacing the assistance provided by the nonirrigation agencies. The reasons for the growing involvement of the irrigation departments are diverse but include the fact that in various countries and regions opportunities for further construction of large-scale hydraulic facilities are closed, or nearly so. The assistance to FMIS by irrigation departments has features that contrast markedly with those noted above for the nonirrigation agencies: (1) amounts of assistance per system are higher, (2) the agency typically is staffed with engineers, and (3) there is a strong tendency for the irrigation departments to bring assisted FMIS into their management orbit.

This trend has large implications for the matter of government costs for irrigation development and O&M. Many current approaches to public assistance for FMIS result in moving to the public sector costs, both initial and recurring, that were previously covered by the private sector. Not only are FMIS provided with an expensive technological apparatus, for which they may be required to pay little or nothing, but much of the burden of recurring costs is also transferred to the irrigation department which may provide government staff for "managing" the system and hire the farmers to perform maintenance activities that they previously performed on their own. In short, present assistance to FMIS frequently exacerbates the problem of government costs by substituting public resources for private ones and reducing the incentives of local people to continue mobilizing their own resources for irrigation development and operation. We should add the sad commentary that this trend is one to which various international donors contribute through the irrigation development projects that they promote and fund in the Third World.

The point to be made here is **not** that FMIS do not require external assistance. Clearly, there are numerous situations in which such assistance is needed and desired by local people. Needs for assistance may arise because of natural calamities, long-term negative trends in water supply, new technological opportunities, or for other reasons. What is needed is not the discontinuance of public assistance but rather the provision of public assistance in a manner that reduces initial and continuing public costs while reinforcing the capacity of local groups to mobilize resources which they control.

At a minimum, irrigation agencies should refrain from assuming control over and responsibility for FMIS. In addition, they should design means for acting affirmatively to assist FMIS without discouraging continued local support. While the specifics of such a policy will vary from situation to situation, the basic principles on which the approach should be based are discernable (Coward, 1984). These include:

i. the FMIS should have the lead in identifying priority needs——with technical support in considering options provided by the agency,

ii. external resources, with some provisions for repayment, should be used to match locally mobilized resources. Control over the external resources should rest with the FMIS to be used within guidelines provided by the agency, and

iii. there should be no ambiguities regarding water rights for the FMIS and control of the system by the FMIS following completion of the external assistance.

In short, FMIS represent a segment of the irrigation sector that can contribute significantly to national production and income goals with little direct dependence on the national budget. A prime public policy objective in irrigation development should be to assist these FMIS, as required, while supporting their continued autonomy and self-financing.

5. IMPLICATIONS OF FMIS RESOURCE MOBILIZATION FOR GOVERNMENT-MANAGED SYSTEMS[3]

An important question for policy-makers concerns the applicability of our knowledge regarding resource mobilization processes in FMIS for increasing resource mobilization on the part of farmers who are served by government-managed hydraulic facilities (Question #2, above). No one expects a direct transfer of experiences—rather one tries to ascertain what are the features that induce resource mobilization in FMIS and whether it would be possible to replicate those inducements in the context of State-operated systems. It seems clear that any attempt to merely shift costs from the agency to the farmers will be met with resistance by the latter.

5.1 Defining Farmer O&M Activities

Before moving to a discussion of the factors required to induce greater farmer mobilization of resources for O&M activities, we need to be more explicit regarding the O&M activities that we have in mind. We also wish to note two qualifying points.

First, farmer O&M activities should go beyond those that the agency typically "assigns" to irrigator groups—maintaining the tertiary facilities, settling disputes among themselves about the distribution of water they receive at the head of the channel, and in some cases, collecting the agency's irrigation fees.

Second, the level at which these O&M activities are performed is something to be determined empirically, based on what users can effectively manage. Typically, farmer responsibility is accepted, or expected, only "below the outlet," below the turnout which delivers water to the field channel (or tertiary) level. Whether users have an O&M role "above the outlet" (Chambers, 1984), and if so, how far above, could have an important effect on how much the government's O&M costs can be reduced. So no a priori assumptions restricting the farmer role "below the outlet" should be made. But this issue needs to be treated as a matter of working out a new shared division of labor, not of "shifting burdens onto users." Otherwise one cannot expect effective farmer mobilization of resources for O&M to result.

Farmer involvement in maintenance activities is relatively straightforward. Given the typical delivery systems in most canal systems, canal cleaning and reshaping is a recurring need. Also, where structures are made of local materials (wood, stone, etc.), farmers are expected to repair and replace these artifacts as necessary. Farmers may also be made responsible for the upkeep and repair of certain structures that are built of nonlocal materials—concrete distribution boxes, for example.

Farmer involvement in systems' operations has been less clear. Typically, irrigation agencies have preferred to restrict farmer participation in operational activities to selected activities below some "turnout" point—which in some systems seems to have been moving lower and lower as agency attempts to expand control have increased. Moreover, farmer involvement often has been limited to implementing the pattern of water distribution that has been established by the agency, for example, the rotational distribution patterns currently popular with many irrigation departments. Such limited operational responsibility does not necessarily produce the best distribution of water, being often inflexible or poorly adapted to local conditions, but it also reduces the incentive for users to take on responsibility for resource mobilization for operations and maintenance activities.

We suggest that farmer involvement in system operations should include the activities of acquiring, allocating, and distributing water. By acquiring water, we mean those activities involved in moving water from some source point to the outlet serving the group involved. In a small-scale system, these activities would involve building or repairing the weir (in a diversion system) or bund (in a storage system) and conveying the water captured to the command area. In a large-scale system, acquiring water would include activities above the outlet that direct more water to the command area of the group concerned—coordination and decision making with other groups or with the government agency, opening and closing various control structures, etc. Allocating water refers to the process of deciding how the water acquired will be apportioned to the users—utilizing information about water rights, crop requirements, and water supplies, for example, to determine what crops will be permitted in what areas. Distribution of water refers to activities through which water allocation decisions are implemented—opening and closing gates, monitoring water flows, observing field needs, etc.

Active farmer involvement in these several operational processes, which get at the heart of irrigation activities, will provide a reason for water user organizations to function in resource mobilization and an incentive for giving attention to maintenance and improvement responsibilities—improved and better maintained systems will allow for more effective acquisition, allocation, and distribution activities.

5.2 Propositions for Action

The effective increase of farmer-mobilized resources to replace some government-provided resources in large public irrigation systems can only be accomplished in the context of several new policies and procedures for implementing irrigation development. While one cannot provide a blueprint of those policies and procedures for the varied conditions in which irrigation development occurs, it is possible to suggest several basic propositions for developing them. Based on our familiarity with the literature and a variety of field experiences with FMIS and with significant action experiments to improve government activities in irrigation development in the Philippines, Indonesia, and Sri Lanka, we suggest the following five propositions.

5.2.1 The Rao Proposition

Any effort to reallocate responsibilities for resource mobilization between the irrigation agency and farmer groups must include reexamination of the processes currently being used to design and construct irrigation works. We agree with Rao (1984) that the current processes result in many irrigation facilities that are "unproductive, irrelevant, and extravagant." Getting farmers to take on O&M responsibilities for facilities with these characteristics may be futile—ditches that are wrongly located, distribution boxes that are unnecessary, or control gates that are overly elaborate. The reasons that such facilities are designed and built include: professional bias toward complex structures, a lack of agency and/or contractor accountability to the farmers who will use the facilities, and the significant financial "leakages" that often arise during the design and construction activities.

Many of these problems can be ameliorated in two ways. First, it is important that farmers have a stake in the cost of what is being designed and constructed. This is the case when there is a clear public policy that farmers will be required to repay some portion of these costs. This requirement then can create farmer demand for greater involvement in both design and construction phases. Program experiences in the Philippines, Indonesia, and Sri Lanka demonstrate that farmer participation in the early stages of project planning and system layout and design can improve the decisions that are made. Thus, farmer responsibility for a portion of construction costs complemented by farmer involvement in these initial project activities can help insure a physical infrastructure that fits the local situation, structures that are well built, and a farmer group committed to using and maintaining properly the new infrastructure.

The basic point of the Rao proposition is to remind us that successful farmer involvement in O&M activities should begin with clear responsibilities for some repayment and involvement in designing and constructing facilities that are appropriate to the locale and that are acknowledged by farmers as being useful and worth using and repairing.

5.2.2 Bureaucratic Reorientation (BRO)

The willingness and ability of users to assume responsibility for resource mobilization is affected by the activities and attitudes of government personnel——how prepared they are to work cooperatively with farmers, how much credit they give farmers for skill and intelligence, how flexible they are willing to be in accommodating a variety of tempos, approaches, etc., in getting O&M tasks done. Thus, one of the requirements for increasing farmer resource mobilization for O&M activities is what has been called "bureaucratic reorientation" (BRO) (Korten and Uphoff, 1981).

Such bureaucratic reorientation would involve, among other things, a greater focus on main system management in large schemes and less on O&M in the tertiary units of larger systems. Moreover, the agency would reorient itself to act as a service organization to the irrigator groups operating portions of the larger commands.

Program experience suggests that such agency reorientation is more likely to occur not as a separate "transformation" but as a consequence of interactions where farmers are themselves in a process of "change" through new modes of organization and action. For example, Uphoff (1985) has noted how the actions of informal groups of farmers in cleaning field channels, rotating water deliveries within field channels, and if possible saving water for downstream users in the Gal Oya system in Sri Lanka served to influence the attitudes of irrigation department staff. With a more positive opinion of the farmers, agency staff were more willing to enter into cooperative activity with farmers regarding O&M activities. In turn, this willingness on the part of officials to treat farmers as responsible persons encouraged them to take on more responsibility.

Agency reorientation also requires policy dialogues with staff that redefine the agency's mission and what constitutes "professional" roles. Training and perhaps recruitment of new types of staff will be needed to develop new skills within the agency for working with farmers. And existing policies and procedures should be examined to see which, if any, are impediments to increasing farmer resource mobilization, so that changes can be introduced.

The basic point of the BRO proposition is that increasing farmer involvement in resource mobilization for O&M activities will depend upon some changes occurring in the style and manner of the agency's actions——and that those agency changes will be interactive with farmer changes.

5.2.3. Farmer Involvement in Operations

Without authority to control some, and influence other, key operational activities, such as the allocation and distribution of water, farmers are unlikely to sustain an interest in resource mobilization. For one thing, farmers' involvement in the actual operation of the irrigation works helps them to identify critical resource needs for both operations and maintenance.

Farmer involvement in operations should mean more than being responsible for allocating and distributing the water supply that arrives at the field channel turnout. While this may be better than no involvement at all, in our judgment, it will not likely be sufficient to sustain resource mobilizaiton by farmers. Also, they need authority for involvement in the processes that determine when and in what quantity water will arrive at those turnouts, that is, they need a role in decision making regarding main system operations. This is not to say they will control such decisions, but that they will have some input. Technical judgments by the agency staff should not be overridden, and in our experience, such judgments made with a view to enhancing the twin objectives of water use efficiency and equity will be accepted by farmers' representatives.

This proposition reminds us that just being caretakers of the irrigation works, field hands of the irrigation bureaucracy, will not be sufficient incentive for farmers to organize and sustain resource mobilization processes. Farmer involvement in O&M must include authority for the O (operations) component as well as responsibilities for the M (maintenance) component.

5.2.4 Local Organizational Capacity

In each of the prior propositions there is reference to farmers mobilizing resources and doing other things in an organized way. None of this can happen unless farmers have an organizational vehicle for ordering these activities. Local organization of some form is a prerequisite for farmer resource mobilization and involvement in O&M activities (Uphoff, Meinzen-Dick, and St. Julien, 1986). It also is necessary for effective interaction between the irrigation agency and the water users—since it is quite unrewarding for the agency to try to deal with a clamorous group of unorganized farmers. The local organization for achieving this may be formal or informal, built on traditional social relations or new principles, and follow any of a spectrum of organizational formats (at least those that do not violate the basic need for a fit between the organizational pattern and the configuration of the hydraulic apparatus).

Innovative programs in the Philippines, Indonesia, and Sri Lanka are demonstrating two important lessons regarding means to create local organizational capacity. First, the task of assisting farmers to form new, or strengthen existing irrigator groups is not an activity that can simply be added to the responsibilities of the agricultural extension staff or the field staff of the irrigation agency. These staff people typically are already overloaded with responsibilities. Furthermore, they lack the basic skills and orientation needed by an organization facilitator. Innovative projects are demonstrating the usefulness of a "catalyst" role (called "community organizers" in the Philippines, and "institutional organizers" in Sri Lanka), performed by specially trained personnel who live in rural areas, assist farmers to organize, and act as facilitators between the irrigation agency and the irrigator groups.

Second, where organizational efforts are accompanying improvements in the physical works (and this is commonly the case), attention to farmer organization should begin before the design and construction activities are initiated, rather than following their completion. Waiting until after the key design and construction decisions have been made before assisting farmers to organize may mean that facilities have been put in place that are unworkable or misunderstood, and that farmers already have been alienated from the project.

This proposition draws attention to the central importance of strong local organizational capacity as a necessary component for achieving farmer resource mobilization and involvement in O&M activities. If new construction is part of the project, actions to assist farmers in organizing need to begin early in the project cycle. Assisting farmer organization is a specialized and time-consuming task. Some type of catalyst role is proving an effective means for promoting farmer organization.

Farmer organizations are not to be conceived or introduced as "turnkey" operations. but rather as part of a new approach to irrigation management.

5.2.5 New Financial Procedures

Very often, farmers are adverse to paying irrigation fees and/or directly participating in O&M activities because they see little relationship between these actions and the resultant state of the irrigation facilities or the performance of the system. It is not clear to them that paying the costs of O&M done by the agency or mobilizing resources to work at the tertiary level results in better irrigation services. One difficulty is that irrigation agency fees usually are general in nature—fees are collected from farmers not to repair some specific structure or correct an identified problem, but for some more general O&M purpose. Moreover, typically, funds collected from farmers in one system are placed in a general fund that may be used outside their project area—or even outside of irrigation.

A recent IIMI study (Small, Adriana, and Martin, 1986) concludes that greater fee collections from farmers will only lead to actual improvement in O&M activities in situations where:

i. the institutional arrangements for the irrigation agency create relative financial autonomy from the national budget—that is, the agency depends on farmer payments to support a significant portion of its budget and the agency has control over the use of those funds, and

ii. a significant portion of the money collected from farmers is used by the agency in the system, or subsystem, from which it is collected—thus, there is a close link between payments made and services provided.

This, as noted previously, is what usually occurs in FMIS. Funds are collected, for example, to pay those who provide leadership and management for the system—and who may be replaced if they do not perform these tasks satisfactorily. Or, funds are collected when some specific repair or improvement is required—and the amount paid by any individual is a reflection of the cost involved and of that individual's share in the system (measured by land owned, water rights held, or some other criterion). Specific payments rather than general payments are the modus operandi.

The National Irrigation Administration in the Philippines, in its assistance to communal (small-scale) systems, has taken an approach that illustrates this idea. In these projects, farmers are required to repay, over an extended period of time, a portion of the construction costs for improving their specific systems. Thus, farmers are not making "general" payments but rather payments directly related to the costs of improving their systems. Moreover, following the participatory approach that has been used in implementing these projects, farmers are able to carefully monitor project expenditures (thus reducing some "leakages"), and for some activities to substitute their own labor or materials for purchased services or items. Farmers responsible for paying back capital costs have a stake in insuring both proper quantity and quality in construction.

For State systems, it might be advantageous to establish the equivalent of special benefit districts (in the terminology of public finance) for individual systems, or for parts of very large systems. In this way, a large part of the resources mobilized by farmers of that system (or subsystem) would be devoted to improvements in O&M in that area.[4] The representatives of water users in that area would have a voice in the operational decisions and in setting maintenance schedules and priorities. To the extent that farmers were willing and able to discharge a greater share of O&M responsibilities through mobilization of their own labor and materials, they could reduce their financial responsibilities to the district. What is needed are new financial arrangements that create a much more immediate, and observable relationship between resources mobilized and irrigation services received.

6. SUMMARY

FMIS represent important cases of farmer mobilization of resources for both system development and system operation. In this paper we have explored two important public policy questions related to mobilizing resources for irrigation development. The first question deals with the matter of appropriate public policies in support of the resource mobilization processes that already occur in many FMIS. We noted the importance of reexamining present public policies for assisting FMIS, some of which have the effect of discouraging continued resource mobilization by these groups. The second question we explored dealt with the relevance of resource mobilization processes in FMIS as a model for increasing resource mobilization in State-operated systems. On this point, we noted that farmers were likely to increase their mobilization only if they were granted more involvement in and control over both operations and maintenance activities, and in cases where construction is being planned, involvement in design and layout as well as construction activities. In short, increasing resource mobilization by farmers in State systems needs to be complemented by significant farmer control of selected activities of those systems.

NOTES

[1] Five studies are referred to in this section. In chronological order they are: Siy (1982), Tan-kim-yong (1983), Meinzen-Dick (1984), Martin (1986), and Duewel (1986).

[2] Traditionally, resources have been mobilized internally by the farmer organization in these systems, but efforts in many places are being made to secure assistance from outside sources. Of 25 farmer-managed systems studied in Nepal, more than helf had received some assistance from various government agencies (Martin and Yoder, 1983). This was usually in the form of a grant in cash or kind for some special repair work, and routine operation and maintenance has remained in the hands of the farmer organization. The matter of public assistance to FMIS was the subject of a recent conference organized by the International Irrigation Management Institute (IIMI). For a review of past research on this topic see the paper prepared for this conference by Coward and Levine (1986).

[3] This section draws heavily on a previous paper prepared by Coward and Uphoff (1986).

[4] There are some examples of this approach in addition to the Philippines case discussed. Easter (1985) reports on such an arrangement being tested in Sri Lanka. Also, the Farm Land Improvement Associations that manage State irrigation facilities in Korea follow this principle (Small, Adriano, and Martin, 1986).

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THE DOMINANCE OF THE INTERNAL RATE OF RETURN AS A PLANNING CRITERIA AND THE TREATMENT OF O & M COSTS IN FEASIBILITY STUDIES

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SUMMARY

A study of the socio-economic and institutional problems reported in recent evaluations of irrigation schemes showed that the Internal Rate of Return had defects as an indicator of a project's worth. Farm incomes have more importance for a project's sustainability, as they provide incentive. Incomes are linked to the ability to pay recurrent costs and so to ensure maintenance. While World Bank guidelines have emphasised the importance of the IRR in assessing project suitability, other guidelines have given greater weight to a design producing good incremental farm income and revenue for the project authority. Examples are given of the way in which concern for farm incomes and for resources for O & M might influence design.

1. INTRODUCTION

A study has recently been made of the socio-economic and institutional problems reported in 50 recent evaluations of irrigation projects in developing countries, funded by various agencies, with the objective of making recommendations for improving the study of these matters during the preparation and planning phases. In five cases the original feasibility or appraisal documents were also examined. Staff of consultancy firms and of the FAO Investment Centre were consulted on the difficulties in taking proper account of socio-economic and institutional factors in scheme design, in these and other cases. During the study the current importance attached to a high Economic Internal Rate of Return (EIRR) as a deciding factor for project funding emerged as in practice a constraint on institutional and technical design, on the phasing of implementation, and on the lack of adequate consideration given to either farmer incomes or to the income and expenditure of the project authority or other operating organisation (Tiffen, 1986).

The assumption is made in this paper that farmers should normally meet at least O & M costs, and where possible, a proportion of capital costs. If it is not possible for them to achieve a reasonable income after meeting O & M costs, this should be clearly stated in the feasibility study, so that a government can take a reasoned decision on whether it wants to subsidise both capital and O & M costs because of social conditions in the area, and if so, whether the cost of the subsidy can be met from alternative sources of government revenue.

2. DEFECTS OF THE INTERNAL RATE OF RETURN AS A DECISIVE PLANNING CRITERION

The EIRR is attractive as a summary indicator of a project's worth, giving a single figure which subsumes many factors, which can then be compared with unlike alternatives, and which appears easy to understand in its comparability to the interest received on capital. It is probably for these reasons it has acquired its dominating importance as a test of project acceptability and the suitability of the project's concept and components.

The major drawbacks against overdependence on the EIRR in the selection of projects are summarised below.

2.1 The bias against durability, and the assumption that capital is the scarce factor

Since costs and benefits occuring in the more distant future are discounted highly, little account is taken of project sustainability after the first 10-15 years of the project's life. For example, there may be little difference in the EIRR of a rehabilitation project which is thereafter maintained, and one which is not maintained, and which disappears after 15 years (World Bank Tenth, 1985). Yet for a farmer, and also for the nation, it is important in practice that the scheme is maintained and endures for 50 or more years. Choosing projects on the basis of a high EIRR introduces a bias aginst those with a high initial capital cost even if they have low maintenance costs, because it assumes initial capital is the scarce factor.

2.2 Bias against slow start up

The EIRR often causes excessive stress to be placed on rapid implementation to secure early realisation of full benefits, and indeed this is stressed in the World Bank guidelines. On the Rahad scheme, the choice betweeen use of pumps and the alternative of a longer gravity canal was based on the greater speed of implementation possible with the former. On the Rahad, charges to farmers do not meet operating costs, including pumping, whereas they do on all the large gravity schemes in Sudan (FAO Investment Centre, 1986).

Correctly used, the EIRR should not bias against projects in which parts of both costs and benefits are delayed, as demonstrated by a discussion in FAO 1986, Annex 2. However, in practice "if two projects, one with a lengthy and the other with a short take-off period, are to have the same internal rate of return then the long-term advantages of the first must be far higher than those of the second" (Bergmann and Boussard, 1976, p. 73). The bias against projects which are implemented in phases also derives from its inconvenience for the financial time horizons of the lending agency.

In real life it may be a distinct advantage to plan for phased implementation since this allows for the build up of experience amongst both farmers and scheme O & M staff, making it more likely that expansion or intensification of the original scheme will be handled efficently. This was what happened, accidentlally, in the case of Muda, Malaysia. The first phase provided field-to-field irrigation for two rice crops per year. A later phase provided for an improved water delivery system for diversified cropping. By the time the second phase was implemented farm incomes were much higher than previously;

farmers were more capable of on-farm investment; higher O and M charges could be met if desired (the Government intentionally subsidised paddy farmers), and institutions and personnel were well established and capable of meeting more challenging O & M requirements.

2.3 Under-emphasis on risk of different outcomes

The comprehensiveness of the sole figure for the EIRR gives a false picture of the very real danger of different outcomes. Theoretically, this is met by sensitivity analysis. However, it is often difficult to predict either the crucial factors which may change or the extent of change. In any case, sensitivity analysis comes at the end of the preparation period, and the results are seldom allowed to cause a fundamental reassessment of the scheme's components.

2.4 Bias against flexibility

It may happen that some of the solutions which are slightly sub-optimal from the point of view of maximisation of the expected benefits, will have a much narrower range of possible outcomes, because of their increased flexibility, and will thus be safer (OECD 1985, pp. 57-59). This is important since one can safely predict that the outcome of an irrigation project will not be as predicted.

2.5 Ease with which cost-benefit analysis can be manipulated

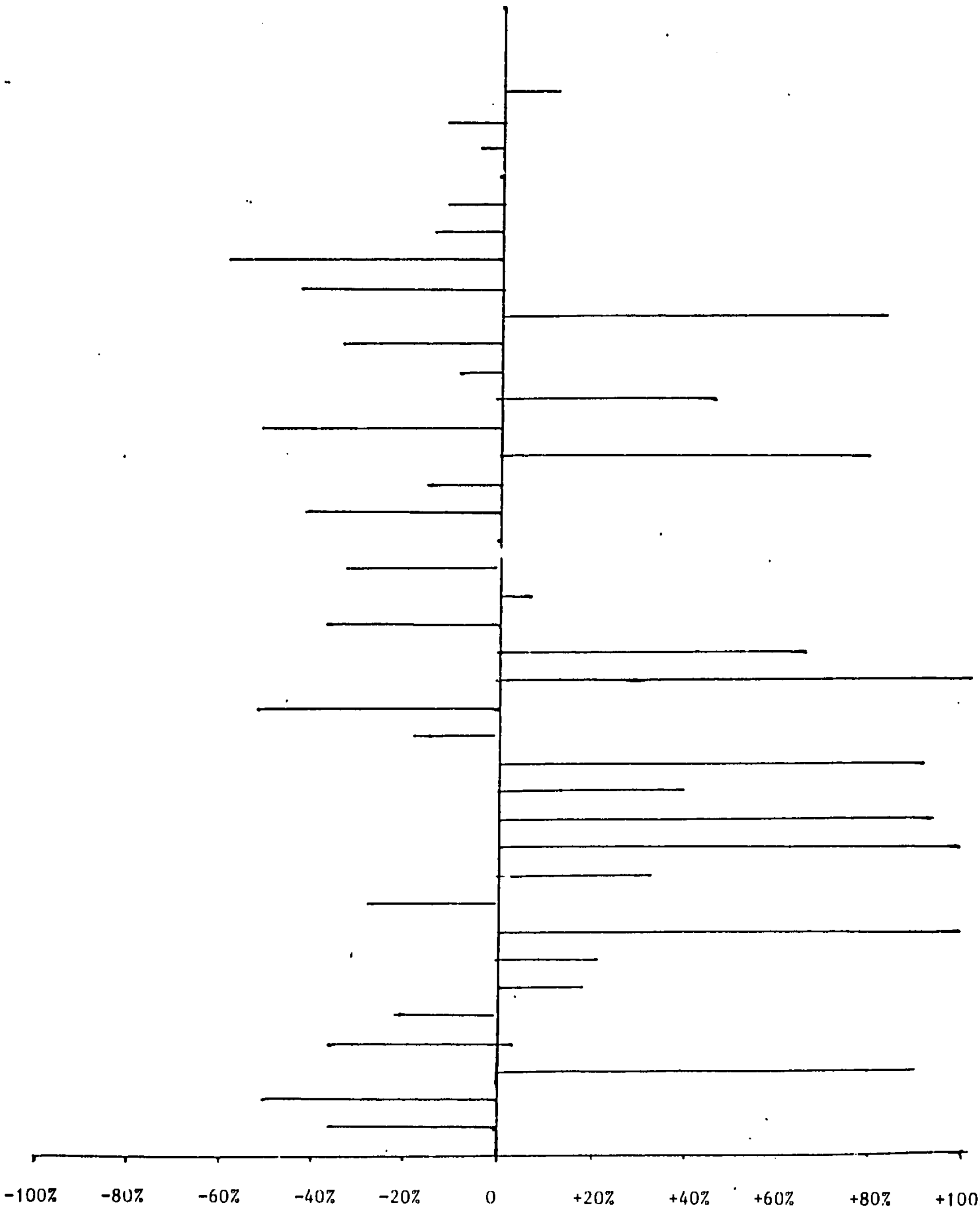
All practitioners know how manipulation of key variables will increase the EIRR to the desired figure, and the abuse has been commented on in the literature (Carruthers 1985).

Because of this manipulation, and genuine difficulties in predicting the outcome, the EIRR is in practice a very unreliable estimate. Fig. 1 shows the difference between the EIRR as predicted at appraisal compared with that calculated at project completion, in the 37 cases out of the 50 where both figures were available. Table 1 shows the calculation made some years after completion, in the three cases where it was available. The completion figure is based on real costs, but on an estimate of the trend of future benefits. The latter may not materialise if maintenance is not carried out, or if farmers lose interest because of insufficient incentive.

Table 1 ECONOMIC INTERNAL RATE OF RETURN AT THREE POINTS OF TIME

Scheme	Appraisal	Completion	Later Impact Evaluation
Gambia Agric. Devt.	30	22	negative
Lake Alaotra	11	22	negative
Mexico Third	11	21	17

Figure 1 IRR estimated at PPAR as a percentage of IRR estimated at Appraisal (39 projects taken from Table 1)



3. FACTORS INFLUENCING PROJECT SUSTAINABILITY

The poor outcome of many agricultural projects, particularly irrigation ones, has been a source of concern for sometime, and the World Bank, in its Tenth Annual Review of the results of its project audits, has suggested that during design there should be much greater concern for sustainability (World Bank Tenth, 1985). There has also been concern with the increased burden of recurrent costs on government budgets, and a number of writers have noted the need to give this issue greater attention during design and appraisal (Carruthers 1985, Heller and Aghevli 1985). It has been suggested that one method of doing this would be to attach a higher shadow price to expenditures which make demands on limited government revenue when calculating the EIRR (Finney, 1984). While this method might have some attraction to governments which fund irrigation O and M costs out of general rather than specific revenue, there would still be the difficulty of deciding the correct shadow price (Heller and Aghevli 1985) and it would still be open to manipulation. It therefore seems doubtful if this suggestion is sufficiently radical. The EIRR has only been used as the dominating criterion for the choice of projects since the early 1970s. If it is an unreliable indicator of the outcome of projects, do we need to consider alternatives or complements to it, and can we decide if there are more important economic issues likely to affect a project's success?

The analysis of the socio-economic and institutonal problems reported in 50 recent irrigation projects is shown in Table 2. While this shows the frequency of certain problems, it does not indicate their importance for the success or failure of the scheme. In general, it was found that problems in Group 1 were most likely to jeopardise a good outcome since they resulted in a lack of interest by the intended beneficiaries. The most important defects were found to be related to the prices and availability of inputs and outputs, which together affected the income a farmer could achieve from the scheme as compared with alternative activities that might be open to him. Thus, one conclusion of the study was that farm incomes were of central importance in deciding whether the constructed facilities would be fully exploited. In Group 3 it will be seen that cost recovery (I) was mentioned as a problem in a third of the cases. Problems connected with the provision of resources for O & M were reported under J and were frequently an underlying factor in the difficulties in securing that farmer organisations carried out the tasks expected of them, (H), which often included some maintenance activites.

There is an obvious linkage between farm incomes and farmer payments for O & M, particularly in low income countries where there is a danger that if farmers pay the full costs of irrigation, they may be left with unacceptably low incomes (Carruthers and Clark 1981, Sagardoy et al, 1982). In this case, the risk is that any structures built will not be fully utilised. However, in such countries, it is also likely that general government revenues are low. The challenge, therefore, is to design appropriate structures for an area that will yield adequate incomes to farmers, including the payments they make for running costs. Whether they should also pay a proportion of the capital cost is an issue the government should decide in advance of the feasibility study, as this will affect the design.

Table 2 PERCENTAGE OF EVALUATIONS NOTING PARTICULAR PROBLEMS, BY REGION

Group	Local Economics				Socio-Political				Institutional/Planning					Implementation		Unpredictable
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Asia	23	40	20	23	23	30	10	70	33	40	54	27	30	17	13	17
N Africa and Middle East	17	33	17	17	67	0	0	17	50	33	50	83	17	33	0	17
Sub Saharan Africa	48	83	17	50	58	33	50	25	33	50	33	58	33	16	8	33
Latin America	0	100	40	0	40	0	40	0	20	0	80	0	40	0	0	0
Total	25	49	21	26	38	26	23	43	34	38	49	34	30	17	9	19

Key on pages 197 and 198

Key to Table 2

Socio-economic and institutional problem areas in irrigation schemes.

Group 1: The Local Economy and Farm Level Economics

A. Existing, non-project activities of intended beneficiaries

B. Agricultural marketing factors (prices and price policy; risk in purchasing inputs or main staple food; crop patterns at variance with market requirements; availability or quality of inputs including repair services and credit; poor communications infrastructure).

C. Natural resource use and conflicts (ground water management conflicts; water use outside project area; conflicting hydro electric power requirements; conflict with livestock owners over land use)

D. Labour (peak labour shortages, appropriate farm size, employment effects)

Group 2: Social and Political Factors

E. Land tenure, consolidation, compensation, resettlement.

F. Equity issues: income, power and wealth distribution and conflicts; disadvantages for women

G. Conflicts between state and farmer aims and other political constraints (excepting price policy issues)

H. Farmer organisations, conflicts between farmers affecting institutional arrangements, conflicts between farmers and farmer groups and other local institutions (eg local governments etc)

Group 3: Institutions, organisation and management, resources for operation and maintenance

I. Cost recovery, water charges

J. Allocation of responsibility and provision of resources for maintenance and on farm development; efficiency and equity of water delivery service

K. Project concept and development assumptions; suitable technology, faulty planning mechanisms (eg. inadequate preparatory studies, unrealistic timetable)

L. Staff: incentives, quality, quantity

M. Relationships of main and other national agencies involved in project

Group 4: <u>Implementational problems not deriving from feasibility study</u>

N. Procurement and contract mechanisms

O. Lending agency role and supervision; lending agency and national government conflict; consultancy and government department conflicts.

Group 5: <u>General</u>

P. Unpredictable external events (unexpected inflation, extraordinary drought, civil conflicts, etc)

4. TREATMENT OF RECURRENT COSTS AND FARM INCOMES IN FEASIBILITY STUDY GUIDELINES

When one examines the guidelines for the preparation of irrigation feasibility studies issued by various agencies one is struck by the different importance given to financial viability at farm and project level by those drawn up mainly on the basis of developed country experience and those drawn up for use mainly in developing countries receiving loans from aid agencies.

This is not to say that the World Bank has been unconcerned with farmer payments for water. On the contrary, particularly in the 1960's and early 1970's, the Bank was most insistent as a condition of loan that there should be a water charge to recover costs. However, this was more because such charges were felt to be indicative of good national economic management and national ability to repay the loan, than because of specific concern with revenues for maintenance. The Bank was not necessarily concerned to see that water payments went to the project authority, or were ear-marked in any way. If a government felt that the farmers in a particular area should not have to pay full water costs on social grounds, the requirements of the Bank could be satisfied if the Government showed that general revenues in the area concerned (from indirect taxes, land taxes, 'zakkat', etc.) were likely to rise sufficiently to cover costs.

The Bank-approved Guidelines for Irrigation and Drainage Projects were first published in 1970 and reissued in substantially revised form in 1983 (FAO Investment Centre 1983). Revised guidelines for Agricultural Investment Projects were published in 1985 (FAO Investment Centre 1985). Both recommend substantially the same 10 or 11 chapters, in slightly different order. In the Irrigation one, a description of the Project Area precedes the central chapters V. Project Design Considerations and VI. The Project. However, it is not shown how consideration of the local economy and institutions should influence design, and no mention is made of O and M costs as a design factor, although they are required to be estimated in the chapter on The Project. The main design consideration amplified in the guidelines is concerned with water supply and technical factors. In Chapter IX, Markets, Prices and Financial Results, one main concern is to show that the extra production can be marketed. It is also required to be demonstrated that the project gives attractive incomes to the farmers, although low objectives are set for this - the projected net cash income should not be lower in any year than it was before the project. It is noted that "incremental cash income may be less than the incremental value of production" and that this should be taken into account in estimating repayment capacity, and in the design of the project. This is not amplified. An examination of the government's cost recovery policy is required, and "Note should be made of the extent to which recoveries meet operating and maintenance costs".

It is noticable that Chapter X, Benefits and Environmental Impact, contain some implied criticism of the Internal Rate of Return, because it may not include all social benefits of the project. This is not a valid criticism since all social benefits will depend on increased agricultural production and sustained O & M, so they must be regarded as secondary objectives. The EIRR is not faulted for leading to under-valuation of the importance of financial viability at farm and project level, or because it is dificult to estimate accurately in the real world of changing conditions. It is clear that the EIRR is still regarded as the main justification of the project, and that much of the earlier financial analysis are required simply to provide data for its calculation.

The Guidelines for the Preparation of Agricultural Investment Projects are in several respects better than the Irrigation ones. Under Design Considerations, it lists more items that need justification, including appropritate scale, the range of components, choice of technology and farming systems, appropriate time frame and phasing, etc. The chapter on consideration of the Project area is given 8 pages instead of the 2 in the irrigation document, and shows greater realisation of the need to see the project matches the locality in more that technical respects. The calculation of the cost of maintaining services at levels necessary to achieve project objectives is required, and it is noted "it may be desirable to comment on the government's capacity to meet the implied finaical commitments". In the following chapter on Organisation and Maintenance it is noted that "In some cases it may be necessary to consider reductions in project scope to conform with institutiional capacities", indicating one way in which O & M considerations might affect project design. In the chapter on Markets, Prices and Financial Results, it is stated that it has first to be shown that the project will be sufficiently attractive financially to encourage the participation of the farmers, and secondly, that it is acceptable from the wider economic point of view. However, the same rather low objectives for farm incomes are set as in the Irrigation document. Very careful attention to the impact on the Government budget is required. The final chapter on Benefits and Justification again concentrates on the EIRR.

In summary one could say of both these Guidelines that they deal with farm incomes and O and M costs, but do not give them central importance as factors to influence design. The revisions show some doubt about the EIRR, but retain it as the main test of project acceptability. Of the two, the Agricultural Project Guidelines go further in showing how local economic and institutional considerations might affect the scope and components of the project. However, both begin with the necessity to maximise benefits and minimise costs. As the recurrent cost element in costs will be discounted heavily in the EIRR calculation, recurrent costs are not shown as necessarily affecting decisions on the project's size, scope and components.

The emphasis on maximising production for national benefit and the lack of centrality for farming incomes and propject O and M costs stands in marked contrast to older guidelines developed in the United States and Europe. The USBR manual of 1951 defines irrigable land as that which can:

> meet all production expenses, including irrigation operation and maintenance costs, and provide a reasonable return on the farm investment;
>
> provide a reasonable repayment contribution toward the cost of project facilities
>
> provide a satisfactory standard of living for the farm family

This summary is taken from Guidelines: Land evaluation for irrigated agriculture (FAO Soils Bulletin 55, 1985) which basically endorses the USBR approach, and which suggests that at the reconnaissance study stage, one looks at potential yields, but that at the final stage of eliminating unsuitable marginal lands, the Net Incremental Irrigation Benefit be calculated, taking into account

a. farm investment and operating costs, and returns ordinarily accruing from the agricultural use of land

b. all project investment, operating and maintenance costs.

The Guide to the Economic Evaluation of Irrigation Projects (Bergmann and Boussard, 1976) was published in 1976 after testing in 14 irrigated areas, mainly in southern Europe. However, it was intended to be useful everywhere. The 5 chapter headings in the illustrative feasibility study indicate the greater importance given to farm profitability and O & M costs than in the World Bank model. The central chapter C, The Targets, covers the technical description of the project, the agricultural development envisaged with irrigation and the operating and maintenance costs. Chapter D is entirely devoted to profitability at farm level. The final chapter, E, looks at profitability from the standpoint of the national economy. The authors state it is essential to deal with private profitability before making the profitability calculation from the national standpoint. They suggest farmers will look for 2 or 3 times their present cash income if they are to be induced to make the necessary complementary investments and to utilise fully the water provided. In their discussions on national economic benefit, the main authors, Bergmann and Boussard, favour the use of the internal rate of return while noting it is difficult for long-term agricultural projects to show a higher rate than 16 to 17%. They include the calculation of the financial viability of the operating organisation where this is an independent legal entity, as it often is in Europe.

5. IMPLICATIONS FOR PROJECT DESIGN

Irrigation must offer farmers a substantial improvement over alternative and perhaps less demanding types of work. It also requires a constant flow of resources for operation and maintenance, without which schemes will decay. The financial outcome at farm level and the resource flows at project level must therefore be the two primary tests for project sustainability. This suggests a return to an older method of preparing irrigation projects, followed for example by the investors in the original Gezira scheme. Even in the case of the old government schemes in India in the nineteenth century there was generally a concern to see that the costs could be met out of expected increases in government land revenue.

There are many ways in which a greater concern from farm incomes and for resources for O & M would influence design. It might affect, for example, the size of the service area and the length of the main canal. It could affect the choice of technology according to local availability and skills for repair. On the institutional side it might indicate a greater role for farmer groups in maintenance, which normally has to be compensated for by giving them also a greater role in design choices and agricultural management at least at the tertiary level, and taking into account as far as possible existing tenure boundaries and social and administrative boundaries in designing block layout. It could affect the phasing of development, with provision for simple structures initially that could be up-graded as funds accumulated. It could indicate in certain circumstances that, for example, heavier and stronger gates are provided initially, rather than cheaper ones that need more frequent repair or replacement. It might indicate the advisability of accepting a higher than normal risk that the optimum water supply was unavailable for the second or third crop.

It is not suggested that the EIRR be totally abandoned. There are two ways of using financial and economic criteria: to try to optimise, and to see whether a test is passed. Currently, most projects have tried to optimise the EIRR, and then tested at farm income level (1). It is suggested it would be better to optimise at farm income level (in practice, it is difficult to prevent farmers from doing this) and to test, firstly by seeing there will be adequate resources for the amount of O & M that will be necessary to sustain the project and secondly, that the EIRR is 8% or better. Given the uncertainties attached to the calculation of EIRR anything less than 8% should be ruled out as within the margin of error that could include a negative outcome and a waste of national resources; given the same margin of error it is not important if the EIRR is 16% or 24%.

(1) I am grateful to discussions with Michael Snell, Senior Engineer with Sir M. McDonalds and Partners, for making this point and for his contributions to other ideas behind this paper. It has also drawn on consultations with several other people, as indicated in the introduction.

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WHY SOME FARMERS DO NOT PAY WATER CHARGERS?

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1. NEED FOR AGRICULTURE SECTOR GROWTH

Recent estimates indicated that the demand for food, fiber and bioenergy products is growing at an annual rate of no less than 5%. Historical evidences only support a growth of output of 1% that can be expected from acreage increase, and, hence, the remaining 4% of needed output growth will have to obtained through yield increases.

Yields are low in Brazilian agriculture. During the next ten years, one can expect the yields of rainfed agriculture to grow at 2% per year. The remaining growth needed will have to be provided by irrigated agriculture.

Table 1 indicates the yield and acreage increases that are needed to satisfy a demand growth of 5%, when the irrigated area varies and the yields of the rainfed agriculture are growing at an annual rate of 2%. To have an overall yield increase of 4%, it is necessary to expand the the irrigated area by 3.5 million hectares, in ten years. The needed acreage increase for the same period, will have to be on the order of 4.4 million hectares, which is in agreement with what can historically be expected.

Table 1 CALCULATION OF RATE OF IRRIGATED AREA INCREASE NECESSARY TO SATISFY A GIVEN YIELD INCREASE

Irrigated Area (million hectares)	Acreage Growth Needed (million hectares)	Yield Increase obtained (geometric rate %)
1.0	13.3	2.6
1.5	11.5	2.8
2.0	9.7	3.2
2.5	7.9	3.5
3.0	6.1	3.8
3.5	4.4	4.1
4.0	2.6	4.5
4.5	.8	4.8
5.0	-1.0	5.2

Source: Alves, E (1986)

The growth of agriculture for the period 1979-84 was small in general, and, especially, for products like rice, edible beans, corn and manioc, which are basic staples of low income people. Per capita consumption of these products decreased. The imports of rice, edible bean, corn and milk increased, and reached high levels in 1986. The overall expenditure on imports of food in 1986 did not increase so much, because of the substantial increase in wheat production.

The government adopted an economic policy to support yield growth, which is strongly based in increasing the irrigated area.

2. IRRIGATION POLICY

There are three systems of institutional organization for irrigation in Brazil.

a) Private - The farmer or a firm makes the decision to irrigate and makes the investments to implement it. The role of the government is only related to credit, road and electricity infrastructure.

b) Mixed - The government may associate with the private sector to build dams, pump stations, main channels and drains, and charges a price for water to recover the investments or it may lend money to the private sector at special interest rates and terms for the construction of the infrastructure.

c) Public - The government acquires the land, builds the infrastructure, selects the farmers, settles them and becomes responsible for the management of the irrigated perimeter. The management role includes elementary school, health, extension, water management, supplying inputs and marketing products, etc.

On these projects, the irrigation law divides the land into two parts: 80% of it is for small holdings (up to 8 hectares); 20% is for larger farmers and private firms. For the small plots, the on-farm irrigation facilities are also built by the government. For the second part, the government provides only water at the farm gate. In some special conditions, the project lands may be split 50 into each type.

Government collects two types of charges: one linked to land value, to recover the expense of acquiring it and to build the on-farm irrigation and housing facilities; the other is a water charge, which is explained below.

Most of the irrigated area in Brazil is private, very little is mixed or public. Out of 2.0 million hectares that are irrigated, the private systems account for 1.93 million hectares.

The new policy aims at irrigating an additional area of 3 million hectares before 1990. One million hectares will be in the Northeast, the poverty stricken region, and two million hectares will be located in the remainder of the country. Public irrigation will be in Northeast only and will be limited to 200 thousand hectares (20% of the program).

The idea is that farmers and firms are able to find out the areas that have lower cost irrigation, taking into account factors of location and existing in infrastructure, and, also, they are much more efficient in making the investments. They can select areas that are small and medium size, and well located. It is difficult for the government to work with small areas. This choice allows the country to ignore the locations that require less investments per hectare and concentrate on the ones that need more.

To implement the program the government created the Irrigation Secretary, with a Ministry in charge. The irrigation policy contemplates credit at special interest rates and terms, a huge training program that includes farmers, agronomists, engineers, etc., and support to the universities and research institutions in the area of irrigation. Investments in infrastructure such as roads, electricity, dams, pump stations, etc., are also contemplated.

The program encompasses all classes of farmers, and whenever there are subsidies in comparison with the well-to-do agriculture of southern Brazil they are for the small farmers and for the Northeast only.

In the context of Brazilian Agriculture, the water charges present an issue that is less relevant, because most of the irrigated area is private and will continue to be so. But it is important enough to merit a serious discussion.

3. WATER CHARGES

Perusal of the literature indicates a great concern with three questions: Should there exist water charges at all? If so, what should be the levels? Finally, how should they be calculated? (Duane, 1975). The concern is with economic efficiency: to avoid waste at farm and macroeconomic levels. The first question is answered positively; the second one is much more complicated. Subsidies are accepted, especially, to help the small farmers. But there is no clear indications as to how much and how long they should last. It is acceptable to charge higher rates to large farmers, a recommendation that is very difficult to implement.

From the practical point of view, "cost recovery" is the only basis upon which to calculate the water charges.

It indicates a monthly amount that if paid, for a given period, all costs are recovered: investment, operation and maintenance costs. It is a financial concept that may have no relation to the economic value of water.

CODEVASF (The Company for the Development of the Sao Francisco Valley) uses the following procedure:

$$w = k + v \qquad (1)$$

w, k and v are expressed in Cz$/m^3

w = water charge

k = fixed costs

v = operation and maintenance costs

k is calculated as follows:

a) the Government establishes the number of years over which it wants to recover the investments: 50 years.

b) The value of the infrastructure of irrigation is summed. They include pump stations, dams, roads, channels, drains, electricity for pumping services and headquarters buildings. Interest rates are not charged.

c) The value obtained in (b) is divided by 50, and then the amount of irrigated hectares of the project.

d) The amount obtained in (c) is divided by the amount of cubic meters planned for the year, and, finally, by 12 to arrive at a monthly figure that is the value of k. Actually k is charged in Cz$/hectare.

The bill sent to the farmers contains two values: operational and maintenance value in cubic meters-that is v; k is shown in Cz$/hectare. This procedure is going to be changed to the one just described.

Note the time dimension that is embodied into the concept of k. It is an average that if paid each month recovers the initial cost of the irrigation infrastructure. But the amounts a particular farmer pays can stay below the average for a period, if later he compensates for the difference.

It is possible to modify the formula to accommodate subsidy or tax:

$$w = (ak) + (bv) \; ; \quad a > 0 \; ; \; b > o \qquad (2)$$

Subsidy: $(a-1)k + (b-1) < o$
If $o < a < 1$; $o < b < 1$, the inequality is true.

Tax: $(a-1)k + (b-1)v > o$.
For $a > 1$ and $b > 1$ the inequality holds.

To set prices for each class of infrastructure is not an easy task. Frequently, rules of thumb must be used for lack of something better.

The other charge is a land charge. For the small farmers it includes the value of land plus the compensation for the site (disproportion) value and every infrastructure built on the lot for individual use. For other farmers, only the value of land is included, since they receive the water at the lot gate and build the infrastructure by themselves, without help of the government.

The small farmers pay the land charges in 25 years. The first payment is after 5 years. The period for the other farmers is 12 years, and the first payment is after 3 years. The land charge is paid monthly.

The urban infrastructure is not recovered: It includes schools, hospital, cemeteries, water and sewerage systems. The houses are included in the land charge.

4. WHY FARMERS DO NOT PAY

The literature bypasses the major issue of the paper: why some farmers don't pay the water charges? Except for the case where $w = o$, the problem of collection is ever present.

CODEVASF is responsible for 46 thousand hectares of irrigated area that are divided into 18 projects along the Sao Francisco Valley. There are 3800 small farmers. Each family is settled in a lot that varies from 4 to 10 hectares. The total number of farmers overall is approximately 4000. The number of farmers that are failing to pay the water charges is around 30%.

The projects are located in a region with a very high potential for

Table 2 EXAMPLE WATER CHARGES IN BRAZIL: 1986

PROJECTS	K US$/HA/YEAR	v US$/1000 m³
Gorutuba	4,81	1,48
Pirapora	20,80	9,57
Estreito	8,56	4,18
Ceraima	8,56	4,18
Piloto Formoso	8,56	4,18
S.Desidério/B.Sul	12,07	2,21
Curaçá	7,36	3,83
Maniçoba	7,36	3,83
Tourão	15,20	2,63
Mandacaru	9,81	2,84
Bebedouro	9,81	5,58
Nilo Coelho	4,90	3,83
Petrolândia	7,36	4,23
Propriá	8,44	1,98
Betume	8,44	1,98
Cotinguiba/Pindoba	4,22	0,99
Itiuba	8,44	1,98
Boacica	4,22	0,99

Source: Prepared by José Bento Correa from CODEVASF.

agriculture, c 'ept for inadequate rainfall and the distribution of it during the year. Conditions for irrigation in the Sao Francisco Valley are excellent.

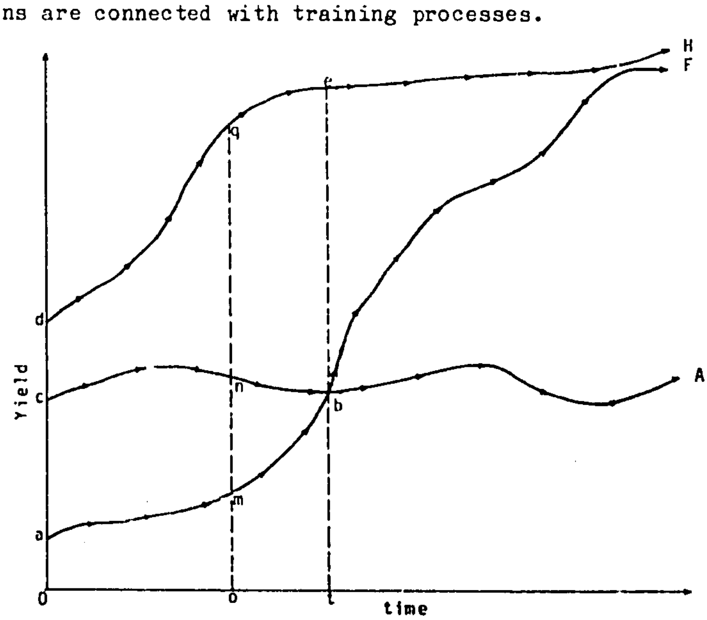
4.1. Reasons for the failure

Most farmers are honest people. A negligible minority fail to pay water charges because of lack of moral principles.

This minority is to be handled by CODEVASF norms that are based on the irrigation law. Medium size and large farmers are similarly handled when they refuse to pay water charges. What is lacking is a good set of criteria and procedures to identify the dishonest farmers, and sometimes, the will to take action against them. Dishonest farmers have the power to spoil the honest ones.

This analysis is limited to small farmers that failed as producers. This failure is one reason for the lack of payment. In the CODEVASF case, they are the great majority of the 30% that don't pay water charges. To understand the problem, let's see how the project starts and develops. A site is chosen for the project. The land is taken out of private ownership if nnecessary. The constructions are carried according to what was planned. The farmers are recruited and selected. Those that lived in the chosen area receive first priority in the selection process.

The farmers that were selected lived in the disapropriated areas or in areas close to them. They do not have experience with modern agriculture. They are unfamiliar with modern inputs such as fertilizers, machinery, and are unfamiliar with modern inputs such as fertilizers, machinery, and they have very little experience with credit, marketing and farm management. Most of them are almost illiterate or have a very low level of schooling. But, among them, there are some bright people that are able to achieve very high standards of farming. The consumption pattern is restricted and it needs to be enlarged to stimulate the family to work more and to desire more income. To bring this group of farmers to modern agriculture represents a great challenge, and most of the solutions are connected with training processes.



Graph 1 LEARNING PATHS

Graph 1 indicates three types of paths:

Path H is the path followed by the best 5% farmers. They start at a higher level of productivity and soon after reach a plateau, after which the growth of yields slows down.

Path A represents the minimum level of productivity that gives condition to farmers to pay the water charges. It covers production costs, other than water charges, and the subsistence expenses of the family. What is left of income is just enough to pay the water charges. Savings are negligible.

Path F represents a typical farmer. He starts at a low level of yield, below Path A. He moves upward as he learns. At time t, he is able to pay water charges. He keeps moving upward, approaching the path of the best 5%.

A learning scale can be constructed, based on productivity data.

$$r = \frac{\text{productivity of the farmer}}{\text{productivity of the best 5\% farmers}}$$

$$\text{At o, } r = \frac{on}{oq} = 1 - \frac{nq}{oq} \quad o \leq r \leq 1;$$

the closer r is to 1, the better it is.

$(1-r)oq = nq$. This represents a loss per hectare to society. In other words, it is the amount that a hectare does not produce, because it is not farmed by the best 5% farmers.

$$R = \sum_{i=1}^{N} (1-r_i)/N \qquad o \leq R \leq 1.$$ The maximum value for R is 1 and the minimum, o. The best situation is for R = o, when r is 1 for every farmer. This is a measure for project success.

The path A moves upward whenever water charges increase and downward when they decrease. The training period, Ot, increases or decreases with water charges. Since we claim that most farmers that don't pay water charges are yet in the training period, Ot, the level of the charges has a great influence on the lack of payment. If there is a land charge, path A reflects it. We utilize, however, the terminology "water charge" to encompass both water and land charges.

Farmers of the region may be quite backward. In this case, it is advisable to settle competent farmers from the advanced areas of the country to serve as demonstration farmers. The reliability of the scale to measure losses to society improves.

Graph 1 indicates that the training period ends at t, and lasts for the period Ot, which can he shortened by improving selection procedures and the training processes.

In the training period, water charges cannot be paid. They can be included in the land price to be paid later or, even considered as training cost.

During this period, the typical farmer is vulnerable to a death wish for bankruptcy. He takes his first loan to finance the crop. His ability to handle irrigated agriculture is yet very low. His managerial capacities are limited. To make the story short, he obtains an income that does not give him wherewithal to pay back the bank. The bank, which belongs to the Government, does nothing to recover the loan, since the typical farmer is poor and the land also belongs to the Government. At the next crop the typical farmer learns that he cannot borrow any more, and hence, he goes back to traditional agriculture, from which the Government was trying to rescue him. He farms the irrigated land without modern inputs, with yields even lower than rainfed agriculture that is close by. He obtains one crop a year, during the rainy season, to save water costs, and, finally, he cannot pay the water charges which have a land component.

The way out of this bankruptcy sequence is to improve the selection and training processes. The investments on this phase have a high rate of return. The supervision needs to be much closer to follow the farmers in every step to avoid serious mistakes. It is also the time to identify and eliminate those that are unable to learn irrigated agriculture or that are dishonest.

We have discussed one reason of failure to pay water charges: the lack of recognition that there is a training perioa that may last for some time.

A second major reason is the way the perimeter is managed. The Government is responsible for every thing: pump stations, drains, main channels, water management, extension, school, health care, etc. There is no participation of the farmers on the management of the project. Paternalism is the key word.

The farmers are subjugated by an authoritarian structure that gives them very little chance to defend their own interests or to criticize the Government when it provides poor quality services. With time, they develop an attitude that is unfriendly to management, and a lack of cooperation prevails.

The project managers lose the respect of the community, and, consequently, cannot have support from it in actions against incompetent farmers or against incompetent extension agents and other public employees that are protected by the power structure.

The solution to this problem is to emancipate the project. This means to transform the farmers into managers of the project from the very beginning. It is necessary to create an association that elects the farmers that will form the board of directors. This board of directors will have the participation of the Government but never to the extent that it becomes a majority. The roles are set to give more and more responsibility to the board in managing the project up to the point that the Government is not needed any more.

With this system, the responsibility for high quality management shifts to the farmers, and they will exercise much closer supervision over every action that happens in the project. The cost to the Government falls.

If there is a reliable cooperative it can substitute for the board. Another crucial point is that resources must be accumulated so as to maintain the irrigation system and that is one important function of the board of directors. Otherwise, the project will be continuously dependent on the Government for resources.

The third reason for farmers to pay water charges is the quality of extension workers. The extension agents have little experience with irrigated and modern agriculture. Training is crucial to the success of irrigation and this involves special courses, seminars, visits to research institutions and to advanced farmers. Whenever possible, it is interesting to have the participation of private firms that are specialized in extension.

Research Institutions must also be present at the project to train the extension agents and to solve problems that require specialized knowledge. These institutions should have research projects designed to measure the parameters that are peculiar to irrigated areas and to solve problems posed by irrigation.

Another point connected to the extension worker is the quality of inputs that is sold to farmers. In a systematic way, it is necessary to collect samples and submit them to analyses, for quality control purposes. When this is not done, farmers buy inputs of poor quality, yields are seriously affected, and consequently, profits decrease or may fail to exist. Among the inputs are seeds, fertilizers, and insecticides. Machinery and equipment must also be checked by specialized firms or by Government agencies.

There is a tendency to cite lack of credit as being the main reason for failure of farmers, and there is merit in this remark. The farmers that were settled, don't have enough savings to support even a crop, and, hence, without credit they cannot modernize agriculture. But if the recommended technology is not the right one, the farmers may lose money or they will have small profits. Over time they will not accumulate savings or wealth to the extent needed to give them resistance to the fluctuations of prices and to crop failures. The accumulated savings cannot finance the next crop. If the banking system is rationing credit at the given interest rate, they go back again to traditional agriculture.

Credit and the right choice of technology go hand in hand. They must be properly adjusted to obtain optimum profits.

4.2. Requirements for Success

There are also the channels, drains and on-farm irrigation equipment that must be properly functioning if optimum yield levels are to be reached. Their correct functioning is a precondition for the extension work. Water has to be available at the right amount and time. If the existing amount of water is less than the quantity demanded, then special devices to save water must be found. Water charge increase is one of them. But before this is applied, every effort should be made to avoid waste of water.

Marketing is another important point. It covers inputs, storage and transport. The solution found is to stimulate the development of cooperatives and the agribusiness. The experience with cooperatives in backward regions is not a successful one, because of the excess of paternalism of the government. In spite of this, it is a solution that has to be tried for lack of a better one.

The Brazilian experience shows that the association of small farmers with medium size, large farmers and firms is a very positive one. Care should be taken to set a limit to size, and the upper bound may be 300 hectares, and to reserve most of the land for small farmers. Our irrigation law requires 80% of the area for small farmers, but this limit can be reduced to 50%, if approved by the Ministry of Irrigation.

Clearly, the overall economic policy has a large influence on the success of an irrigation project: credit, support price and export policies are the most important ones. They are not discussed to keep the paper within reasonable limits.

5. CONCLUSION

The paper stresses two points. The first point is that irrigation is necessary to sustain the growth of Brazilian agriculture and, hence, the Government has decided to irrigate 3 million additional hectares before 1990.

The second point is that the lack of payment of water is synonymous with the fact that farmers fail as producers in a broad sense. The recovery of water charges will improve only if farmers become more competent. A set of measures to reach this goal were proposed and discussed.

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COST RECOVERY

FOR

THE LEZIRIA GRANDE PROJECT

a case study of a rehabilitation project in Portugal

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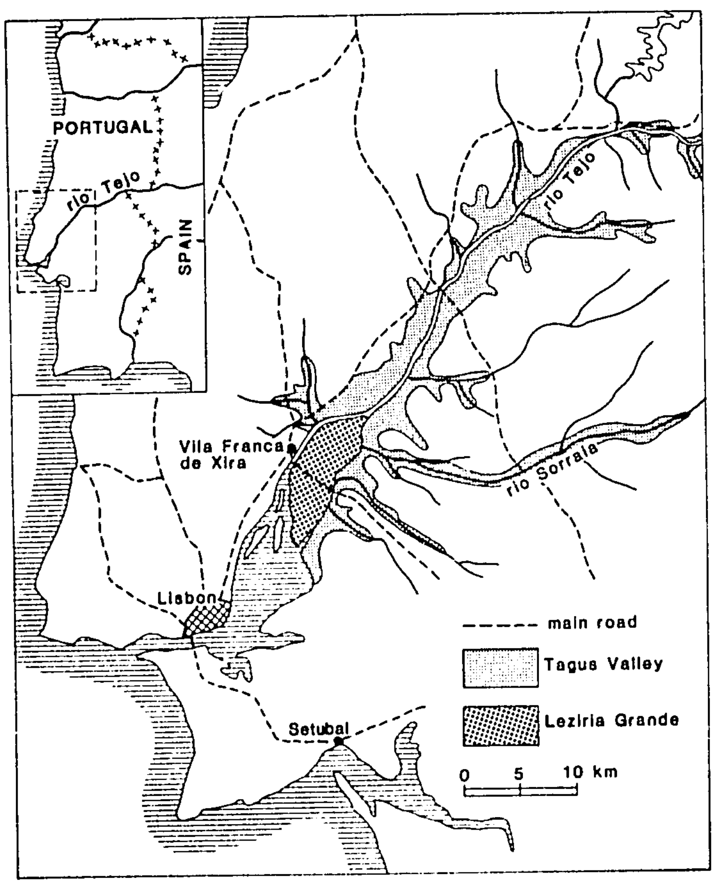


1. INTRODUCTION

In many countries, irrigation fees are so low that they cover only part of the cost of operating and maintaining an irrigation system. The remainder must be subsidized by the Government. Generally, insufficient funds for Operation and Maintenance result in a gradual deterioration of the existing systems, leading in turn to a pressing need for rehabilitation.
To counteract this reverse development, some donor agencies require the recipient Governments to involve the beneficiaries of development projects in the financing of the operation and maintenance costs and even in the recovery (of a part) of the investment costs. Cost recovery is therefore becoming increasingly important, not only to improve equity and efficiency, but most of all to alleviate the ever-growing burden on public finance.
In search of a repayment system that would result in equitable sharing of project benefits between Society and the project beneficiaries in different income classes, a system of cost recovery has been developed, based on farmers' repayment capacity. The effects of this cost-recovery system are analysed and evaluated with respect to farmers' net profit and income distribution.

The data used in this case study were taken from a comprehensive feasibility study that was made to evaluate and compare alternative plans to improve the existing water-management system in the Lezíria Grande in Portugal. The feasibility study was based on extensive investigations that had been conducted from 1976 to 1981. All data were analysed on the basis of soil types, in line with FAO's "Framework for Land Evaluation". A great many soil types were distinguished, which generated a large data base. In comparison, a normal feasibility study would distinguish no more than two or three soil types.
To simplify the case study, the identified soil types were aggregated into six major groups whose production potential was considered adequately homogeneous.

2. THE LEZIRIA GRANDE

2.1 Natural conditions

The Leziria Grande, near the town of Vila Franca de Xira, is a reclaimed tidal flood plain of some 13,000 ha in the highest part of the estuary of the River Tagus, about 25 km upstream from Lisbon.

The climate is Mediterranean. The average annual rainfall is 700 mm, most of which occurs between October and March. From April to October, there is a moisture deficit.

About 20 per cent of the area is covered by light-to-medium-textured, mainly fluvial deposits; the remaining 80 per cent is heavy-textured marine deposits, most of which are moderately to very saline. The lighter, non-saline soils are found exclusively in the northern part of the area (see Map 1). The chief characteristics of the distinguished soil groups are summarized in Table 1.

Table 1 Major characteristics of soil groups in the Leziria Grande

Soil group	Drainage status	Texture	Salinity	Sodicity
A	Well drained	Light	None	None
BC(D)*	Moderately well-drained	Light to medium	None	None
E	Moderately well-drained	Medium	Slight to moderate	Moderate
FGH(I)*	Moderately well-drained to imperfectly-drained	Heavy	Moderate	Moderate
JKN	Imperfectly to poorly-drained	Heavy	High	High
LM(O)*	Poorly-drained	Heavy	Extreme	High

* Soil groups D, I, and O can be considered inclusions in the larger areas

2.2 Present agriculture

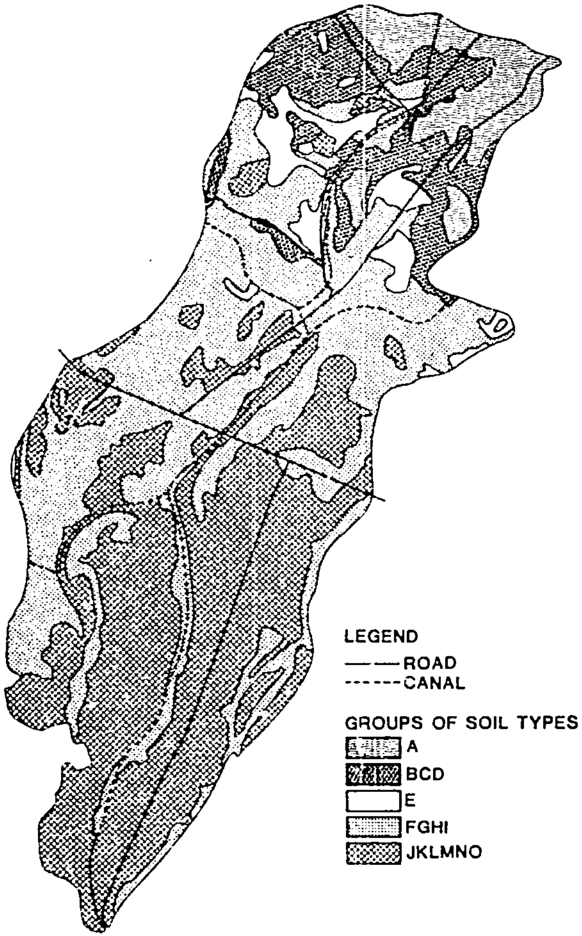
Two-thirds of the land is owned by the State, the rest by about 65 private landowners. One-third of the land is operated as a State farm by the "Companhia das Lezírias", the remaining part by 65 large-scale farmers: some 20 owner-operators and some 45 tenant farmers. The "Companhia" and half of the large-scale farmers lease small areas of land to seasonal workers ("seareiros") for the growing season.
Whereas only a few people live permanently in the Leziria Grande, almost all the "seareiros" live in the vicinity, moving to the Leziria Grande for the growing season. All in all, there are over 800 "seareiro" families.

The land is used almost exclusively for agriculture. About 45 per cent of the area is under wheat, producing 2 to 3 tons per ha depending on the soil group. A further 25 per cent is under natural pasture, about 10 per cent under oil seeds and fodder crops. Tomatoes and melons are grown exclusively by the "seareiros" on 20 per cent of the area. Tomato yields vary roughly between 40 and 60 tons per ha, and melon yields between 10 and 15 tons per ha, depending on the soil group. Although crop productivity is relatively high, there is still considerable room for improvement.

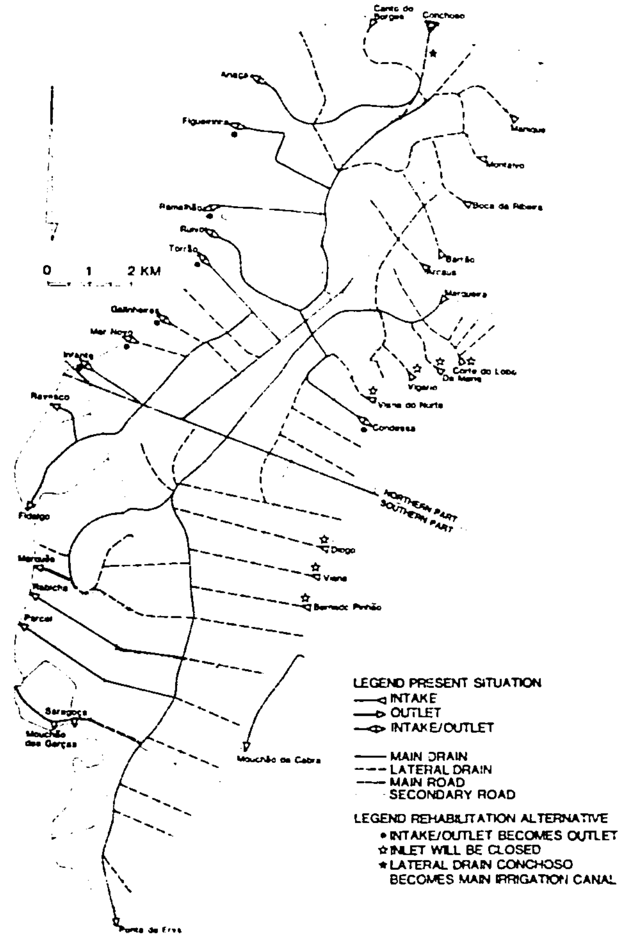
2.3 Water management

The present drainage system of gravity-based, open water courses was constructed in the late fifties. Its total length is about 460 km. Sluices discharge drainage water through the dike during periods of low water levels in the Tagus (see Map 2). Originally, the discharge capacity was sufficient, but, owing to lack of maintenance, the system has deterioriated over the years and is at present incapable of discharging the excess rain water in a normal year.

Irrigation water for the summer crops is distributed through the same system that serves for drainage in winter. Water for



Map 1. Simplified land-evaluation map



Map 2. The compound irrigation-and-drainage system before [illegible] project implementation

irrigation is lifted by small mobile engine pumps. The highest irrigation intensity (50 per cent) is attained in the northern part of the Leziria, where the lighter, well-drained soils prevail.
Using the drainage system for irrigation in summer creates an ideal situation for the luxuriant growth of water hyacinths, which hampers the flow of water through the canals.
As the discharge of the Tagus decreases in summer, seawater intrudes into the River. In extremely dry years, only the sluice gates in the north can be used for the intake of irrigation water. In practice, irrigation with water of bad quality occurs frequently.

3. AGRICULTURAL DEVELOPMENT

3.1 The project

The main constraints to future development of the Lezíria Grande are inadequate drainage, soil salinity, soil tillage problems, and uneven rainfall distribution. Moreover, low winter temperatures and restricted marketing possibilities limit the choice of crops and confine the cropping intensity to about 100 per cent.

The feasibility study presented an analysis of five alternatives that could ease some of these constraints. Of the five, the rehabilitation of the existing irrigation and drainage system appeared to be the best option economically.

The proposed rehabilitation project includes:

- Infrastructural works (see Map 2)
  - Rehabilitating and improving the existing surface drainage system;
  - Constructing an inlet for irrigation water at Conchoso and building a main irrigation canal to connect this inlet with the main canal system;
  - Rehabilitating and extending the existing road system.
- On-farm works, such as land levelling and the application of gypsum.
- Improving the operation and maintenance of the water-management system.

The project will considerably improve general conditions of drainage and soil salinity. And it is expected to have a marked effect on crop and land productivity, ultimately increasing crop production by 20 to 50 per cent, depending on crop and soil type. The irrigation facilities will enable the irrigation of some 3500 ha with water of good quality. This area might increase in future if a higher irrigation efficiency can be achieved.

A comparison of the economic costs and benefits of the rehabilitation project in the northern half of the area resulted in an Internal Rate of Return of about 10 per cent. Development of the southern half of the area proved not to be economically feasible, therefore this case study is confined to the northern area.

3.2 Project cost

3.2.1 General

The cost of the rehabilitation project has two components:

- Investment cost (around 115,000 Escudos or U.S. $ 1900 per gross usable ha on average in 1981 financial prices);
- Additional O & M cost (negligible for the entire northern half, but differing from place to place because of the anticipated changes in irrigated area).

Cost-recovery procedures take basically the financial costs into account; these are summarized in Table 2. The economic costs can be estimated at 85 per cent of the financial costs.

Table 2. Investment cost and cost of operation and maintenance for the irrigation and drainage system in 1981 financial prices (x 10^3 Esc/ha)

Soil group	Area in ha	Investment cost		Drainage cost in year 1 and 10	Irrigation cost Year 1				Irrigation cost Year 10			
					Without project		Rehabilitation		Without project		Rehabilitation	
		Communal infrastructure	On-farm works		unit cost	% of area A-O	unit cost	% of area A-O	unit cost	% of area A-O	unit cost	% of area A-O
A	838	46.3	50.8	2.2	3.2	6	3.1	6	2.8	7	2.8	7
B-D	1,220	46.3	50.8	3.9	3.1		3.2		2.8		2.6	
E	546	46.3	64.2	3.9	3.1	14	3.2	13	2.8	15	2.6	16
F-I	2,586	55.2	64.2	2.9	3.8		4.3		7.6		2.9	
JKN	614	55.2	104.4	2.9	3.8	22	4.3	19	7.6	11	2.9	28
LMO	116	55.2	104.4	2.9	3.8		4.3		7.6		2.9	
A-O	5,920	51.3	64.5	3.1	3.4	42	3.7	38	4.3	33	2.8	51

3.2.2 Investment

The total investment cost of rehabilitating the project area was estimated at 690 million Escudos in 1981 financial prices, or 590 million Escudos in 1981 economic prices (1 US $ = 61.4 escudos; 1 ECU = 68.5 Escudos).
After the system has been rehabilitated, the drainage of all the farmland will be improved to provide irrigation water for about 50 per cent of the area. As all farmers have equal access to the irrigation water, irrigation is spread fairly evenly over the northern area. And the investment costs of improving irrigation and drainage can therefore be allocated evenly. The water-management system is indivisible, so differentiating the costs for the infrastructural works is not desirable. The on-farm works, which are a considerable portion of the implementation costs, differ according to soil group, mainly because of the differences in the amount of gypsum required. Here, the project is not indivisible, because an individual farmer can decide not to apply gypsum in a certain area without other farmers' benefits being affected. Thus, cost diversification may be applied to reflect the different investment costs for each soil group.

3.2.3 Operation and maintenance

The farmers themselves should be fully responsible for operating and maintaining the system, not only to alleviate the burden on public finance, but also to strengthen their involvement in the project.
The actual O & M costs for both irrigation and drainage have been calculated on an area basis. These costs can differ depending on the length of the canal system required per unit of area for each soil group and, more important, because of the differing irrigation intensities on the various soil groups (Table 2). The differences are so small, however, that, for administrative ease, one rate has been set for irrigation and another for drainage. This is a simplification of the current three-rate system: one rate for drainage, one for irrigating tomatoes or melons, and one for irrigating any other crop.

3.2.4 Opportunity cost of irrigation water

When the cost of irrigation is being established, the actual value of the water can be important, especially when it is scarce. The value of water can be defined as its economic or opportunity cost. The opportunity cost of the Tagus water that enters the Leziria Grande at Conchoso is zero, because if the water is not used for irrigation, it simply flows into the ocean. Once the water enters the area, however, it becomes scarce because of the limited capacity of the intake and main system in relation to the irrigation opportunities. Water scarcity would call for water metering to increase efficiency, but this is not possible due to the shifting nature of the irrigation. Nevertheless, to keep their costs down, the farmers will certainly not pump more water onto their fields than is needed, thus assuring reasonable water-use efficiency. Water pricing to pursue allocative efficiency is not needed either, because the combination of irrigated crops is close to the optimum.

3.3 Project benefits

The project will result in an increase in agricultural production. The resulting project rent can be defined as the incremental net value added because of the project, minus the value of the production factors labour, capital, and management employed in obtaining the incremental production.
The project rent does not represent the repayment capacity of the individual farmer, as is sometimes suggested. The repayment capacity, however, can be directly derived from the project rent, as will be discussed in the next section.

4. COST RECOVERY

4.1 Approach

Cost recovery is defined here as the recovery of the project's investment costs (in real terms) from the direct beneficiaries. Payments for adequate O & M costs are thus not included in the proposed charges for cost recovery. In the context of the Leziria Grande Project these payments are considered as a matter of course.

The basic principle of the approach to cost recovery presented in this paper implies charging farmers according to their ability to pay, as derived from their project induced benefits or project rents. The resulting cost-recovery rate will then represent the maximum achievable rate. Higher rates of cost recovery could only be obtained by overcharging groups of the beneficiaries, thereby jeopardizing the sustainability of the scheme.
The essential difference between the present approach and traditional cost-recovery systems is that here the investment costs play a secondary role, only determining the upper limit of cost recovery instead of the rates themselves.

To actually determine the levels of charges that will result in fairly sharing the investment costs between the direct beneficiaries and Society, the sequence of operations is summarized below.
After discussing some relevant legal aspects, first the extent of cost recovery will be determined.
Next, the annually changing repayment capacities of groups of farmers in the Lezíria Grande will be assessed. Subsequently, the present worths of the repayment capacities over the whole project lifetime will be calculated.
Then, the various cost-recovery rates will be calculated, dividing the present worths of the repayment capacities over the project lifetime by the corresponding present worths of the necessary investment costs.
Thereafter, the actual levels to be charged will be determined in view of the part of the investment costs to be recovered.
And, in conclusion, the effects of the proposed charges on farmers' incomes and income distribution will be analyzed.

4.2 Legal context

In Portugal there is a tradition that the direct beneficiaries of public water-management projects finance the system's annual operation and maintenance costs and repay part of the investment costs. Until recently, the direct beneficiaries had to repay half of the investment costs over a period of 50 years. An interest rate of 4 per cent a year was charged on the outstanding debt. As no indexing was applied to the annual repayments, the high inflation rates that have been prevalent since the early seventies have caused the actual cost-recovery rates to fall below 20 per cent.
In 1982, a new law was passed. This law makes it possible to design systems of water pricing or cost recovery that fit individual projects. The new law also enables a number of other important goals to be pursued:

- Equity in the region. Projects are designed to offer substantial incremental income to limited groups of beneficiaries, who consequently become much wealthier than the rest of the region's inhabitants. Cost recovery can limit these induced income differences by tapping off part of the incremental benefits;
- Equity within the project. Even when a project offers similar potential benefits to all beneficiaries, the benefits actually realized will differ. Differences in farm size, farming system, soil type, and so on, will often exaggerate discrepancies in income distribution. The larger the farm, the greater the farmer's profit, thus the poor, unskilled smallholder will receive only a small profit. Differential rates of cost recovery could counteract this;

- Efficiency. Charging farmers for cost recovery will necessitate the productive use of land and project facilities, especially when the charges are based on potential productivity, rather than actual achievements.

4.3 Extent of cost recovery

To determine the rates to be charged from the project beneficiaries cost recovery through ordinary taxes need not be taken into account. Cost recovery is project specific and cannot be replaced by general taxation.
Since farmers could join hands and implement the project themselves, it is considered reasonable to charge the project's beneficiaries no more than the costs they would have incurred if they had implemented a similar project themselves. Exceeding this amount would go beyond cost recovery as such, and turn it into taxation.
As the economic costs indicate the true costs to Society, recovery of these costs would at least be pursued.
Because the proposed project was found to be the best alternative for the development of the area, it is realistic to assume that the financial costs of the project represent the costs of the alternative that the farmers could have implemented themselves. Since in the Lezíria Grande, a number of groups of soil types with different development costs have been distinguished, the upper limit to cost recovery can be assessed as the average financial cost per unit area, differentiated per soil type.
It would also be possible, however, to regard the project as an indivisible entity. The upper limit to cost recovery of all farm land together could then be set as the total financial costs of the project. This target amount accepts charging some groups of farmers - those on soils that are relatively cheap to develop - more than the average costs incurred on their land, whilst other groups of farmers - on soils that are relatively expensive to develop - would be charged less than the average costs incurred on their land.
The choice of the upper limit can considerably influence the cost-recovery rate, especially if there is a great variation in project rents, resulting from differences in natural conditions.

4.4 Assessment of repayment capacities

4.4.1 Methodology

The financial impact of the project, measured in terms of the project rent, is determined to a great degree by the pertaining cropping pattern, which varies from farm to farm. For instance, the project rent can be calculated using the average cropping pattern or the cropping pattern most frequently encountered. In the Leziria Grande, there was little variation in cropping pattern per soil group, so the average could be used to determine the project rent (see Figure 1).
The assessment of repayment capacities, which is the basis of the cost recovery system developed in this paper, is done in three stages:
- Assessing the repayment capacity of an individual farmer;
- Aggregating the repayment capacities of individual farmers to establish a repayment capacity that is valid for groups of farmers;
- Matching the calculated repayment capacities with the critical consumption level.

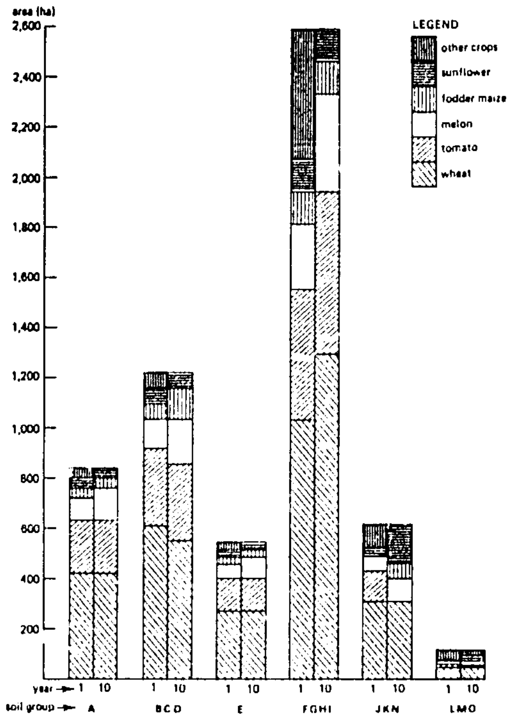


Figure 1 Cropped areas and cropping pattern of the soil groups, with and without project

Defining the repayment capacity as the entire farmers' project rent would ignore the fact that farmers require an incentive to change their farming practices. A noticeable change in farming practices is necessary to realize the expected project benefits. In their efforts to modify their agricultural practices the farmers will incur higher costs, and thus higher risks, which will have to be compensated by a share of the project rent.
To leave ample incentive for the farmers in the Lezíria Grande, this compensatory share of the project rent has been assessed at 30 per cent. As a result, the repayment capacity of the individual farmer is determined at 70 per cent of the realized project rent.

In designing a system of cost recovery, it will not be possible to accommodate all the farmers individually. This would require too many different rates. To simplify matters, the repayment capacity of groups of farmers will be assessed. This is a repayment capacity that is assumed to be valid for all farmers in the group.
A major consideration in composing groups is that the farmers have a similar individual repayment capacity. This can be achieved by classification according to soil group, farming system, farm size, and so on.

Nevertheless, even within such more or less homogeneous groups of farmers, the repayment capacity of individuals will differ, and be distributed around the mean. To take the mean of the individual

repayment capacities in a group as being representative of that group would result in too high an estimate for all those farmers that are generating a lower than average project rent. On the other hand, to take the repayment capacity that can be applied to all of the farmers within the group, without overcharging any of them, would result in an unacceptably small margin for repayment. As a compromise, the repayment capacity of the group is assessed at such a level that is within the capability of the vast majority of farmers in the group.
Farm surveys have shown that in areas which are fairly homogeneous in their climate, soil and farming system, the greater part of the farmers will have a project rent higher than 60 per cent of the average. Including the roughly 30 per cent of the project rent allowed to compensate the farmer for the extra risk and give him an incentive, the repayment capacity of farmers of a more or less homogeneous group can safely be assessed at 40 per cent of the group's average project rent.

Finally, in establishing the repayment capacity of the beneficiaries, one should take into account the current and expected income levels of the groups of farmers. Farmers with an income below the critical consumption level should not be charged for repayment. In the Leziria Grande, however, even the smallest farms produce incomes that exceed the national average and are much higher than the critical consumption level. This allows full cost recovery to be pursued.

4.4.2 Repayment capacities in the Leziria Grande

According to the above described system, the repayment capacities of three different farm types, viz. large-scale farms and small-scale tomato and melon farms, on six distinguished groups of soil types have been determined (Annex 1). A summary of these repayment capacities is presented in Table 3. They relate to the reference years 1 and 10. To simplify matters it is assumed that the project rents will stay at the level of year 10 over the remaining 20 years of the project's lifetime.

Table 3 Summary of the repayment capacities for the different farm types according to group of soil types, in 10^3 Esc per ha (1981 financial prices)

Reference year	Farm type	Repayment capacity for soil group A	B-D	E	F-I	JKN	LMO
1	Tomato farm	1.8	2.4	2.6	3.3	0	0
	Melon farm	5.1	3.4	3.5	1.7	0	2.3
	Large-scale farm	1.5	0.9	0.9	0.4	0.8	0.7
	Weighted average	2.5	1.9	2.0	1.2	0.8	0.9
10	Tomato farm	11.2	11.7	6.8	14.9	-	-
	Melon farm	7.0	8.2	7.8	15.6	16.3	-
	Large-scale farm	5.2	4.7	5.3	2.9	5.9	7.8
	Weighted average	8.7	8.4	7.8	8.2	7.9	7.8

The data in Table 3 indicate that there is a considerable difference between the repayment capacities of the distinguished farm types, even when they are on the same soil groups.

The average repayment capacity of the whole farm area is the weighted average of the repayment capacities of the "seareiro" and the large-scale farmer.

4.5 Alternative systems of cost recovery

4.5.1 Acceptability of charging

Charges for cost recovery cannot be fixed in isolation; tradition plays an important role. Also, the beneficiaries must feel that the level of the rates is fair and in relation to the improvements offered. Moreover, when different rates are being charged, the reasons for these differences should be clear and acceptable to the beneficiaries.
The acceptability of any charges for operation, maintenance, and cost recovery of a water-management project will depend on the farmers' belief in the project. This, in turn, depends on the degree of their participation in project affairs, on the economic incentives of the project, and on the reliability of the services provided by the project, e.g. the water supply. In the Leziria Grande the above mentioned requirements are fulfilled, thus it is assumed that cost recovery of the rehabilitation costs is acceptable to the beneficiaries.

4.5.2 Differentiation of rates

It is important from whom charges will be collected. When "seareiros" and large-scale farmers are charged individually, rates can be differentiated according to soil group and farm type to capture as high a portion of the project benefits as possible, and so ascertain a maximum cost-recovery rate. An important advantage of such differentiation is that a cost-recovery system can be designed to fairly share the cost according to the benefits derived. This would, however, result in 15 different rates. To simplify, it is possible to consider the large-scale farms, including "seareiros", as an aggregate farm unit. The repayment capacity of this unit can be determined as the weighted average in Table 3 and the charge to be paid by the large-scale farmer can be assessed accordingly. This method has the considerable advantage of reducing the number of rates to 6 without affecting the level of cost recovery, but it does assume that the large-scale farmer will not pass on more than a fair share of the charges to the "seareiros". This assumption might not be entirely valid if the demand for farm land continues to be much higher than the supply. Nevertheless, as the land rents are generally much higher than the rates that can be charged for cost recovery, it is not likely that diversification according to farm type will significantly affect the total amount to be paid by the seareiros for land rent and cost recovery together.

For the sake of administrative ease, the number of rates may have to be further reduced. The variation of project rents within aggregate groups will be larger than in any one of the original groups. It must be ensured, however, that the cost-recovery charges established for the aggregate groups do not overcharge more farmers than were overcharged in the original groups. Since the distribution of the repayment capacities is unknown, the lowest repayment capacity (per ha) of any one of the original groups is taken to be valid for the aggregate group. Consequently, if an aggregate of groups is charged one rate, a smaller number of farmers will be overcharged than if the original groups are charged several rates. When data about the distribution of project rents become available, a better approach is to use statistical procedures to establish the repayment capacity of aggregate groups at the same level of significance.

To analyse the effects of the degree of differentiation in charges on the cost-recovery rate three alternative systems are compared:
- One rate for each soil group (six rates in total);
- Aggregation of soil groups into three major groups: A-E, F-I, and J-O;
- One rate for all soil groups.

4.5.3 Rates of cost recovery

The cost-recovery rate represents the percentage of the discounted investment costs that is recovered by the sum of the discounted annual charges for cost recovery over the project's lifetime. The discount rate to be used is the real interest rate, because inflation has been excluded in assessing the project costs and benefits by using constant prices. The long-term real interest rate in Portugal has been estimated at 4 per cent per annum, being equal to the cost of borrowing money when inflation is excluded. The project's lifetime is set at 30 years as usual.
The annual repayment capacities, representing the maximum levels of charges, can be derived from Table 3. The sums of the discounted annual repayment capacities and the discounted investment costs are presented in Table 4, for the three above mentioned alternatives, as well as the resulting cost-recovery rates.

It can be concluded from Table 4 that whatever the repayment system adopted, high rates of cost recovery can be achieved. The figures clearly demonstrate that differentiation of rates has only a small impact on the cost-recovery rate. But as the differences between the repayment systems are rather small, other factors such as acceptability and administrative ease play a more important role in selection.
If the government decides to limit the cost recovery to the real cost to society (the economic cost), the cost-recovery rate would increase substantially.

The high rate of cost recovery is not surprising as all data are derived from the feasibility study of the project, which indicated an Economic Internal Rate of Return of around 10 per cent for the nothern part of the area. More generally, a feasible project will allow high rates of cost recovery if:
- The difference between economic and financial prices is not too large;
- Farmers' income is well above the critical consumption level;
- Project benefits are evenly spread among the beneficiaries.

In the Leziria Grande, the first two conditions have been met, but the project benefits are not evenly spread among the beneficiaries.

Table 4 Assessment of the rate of cost recovery for three degrees of diversification

Soil group	Area ha	Discounted repayment capacities 10^3 Esc/ha	Financial cost		Economic cost	
			Discounted investment 10^3 Esc/ha	Cost recovery rate %	Discounted investment 10^3 Esc/ha	Cost recovery rate %
Case 1. One rate per group of soil types is charged						
A	838	118.2	97.1	100*	82.8	100*
BCD	1220	113.2	97.1	100*	82.8	100*
E	546	103.3	110.5	93	96.7	100*
FGHI	2586	91.9	119.4	77	103.2	89
JKN	614	105.8	159.6	66	141.7	75
LMO	116	105.0	159.6	66	141.7	74
Average	-	-	-	83	-	91
Case 2. One rate per aggregate group of soil types is charged						
A-E	2604	103.3	99.9	100*	85.7	100*
F-I	2586	91.9	119.4	77	103.2	89
J-O	730	105.0	159.6	66	141.7	74
Average	-	-	-	84	-	91
Case 3. The same rate is charged for all groups of soil types						
A-O	5920	91.9	116.4	79	100.3	92

* not more than the real costs can be charged to the farmers

4.6 Establishing equitable levels of charges

4.6.1 Actual levels of charges

To establish the actual levels of charges one has to make a choice between recovering the economic or the financial investment costs. As can be seen in Table 4 there is only a marginal difference between either approach. Since cost recovery is basically a financial exercise it is justified to opt for recovering the financial investment cost, however, the decision is in practise a political one.
Within the category of financial cost recovery the differences in the overall cost-recovery rate between the three distinguished systems of cost recovery are very small. Consequently it could be argued that charging one single rate for all groups of soil types would give the optimum result in view of the amount recovered and the effort of collecting the charges. This would mean that 79 per cent of the financial investment cost (or 92 per cent of the economic investment cost) would be recovered.
The level of charges needed to obtain these results are 800 Escudos per ha in year 1, gradually increasing to 7800 Escudos per ha in year 10 and thereafter. From Table 3 it can be observed that these levels are within the weighted averages for each group of soil types.

4.6.2 Indexing

In principle, charges for cost recovery would have to be adjusted every year because of inflation and the increase in repayment capacity during the first decade. For the sake of administrative ease, the rates should generally be adjusted, say, every 5 years, taking as a basis the average repayment capacity, in real terms, valid throughout the 5-year period. Indexing should be done according to the increase in the cost of living. Of course, this simplification would lower the attainable cost recovery rates.

With high inflation, for example 15 per cent, to adjust for inflation only once every five years would have serious consequences for the rate of cost recovery. If charges are levied according to soil type, taking into account the actual investment per type of soil, the cost-recovery rate for the whole project would decrease some 30 per cent. In such cases, it is worth considering a more frequent rate adjustment.

4.7 Impact on income distribution

Apart from the cost recovery rate, the distribution of the net profits is also important. To determine the impact of cost recovery on the distribution of incremental profits, three farm types are being analyzed for each soil group. The farm budgets for reference year 10 are summarized in Annex 1, including their repayment capacities. The farm budgets indicate that the impact of any cost-recovery system on the distribution of the net profits, and therefore on the income distribution in the Leziria Grande, is limited. The repayment capacity represents a small portion of the net profit, generally around 10 per cent.
In the Leziria Grande, there is little scope for a repayment system to have any significant impact on the income distribution.

4.8 Charging agencies

4.8.1 Operation and maintenance

The Associação de Defesa da Leziria Grande de Vila Franca de Xira is responsible for O & M. This organization operates under the Direcção Geral de Hidraulica e Engenharia Agricola (DGHEA) of the Ministry of Agriculture and is directed by an official of the DGHEA. In 1981 the Associação received eighty per cent of its funding from the landowners and the rest from the Government. These funds and the available equipment are inadequate, mainly because of the high rate of inflation, which has increased the costs, while the charges have not been increased accordingly. In future, the charges will have to be indexed to ensure that the Associação receives adequate funding to strengthen its O & M organization and realize the expected project benefits.

4.8.2 Investment costs

The Associação should not act as the collection agency for recovery of investment cost because this is not compatible with its function as a farmers' organization. Cost recovery is a sort of taxing, and its charges should be collected by the tax department or its representatives. To facilitate cost recovery, the tax department should fix the rates (in real terms) beforehand, for the entire 30-year period. Periodic indexing should ensure that costs are recovered according to plan.

5. CONCLUSIONS

1. If a project is assessed as being feasible in economic terms, a high level of cost recovery from the beneficiaries can be pursued, provided there are no constraining factors such as:
   - Large differences between economic and financial project costs and/or benefits;
   - A large variation in project rents in the project area to be developed;
   - Too-low incomes of large groups of farmers, even after project implementation, so that these farmers would have to be exempted from cost recovery.

2. The upper limit of the charges is defined as the financial cost of the project if all farmers together had implemented the project themselves.

3. The design of an equitable cost-recovery schedule that results in a fair distribution of the project benefits between Society and the direct beneficiaries requires the basic data that are collected for a normal feasibility study. However, this must include data on the size and distribution of the project rents and farm income in the project area.

4. Benefit pricing proves to be a more realistic approach to cost recovery than cost pricing, because benefit pricing takes the farmers' repayment capacity into account.

5. The average project rent cannot be considered as the farmers' repayment capacity. As a preliminary assessment, the repayment capacity of homogeneous groups of farmers has been set at 40 per cent of the project rent.

6. The assessment of the repayment capacity is based on arbitrary assumptions. The validity of these assumptions has to be tested in practice and their values adjusted accordingly. In this, monitoring of project performance would be of great help.

7. Cost recovery through benefit pricing can theoretically be used as a policy tool to pursue equity. However, in the Leziria Grande the effect of benefit pricing is limited, since the charges constitute only a minor percentage of the total net profit of the farmer.

8. Farmers should pay the annual cost of O & M to their own organization which carries out the work. This is fair, since the facilities are highly beneficial to them.
   While O & M costs are clearly related to services rendered, cost-recovery charges are often regarded as a kind of tax. The collection of cost-recovery charges should therefore not be done by the same farmers' organization resposible for O & M.

9. The payment schedules should be fixed at the beginning of the project so that the farmers know beforehand what basic amount they will have to pay each year. They must also be informed in good time of the periodic adjustment of the rate due to inflation.

10. The farmers' willingness to pay the charges for cost recovery and O & M depends greatly on the reliability of the services offered to them and on their participation in project affairs.

11. Inflation has a great effect on the cost recovery rate, since it is often not possible to adjust the charges frequently. With an inflation rate of 15 per cent and an adjustment of the rates once every 5 years, the cost-recovery rate will fall about 30 per cent.

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ANNEX

In the analysis, three categories of farms are distinguished, each with its own cost-benefit situation and resulting repayment capacity. The calculation of the repayment capacity is illustrated in Table A1, A2, and A3. These tables represent the farm budget in year 10 for a "representative" farm out of each of the three categories (large- scale farms, tomato farms are melon farms). The major components of this calculation are described below.

Farm size:
The average size of all farms in each category is taken as representative for the entire category. However, this should be considered merely as an indicator of the magnitude of the budget of that category of farm. It must be appreciated that a large variation exists in farm size especially regarding the large-scale farms. The ranges of the farm size distributions for each category are:
- Large-scale farms: 15 - 250 ha;
- Tomato farms: 3-6 ha;
- Melon farms: 1-3 ha.

Gross production value:
The value of the entire agricultural production is assessed at 1981 financial prices. For the large-scale farms this includes the revenues of the natural pasture that emerges during the winter season on the entire area of the farm (including that part that is leased to the "seareiros" during the summer season). The gross production value of the "seareiros" consists of the value of the tomatoes c.q. melons produced during the summer season.

Production cost:
All production costs are included in this item except the cost of irrigation and drainage, labour, management and land rent.

Irrigation and Drainage cost:
As discussed in Section 3.2.3, the irrigation and drainage costs are not differentiated per soil group. It is assumed that the "seareiros" pay the full cost of irrigation and drainage for the area under tomatoes and melons. In consequence, the large-scale farmer is only charged for draining the 39 ha (out of the total of 60 ha) that he cultivates all year around. The irrigation cost, naturally only relates to the 9 ha that is on average being irrigated under own management on a 60 ha large-scale farm;

Labour cost:
The cost of labour includes the labour input of the members of the household, valued at the market price of labour.

Land rent:
The land rent that the "seareiros" pay to the large-scale farmer is assessed at the level of the net profit the large-scale farmer could realize on this area, cultivating his "average" cropping pattern during the same period. This excludes the revenues from the natural pasture.

Management cost:
The remuneration for management is estimated at 5 per cent of the gross production value.

Net profit:
The net profit is the result of the subtraction of all costs from the gross production value. For the owner-operators (large-scale farmers) the net profit includes the remuneration for the land cultivated under own management.

Repayment capacity:
The difference between net profits in case of rehabilitation and in the situation without project is a basis for calculating the repayment capacity. As argued in Section 4.4.1 the repayment capacity can be assessed at 40 per cent of this difference. For the large scale-farmers the presented repayment capacity concerns all 60 ha.

Table A1 Farm budget for a seareiros family cultivating 4 ha tomatoes (in 10^3 Esc, 1981 prices) in year 10 of the rehabilitation project (R) and the situation without project (W)

Soil type	A		B-D		E		F-I	
	R	W	R	W	R	W	R	W
Gross production value	1652	1487	1581	1416	1416	1298	1298	1109
Production cost	193	190	193	190	193	190	193	178
Irrigation, drainage cost	24	30	24	30	24	30	24	30
Labour cost	225	225	225	226	225	226	244	244
Land rent paid	143	96	129	85	122	74	70	49
Management cost	83	74	79	71	71	65	65	55
Net profit (NP)	984	872	931	814	781	713	702	553
Repayment capacity (RC)	45		47		27		60	
RC as % of NP	5		5		3		9	

Table A2 Farm budget for a seareiros family cultivating 2 ha melons (in 10^3 Esc, 1981 prices) in year 10 of the rehabilitation project (R) and the situation without project (W)

Soil type	A		B-D		E		F-I	
	R	W	R	W	R	W	R	W
Gross production value	470	425	450	400	425	375	375	300
Production cost	115	127	115	127	115	127	115	130
Irrigation, drainage cost	12	15	12	15	12	15	12	15
Labour cost	75	75	75	75	75	75	93	93
Land rent paid	71	48	64	43	61	37	35	24
Management cost	24	21	23	20	21	19	19	15
Net profit (NP)	173	139	161	120	141	102	101	23
Repayment capacity (RC)	14		16		16		31	
RC as % of NP	8		10		11		31	

Table A3 Farm budget for a large-scale farm of 60 ha (in 10^3 Esc, 1981 prices). During the summer season 21 ha is leased to seareiros; 9 ha is irrigated by the land owner himself. Data are presented for year 10 of the rehabilitation project (R) and the situation without project (W)

Soil type	A		B-D		E		F-I	
	R	W	R	W	R	W	R	W
Gross production value	3081	2582	3057	2519	2867	2356	2258	1739
Land rent received	750	504	676	447	641	386	365	256
Production cost	741	784	815	796	741	784	815	659
Irrigation,drainage cost	146	160	146	160	146	160	146	160
Labour cost	121	121	152	125	121	121	98	78
Management cost	154	129	153	126	143	118	113	87
Net profit (NP)	2669	1892	2467	1759	2357	1559	1451	1011
Repayment capacity (RC)	311		283		319		176	
RC as % of NP	12		11		14		12	

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·235·

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

Rome, 1987

PREFACE

This document contains the Papers prepared during the course of the meeting. In a few cases, slight editorial changes have been made.

These papers form a companion publication to the "Report on the Expert Consultation on Irrigation Water Charges", published in 1986. Together, they comprise a proceedings of the Expert Consultation.

Owing to the decision to print all the working papers, it has been necessary to divide them between two volumes. Volume 1 contains an introduction and its background, and the Technical Papers. Volume 2 contains the Country Papers and the Annexes.

Any queries should be referred to Prof. J. Němec, Chief, Water Resources, Development and Management Service, Land and Water Development Division.

-237

CONTENTS

238

Page

C. COUNTRY PAPERS

IRRIGATION DEVELOPMENT AND WATER CHARGES

by

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1. TRENDS IN IRRIGATION DEVELOPMENT

1.1 Global Trends

At the end of the last decade 1.500 million hectares of land were under cultivation and, of these, 210 million hectares were under irrigation, which means that 14% were irrigated. It has been estimated that on this relatively small portion of the cultivated land, 37% of the total crop value was produced. If other measures for water control in agriculture, such as land reclamation, flood protection and drainage are included, the estimate would be that, for around 50% of the crop value produced, water was manipulated in one way or another.

In the last twenty years there has been a noticeable decline in the rate at which irrigation expanded in the world, and the average annual growth rate of irrigation development, which was at a level of 5% per annum during the decade 1965 - 1975, has dropped to 1.8% per annum for the subsequent decade. Until recently, these growth rates were still sufficient, as the part irrigated of the total cultivated area increased from 12% in 1970 to 14% in 1980, but thereafter the increase levelled off and the irrigated portion remained stagnant at about 14.5% during the first part of the 1980 decade.

This decline in irrigation development is also discernible for developed as well as developing countries. Whereas for the former the growthrate was 2.7% p.a., it was as low as 1.5% for the developing countries. The reason for this might be - in rather general terms - the increasing costs of water development schemes on the one side, and the declining prices of agricultural products on the other, which both tend to reduce the economic viability of new irrigation projects. It is obvious that in developed countries specializing in irrigation for high value crops and with a high degree of intensification these constraints can be absorbed more easily than in developing countries where irrigation is needed more for staple food production and where, moreover, in most cases, large-scale water development is dependent on external loans which have become so difficult to obtain. A more differentiated view of the role of irrigation in agriculture as a means for intensification of production and expansion of cultivation, could be obtained from an analysis of different regions or groups of countries as the requirements and constraints vary according to demographic, economic and social factors, availability of land and water resources and degrees of development of the rural infrastructure.

1.2 Europe, North America and Other Developed Countries

About 29% (61.5 million ha) of the irrigated area in the world is in developed countries, with the major shares being in the USSR, (19 million ha, with an average growth of 3.9% p.a.), USA (20 million ha, 2.6% growth) and Western Europe (10.6 million ha, 2.0% growth). In all three areas irrigation has been growing quite fast, whereas the total area under cultivation remained stagnant, or even declined, as in Europe. Therefore, the additional irrigation was provided tor compensate for areas lost to production, or for conversion of land so far under rainfed production to irrigation for intensification of production, higher input use, and eventually for higher value crops. In Russia, for example, the expansion and intensification of cotton production - in the Asian part of the country - has been made possible by the construction of large modern irrigation schemes designed for a high degree of mechanization and input use. In order to achieve the enormous expansion of irrigation (6 million ha during the last decade, according to statistics), large investments had to be made for water development works (canal diversions, pump-schemes, storage dams), and also for land reclamation and salinity control.

In contrast, for the expansion of irrigation in Western Europe and North America, existing infrastructures were used, thus high investments in water development schemes could be avoided. The conversion of rainfed to irrigated production has essentially been done by extended use of sprinkler irrigation because of its flexibility and adjustability to the particular requirements of supplementary irrigation in individual farms and schemes for small groups of farms with similar cropping schedules. The water supply for these sprinkler systems is often from groundwater through individual farm wells which have the advantage of short water conveyance. Complete rural electrification and the availability of efficient agricultural services have been an important prerequisite for this development, as have been the completion of land consolidation measures in areas of previously highland fragmentation.

This trend in developed countries to expand irrigation substantially against a reduction in the rainfed area is, however, not followed in Australia, where the total cultivated area in real terms grows much faster than irrigation for the obvious reason that large land resources are still available; but irrigation is also gaining importance in Australia as indicated by the high growth rate of 3.8% per annum during the past decade, which has brought the irrigated area to 1.75 million ha.

Japan should also be mentioned in this group of developed 'irrigation countries', because the share of irrigation is as high as 68%, but the irrigated area has been shrinking constantly during the past decade, as have the total cultivated area and the use of fertilizer. Therefore the agricultural production index has fallen to 94% of the 1973 level.

242

1.3 South East Asian Developing Countries

The developing countries have a share of 71.2% of world irrigation and two thirds of this (103.2 million ha) are in the region of South East Asian (excluding Pakistan, Japan and the Asian part of USSR). Two countries account for the bulk of this: China with 45.1 million ha and 21% of the world total, and India with 39.5 million ha and 18.5%. They are the two biggest 'irrigation countries' in the world, according to size of the irrigated area and also the pace of irrigation development - if it is counted in real terms (426 000 ha and 766 000 ha, respectively, of additional irrigation p.a. during the past decade). They both set the trend in irrigation development for this region, which is to use irrigation as a means for intensification of production, multiple cropping, use of high-yielding varieties of rice, and gradually increasing input use, as these become available (growth rates of fertilizer use are above 10% p.a. in almost all those countries with a high share and a high growth rate of irrigation). This is underlined by the fact that in the region, irrigation expanded at a higher rate in real terms (1.65 million ha p.a.) than the total cultivated area (1.0 million ha p.a.), which indicates that most of the additional irrigation facilities were used for the conversion of rainfed production to irrigated production.

The reason for this can be attributed to the low reserve of land resources in the monsoon areas of the region where irrigation is concentrated, and the high population density (125 persons per km^2). Moreover, irrigation has been used traditionally for paddy-rice, which is the staple food for the region. A staple food - even if it is a high-yielding multiple cropping rice - cannot easily pay for the high investments required for additional large-scale water development works and, consequently, the highest growth rates for irrigation are in areas where existing infrastructures allow for a further direct development of irrigation.

In China for example, the additional irrigation installations have been used entirely for the conversion of rainfed production to irrigation and reclamation of land with declining productivity. The total cultivated area has even decreased by half a million hectares during the past decade, because of losses of land due to salinity, waterlogging, flood damage and erosion, which could not be reclaimed or compensated by new land coming under cultivation. The installation of additional irrigation at a magnitude of 4.3 million ha (about 10% of the total irrigated area) in one decade, has been done within the existing infrastructure, with small and medium-scale water development works, pump schemes and groundwater use, and in many places in combination with measures for flood protection or erosion control. With this increase, irrigation has been provided for 45% of the cultivated area, and this has greatly supported the enormous rise in intensification of production, expansion of multiple cropping and increase in the use of inputs (the growth rate of fertilizer use is 13.6% p.a.). As a result, the production index reached 155% of the 1974-76 level, and rice yields - almost entirely from irrigation - are now amongst the highest in the world.

The trend in India is quite similar, as irrigation growth has been about triple that of the total cultivated area during the past decade. With an average of 0.77 million ha p.a. of new irrigation facilities, India, in real terms, has the fastest irrigation rate in the developing world. The expansion of irrigation to land so far under rainfed production or partially irrigated is done in India, in most cases, through the special Command Area Development Programme. This provides for the district and farm-level distribution systems and their connection to the existing main canal systems, by which efficient irrigation can be rapidly carried through to the field at relatively low investment costs, as existing irrigation infrastructures can be used. This trend to connect the expansion of irrigation to existing infrastructures, which reduces costs and increases the efficiency of the system, is the same in India and China. In addition, both countries have the capacity through their trained personnel and available construction facilities, to implement this type of project with their own means, and in most cases the required capital investment can be generated locally and with the help of government resources. Both these factors explain the high rate at which irrigation has been able to expand in both countries.

Bangladesh should be added to this group because it has a high growth rate of 3.6% p.a. for irrigation development, essentially for conversion or reclamation of land previously under rainfed production. But the total amount of available land resources is insufficient, and much of the land is under constant threat of flooding. Therefore there has been no expansion of the total cultivated area, and the intensification of production which has been obtained so far by improvement of irrigation and a high growth rate of fertilizer use, has not been enough to compensate the increase in population so that Bangladesh is the only one of the large countries in Asia's monsoon zone where per caput agricultural production is declining, now at 0.1% p.a.

Three smaller countries also belong to this category with a high share of irrigation: the Republic of Korea 55%, the Korean DPR with 46%, and Sri Lanka with 25%; in there irrigation is growing quite fast, even faster than total cultivated area. In the cases of South Korea and Sri Lanka the fast irrigation expansion has been influenced decisively by the progress in the major water development projects, e.g. Naktong and Mahawelli Ganga. Thus, the countries mentioned under this category have been able to base irrigation development on existing infrastructure and on some which are now developing. Irrigation itself continues according to standing practice and experience, particularly with regard to the main crop of paddy-rice, for which there is a long tradition. This trend to expand irrigation to land so far under rainfed production has been further caused by lack of land resources suitable for expansion of non-irrigated production. The demographic and economic pressures have forced production to be intensified on existing cultivated areas through multiple cropping and high input use, and these are both possible for paddy-rice.

Indonesia and the Philippines do not follow exactly the same trend, irrigation growth is substantially below that of the non-irrigated cultivated area. Indonesia, for example, is quite dependent on irrigation, which covers 28% of the cultivated area. However, the country has achieved self-sufficiency in rice and has started to export some surplus; therefore it is less necessary to extend the paddy area, and moreover sufficient land resources are available to expand non-irrigated production in Sumatra and the outer islands. Irrigation has been concentrated in Java, for demographic reasons, and further expansion on the island, although very much needed for the same reasons, is extremely hindered by the high costs of the development of additional water and land resources. The short and steep catchments of islands cause a very unfavourable ratio of cost-effectiveness for water storage and diversion, terracing of land, access roads, etc. Therefore, besides some expansion of irrigation in Sumatra and the other islands, investments for irrigation are directed towards improvement of existing schemes for better water control and management for intensification of production, but also for protection of the catchment areas, soil conservation and measures for the preservation of the value of the schemes.

Similar tendencies have been observed in the Philippines and Thailand.

The common trend in all these countries in the monsoon zone of the Far East, is the expansion of irrigation for intensification of production, essentially for rice. The growth rates are above world average, and irrigation development comprehends extension of existing systems and conversion of rainfed land, in cases where the infrastructure for water development and supply is already sufficient for this. In countries which do not have the water and land resources ready for irrigation development, improvement of existing schemes for intensification is becoming the new trend. The prevailing irrigation technique used in both cases remains the traditional surface method, mainly for paddy. The particular problem of this development is the conversion of rainfed or partially irrigated cropping into a highly efficient, fully irrigated system for two or more crops with high input use. Special concepts have been introduced for such schemes, typified in the Command Area Development Projects in India.

1.4 South West Asia, Developing Countries

The region comprising South West Asia and the Near East (from Pakistan to the Mediterranean, excluding the USSR and North Africa) is the most extensive arid area in the world, but its irrigated part is only 12.6% of the world total, being 26.8 million ha, only one quarter of that of East Asia. However, because of its aridity, irrigation might be considered even more important in the region. As has been estimated, 70% of the crop value is produced under irrigation, although only 31% of the total cultivated area is provided with irrigation facilities.

As a general trend, irrigation is decreasing in this region, but so is the total cultivated area; during the last decade, the area irrigated was reduced by about 500 000 ha, and the total cultivated area lost about 4 million ha. These losses have partly been caused by increasing salinity, waterlogging and soil degradation due to erosion and desertification, and have not been compensated by expansion of irrigation and other reclamation measures. Neither were the results of intensification by better irrigation management and higher input use (average fertilizer use is about 50 kg/ha p.a.) sufficient to compensate the losses of productivity; consequently the production index remained far below the world average, and agricultural production per caput remained stagnant or even declined in some of the countries of this region.

Pakistan, with 72% of its cultivated area under irrigation, and the third highest share of irrigation in the world, is an exception in this region, as its irrigation has been growing at a rate of 100 000 ha. p.a. Progress which is quite remarkable as it has not only compensated high losses due to salinization, but even led to a steady increase in the total area under cultivation. Apparently, this has been made possible by earlier investments for the Tarbela Dam, for canal improvement and for groundwater development on a large scale. Now the effects of these investments have been absorbed and a reduction in the growth rate of irrigation can be expected for the first half of this decade. Therefore the trend for the remainder of this decade will have to direct efforts toward further intensification of irrigated production - for which some room exists. Possibilities are: the introduction of water-saving techniques and practises on a large scale (e.g. the ditch lining programme), the prevention of losses of irrigated land or its reclamation through drainage for control of salinity and waterlogging, and the further development of groundwater for medium and small size farms or farming areas with the introduction of piped distribution, and, eventually, sprinkler systems as a long-term goal. Research will be needed on all these subjects for adaptation of methods and techniques and generation of local know-how.

Most of the countries between Pakistan and the Mediterranean suffer particularly from waterlogging and the increasing spread of salinization; as a result, investments in drainage and water control will call for more attention than expansion of irrigation as such. This reclamation of land requires, besides the high investments, a lot of time as positive results in the form of increasing production are only noticeable after a long gestation period. In this way, Syria and Jordan show a high production index as a result of large previous investments for reclamation, whereas for Iran and Iraq the production index remained below average for lack of corresponding investments during the past decade.

The same zone of this region is also known for its traditional technique for groundwater development through hand-dug underground collector galleries. Most of these areas still have untapped groundwater resources (e.g. Afghanistan, Iran, Iraq, Turkey), but there has not yet been a break-through in the application of modern techniques of groundwater development which, combined with sprinkler or other piped irrigation systems, could provide a basis for rapid expansion of high value production, higher input use, more efficient use of the scarce water and reduction of the danger of salinization. If there were such a move for the introduction of modern groundwater development techniques and irrigation methods, it could be well supported by a regional cooperative research and support organization.

In the southern areas of the Arabian peninsula the age-old technique of water-spreading, often referred to as spate irrigation, is still in use. Although the area under this technique is has hardly more than half a million hectares, it has provided the lifeline for the Wadis which would otherwise have been uninhabitable because of extreme aridity. The method provides for the diversion of flash-floods into bunded fields to store soil-water for one crop and excess water to replenish the underground aquifers. The modernization of these systems for better production and greater security against sometimes devastating floods (as occurred recently in South Yemen) must be done with full respect to the function of the system as a regulator of the water household of the Wadi. One task during this decade should be to provide the technical and financial means for this modernization.

Common to all countries in the South West Asian region is the high dependence on irrigation on the one hand, and the stagnation of further irrigation development on the other, this is due to physical and financial constraints to the development of additional water resources. In many countries, the productivity of land has declined due to salinization and waterlogging; therefore, investments should first be directed towards the reclamation of such lands rather than to expansion of irrigation. Modern techniques for groundwater development, water distribution and irrigation have not found a substantial application so far in this region, but are promising - together with the introduction of better water management - for expansion of irrigation and reduction of the spread of salinization. Research must be conducted for these aspects.

1.5 Africa, Developing Countries

The African region (i.e. the 51 developing countries of the continent) has the lowest share of world irrigation, and 9 million hectares under irrigation represent only 5% of the total cultivated area; yet the value of the production from irrigation (without fodder crops) is about 20% of the total crop value. Irrigation in Africa refers to a wide range of conditions for major water supply to fields from sophisticated formal irrigation schemes with extensive permanent infrastructural facilities, to traditional peasant irrigation with simple local techniques, as well as traditional flood recession practices under limited water control systems. For climatic and demographic reasons irrigation has been concentrated in the Mediterranean and arid North African zone, which accounts for 47% of all irrigation in Africa, and the Sudano-Sahelian zone with another 25%, leaving just 2.5 million ha for sub-Sahelian African, of which Nigeria and Madagascar have the major share.

2151

In the Mediterranean and arid North African zone, Egypt occupies the most prominent place, because almost all cultivated land is under irrigation, and all agricultural production comes from irrigation. The additional water from the Nile - the life-line of the whole country - which has been made available through increased storage behind the Aswan dam, has been used more for intensification of irrigation than for its horizontal expansion, and irrigation intensity has reached an average above 150%. This has allowed a high input use, which is evident by the high rate of fertilizer use at an average of 360 kg/ha p.a., and yields are amongst the highest in the world. However, during the past decade, irrigation expansion to new areas was only marginal; in some areas production declined and land was lost due to increasing salinity, so that the total cultivated area was in a continuing decline, and an average of about 40 000 ha are being lost annually. Consequently, and as production per land unit is already at a high level, growth of production has been and is very slow, only 1.3% p.a. during the last decade, and insufficient to match the population growth. Thus per caput agricultural production is declining, now at a rate of 1.2% p.a., and food imports are increasing at the alarming rate of 20% p.a. As water resources from the Nile are insufficient for a rapid increase in the irrigated area in order to change this trend, the country's efforts have been directed towards prevention of land losses and to reclamation of land with declining productivity. This requires substantive investments in new drainage installations, and improvement and maintenance of such existing systems. Moreover, prevention of salinization and waterlogging calls for efficient water use and management, and improvement and maintenance of the irrigation systems, which would also save water. It is obvious that the traditional surface flow method will continue to be the irrigation method in Egypt, but in marginal areas (i.e. Sinai and oases) a tendency has been noticed to install water-saving irrigation techniques, such as drip irrigation, on small farms, because of the high cost of supplying water and the scarcity of this resource.

In the Magreb countries - a part of this zone - the irrigated portion in contrast to Egypt, is only about 5%, but irrigation growth rates are high, and apparently there has been a break-through in the use of sprinkler irrigation, as most of the new installations are of this technology. Water supply in most cases is from groundwater, and if this trend continues, special measures will be needed to protect the aquifers against over-exploitation or eventual degradation through salinization (as is already the case in Libya). In all these countries the production index is at a very low level, and agricultural production per caput is declining at an unacceptably high rate. But all three countries have a chance to change this situation by further expansion of modern irrigation together with much higher degrees of intensification. The research for developing additional water resources, better water management and eventual re-use of waste water should be accorded a high priority.

In the Sudano-Sahelian zone, the Sudan itself has the largest irrigated area with about 1.8 million ha and 14% share of the cultivated land. This could make a substantial contribution to the national economy, but agricultural production is low, per caput even declining, and input use is low (less than 50 kg/ha of fertilizer on irrigated land, against the 35C kg/ha in Egypt). It is very obvious that irrigation has not met the requirements for intensifying production, which might have been due to a set of constraints which are typical for Sahelian and Sub-Sahelian Africa. There are deficiencies in the rural infrastructure, transport, markets, supply systems, support services and policies. The effects of this are shown in the Gezira scheme which is of a size to be typical for large-scale projects. The scheme, which was originally built for cotton as an export crop, has neither the technical facilities to be adjusted to the requirements of an intensified and diversifie production, nor the capacity and organizational structure for appropriate operation and maintenance. The spread of waterborne diseases, changes in the structure of the rural society, lack of support services and obsolescence of the infrastructure have added to the increasing deterioration of the viability of the scheme. The necessary and, in fact, already initiated programme for rehabilitation, which is typing to control these factors, should reverse the negative trend; and it could then be an example of am approach to rehabilitation of large schemes.

Somalia, regarded as a part of the Sudano-Sahelian zone because of its aridity, has such limited resources for rainfed or irrigated production that it, at present, cannot provide the food for its population, and production per caput is declining at the very high rate of 4.6% p.a. The irrigation systems in the two river valleys of the country cannot provide the basis for intensification, and input use is almost nil. To obtain a substantive expansion in river irrigation, large-scale water development works have been planned, but their implementation has not yet been started due to lack of financial resources (large external loans are needed), and benefits will not materialize for one or two decades to come. Therefore, to alleviate the country's dependence on food imports, all irrigation efforts should be directed to the modernization and improvement of existing schemes for intensification of production to higher input use, and to the expansion of irrigation through the development of so far untapped groundwater resources and their appropriate management.

In contrast to this is Madagascar, which is more similar to the Asian islands than to Africa. By tradition the staple food in Madagascar is rice, and experience from Asia has proven that rice yields are best under irrigation (full water control) even at low input use. In mountainous islands, water development for large-scale irrigation schemes is costly, if not impossible. Hence, small-scale development of water resources (stream diversion and small storage, although not low-cost are suitable for construction and maintenance by local means) has made possible a large number of small irrigation developments which together provide 80% of the rice land with water. With this average, rice yields are relatively high and stable (1 800 kg/ha) even with a low use of mineral fertilizers (average about 10 kg/ha). In view of this, it is understandable that this type of irrigation has still been expanding at an average rate of 10 000 ha p.a. (9.2%) during the past decade.

Some countries which have a minimal share of irrigation in the sub-Sahelian zone must be mentioned because they are representative of a particular trend in irrigation in Africa:

- Nigeria has about 850 000 ha under irrigation, most of it locally managed minor small-scale irrigation in the more marginal northern areas. This type of irrigation has some importance for the local production of high value perishables, and eventually could be expanded for some rice or export crops. Irrigation, however, represents less than 3% of the total cultivated area, and at national level Nigeria has sufficient resources to eliminate the present and predicted food deficits by intensification of rainfed production.

- Senegal is environmentally marginal, and present performance of the agricultural sector gives cause for grave concern (production index 74% of 1974-76 level, per caput production is minus 3.7% p.a., and fertilizer use; minus 5.6% p.a.). Therefore, much hope has been placed on harnessing the resources of the Senegal river. Once the investments for the large storage dam and salt-water barrage have been completed, irrigation could indeed be modernized and extended, if the additional investments needed for this can be made available. However, types of irrigation, production and management systems first have to be determined, and present irrigation development should be used as a pilot activity to conduct the studies and research and to build the required cadres.

- Mali has achieved a remarkable expansion in irrigation which is now 160 000 ha or 7.8% of the cultivated area. This certainly has been a major contribution to the high growth rate of 4.8% p.a. in agricultural production in this country, which is an exception in all Africa.

- In all these countries, water resources planning is done through river basin commissions (Senegal, Niger, Chad) which have been established for most international basins in Africa. Their influence on irrigation development is, however, is rather limited as agricultural planning and corresponding investments are the privileges of national governments.

The continent presents a variety of conditions and constraints which result in quite a diversity of trends in irrigation development in the different zones; for the North and the Sahel these are:

- the aridity of the climate causes a high dependence on irrigation, but a further substantive expansion in irrigation is blocked practically by the non-availability of additional water resources of large potential (Egypt, Libya), or high costs and long gestation periods for their development (Somalia, Senegal);

- as a consequence, most attention has been given to intensification of production (Egypt), but it also needs to be given to better water use in those areas where production is low (Sudan, Somalia).

·750

- where performance of irrigation is low, measures for the increase of productivity must be introduced, such as improved irrigation methods, better management, higher input use and appropriate support services (Somalia, Senegal, Sudan);

  This may entail complete rehabilitation and modernization of the entire scheme, such as for the Gezirna in Sudan;

- where irrigated production per land unit is high, because of high degrees of input use and irrigation intensity (Egypt), more attention needs to be maximizing production per unit of water by judicious water management, minimum leaching, reduction of water losses and, eventually, introduction of water-saving techniques;

- waterlogging and salinization, often induced by irrigation, place a constraint on production and require appropriate prevention measures, or reclamation of affected lands, which requires additional investments for installation of drainage, its operation and maintenance;

- modest expansions in irrigation could be made possible through development of groundwater or re-use of low quality water from effluents, which - combined with piped distribution and sprinkler or drip irrigation - could be quite effective in marginal areas.

By contrast, in the sub-Sahelian part of the continent, trends in irrigation development have been conditioned not so much by a given physical environment, but rather by a set of external and internal factors which can change over a period of time. Factors promoting irrigation development have been:

- experience with traditional irrigation, based on local technology which has been practised in suitable locations by peasant communities for self-sufficient farming (i.e. Northern Nigeria), or for rice as a market crop where the market has existed traditionally (Madagascar);

- growing urban demands which have promoted small irrigation developments for production of perishable crops around urban centres;

- increasing consumption of rice in place of traditional staple foods which lead to the construction of medium and large-size irrigation schemes, specifically for rice;

- demand for agro-industrial production (sugar, milk, fibre) for which a commercial type of irrigated agriculture has been introduced often with substantial foreign investments and under foreign management;

- the socio-economic stabilizing effect of irrigation, which can help to settle the population, improve standards of living and satisfy demand for food and employment;

- and last but not least the demand for an adequate food supply for the whole population, and also for stabilization of food supplies in drought-prone areas.

These last two are the major reason for which the role that irrigation can play in Africa must be redefined.

Factors impeding irrigation development have been:

- the disproportionately high costs of water development and irrigation projects where the appropriate local infrastructure does not exist or is insufficient for the required works (capacity for construction, transport, power supply, settlement, planning and services);

- the sometimes low performance of new irrigation schemes which do not reach the expected level of benefits owing to shortcomings in design, management and services, and also to lack of incentives for the irrigators;

- the discouraging effect of an economic depression, deterioration of the country's balance of trade, or reduction in foreign aid;

- the absence of a consistant national policy for irrigation development as part of agricultural and rural development, also with regard to investment and pricing policies.

In the light of the African food crisis and from an analysis of the situation described above, a recent FAO consultation with irrigation experts from African government services has developed an African concept for irrigation development which provides a definition of the role of irrigation and guide-lines for its further development.

- Large irrigation perimeters can be justified for a viable agro-industrial production where irrigated production is in a competitive position compared to non-irrigated production.

- Irrigation as the sole form of farming is suitable where no cultivation is possible without (arid zones).

- Irrigation can be complementary to rainfed farming when irrigation makes it possible to intensify crop production, to introduce new crops or to open new markets (semi-arid areas).

- Supplementary irrigation can be of interest for particular crops (humid and semi-humid zones).

- Irrigation, as well as other forms of land reclamation, may also be used as a socio-economically stabilizing factor in rural development to help settle the population, improve its standard of living and satisfy its food requirements.

- Irrigation should be developed preferably as part of a wide-ranging area development programme, which must take account of the need to overcome those constraints to irrigation which are of an economic, social and institutional nature.

- Farmers' involvement in all stages of irrigation development and management, and transfer of responsibilities to farmers and water users associations are indispensable for success.

Furthermore, a series of measures are needed to place irrigation development on a sound basis:

- provide a reliable resources data base and broaden it to include socio-economic information;

- establish national policies for irrigation development;

- develop national/local capacities for irrigation planning, implementation, management and irrigation training down to the farmers' level;

- include social parameters in project appraisals;

- include rehabilitation of old schemes in the programmes of irrigation development.

In summary, irrigation should be able to play a more important role than at present to increase and intensify agricultural production if and when the above guidelines are converted into direct action.

1.6 Latin America

A review of the trends in irrigation development in Latin America can be brief, as most of its elements are the same as in other continents. Latin America has only the small share of 7% of world irrigation, and most of the irrigated area is in five countries.

- Peru is rather dependent on irrigation which is practised on 35% of the total cultivated land. The aridity of the western slopes of the Andes, together with the difficult topography causes new irrigation developments to be very expensive. In addition, measures for the reclamation of salt-affected land needs to be extended in the lower coastal strip. The growth rate of irrigation is only marginal and production is declining. The present financial crisis will lead to a complete halt of investments in irrigation and reclamation and will probably also seriously hinder the necessary maintenance work for the more sophisticated schemes.

- Brazil has the second largest irrigated area of the region, but as this is only 3% of the cultivated land, its dependence on irrigation is low. It is mentioned here because of a very high growth rate for irrigation emanating from a fast expanding

23

irrigation development programme for the North East. An interesting part of this is the government programme which provides support for the introduction of irrigation on small and medium farms as a means to intensify production and reduce the risk of failure of high value crops.

- Mexico has 23% of its cultivated area irrigated, and is well known for its efficient systems under good management and high productivity. Irrigation is still growing fast as the country has been able to provide some financial resources for hydraulic works which formed the basis for the present expansion.

- In Chile, although in real terms the irrigated area is the smallest among these five countries, it represents 22% of the total cultivated area. However, there was practically no expansion of irrigation in the past decade, fertilizer application was low and declined, and the little rise in total production probably came from an increase in cultivation on non-irrigated areas. Salinity problems in the north could have contributed to the decline in productivity under irrigation.

- Argentina has a long tradition of irrigation development in Mendoza, where irrigation is still being expanded by introducing sprinkler irrigation from groundwater wells.

One particular aspect of irrigation in this region should also be mentioned, these are the ancient small irrigation plants in the higher Andes. They have been of great value for the viability of rural settlements in the high mountain valleys, but are now tending to fall into ruin as a result of the economic depression in those areas. Some support should be provided by all the Andean countries to save these little schemes which are the basis for survival of these rural mountain populations.

1.7 Summing Up

From this review of the trends in irrigation development in the world, it is possible to identify problems which are of relevance to questions such as how to recover the cost of irrigation, and how much can be charged to the direct or indirect beneficiaries. Following the sequence of this review, the problem areas can be listed as follows.

a. The problem of really global concern is the high investment costs for the development of additional water resources, if irrigation is to be extended on a large scale to new areas. This problem have been approached in different ways.

   i) In developed market economies, there has been a change towards decentralized irrigation which has been made possible by sprinkler irrigation and groundwater development. Both have low investment costs, but high costs for operation, thus shifting the burden of costs from the public to private sector.

ii) In the developing countries of South East Asia, it was not only the high costs but also lack of opportunity for water development on a large scale which caused a change in trend towards the expansion of irrigation within the existing infrastructure where ever possible and needed. Alternatively, the expansion of non-irrigated production and the better use of water through improved management received priority over new projects.

iii) In the arid zone of Western Asia and North Africa, expansion of irrigation is blocked in both directions by high costs and low availability of resources. Thus greater efficiency in the use of water appeared to be the only way to obtain the necessary increase in production; however, this had not often, met with success. The introduction of water-saving irrigation techniques and cost-effective groundwater development could ease the tense situation to some extent.

iv) In Africa the high cost of water development - as experienced in Senegal - might cause a change of priority towards small scale, effective schemes.

b. The second area of interest was the change from horizontal expansion of cultivation to a vertical increase in production per Land and Water Unit. This has been rather successful in irrigated rice production in the Far East and must therefore become the new move in the Near East and North Africa. It affects the irrigators directly as they become more dependent on an exact water supply by the system, as well as on the supply of inputs by the agricultural services.

c. The third problem is the decline in production and degradation of the rural environment caused by salinization, erosion, flooding, diseases etc. It requires countermeasures for which appropriate funding is difficult as investments are not directly productive. The positive role of irrigation for the improvement of the rural environment, as shown for Africa, can be listed under this area.

d. As the last item, the problem of rehabilitation and modernization of irrigation and drainage schemes is mentioned, because it is more the task of the future than an identified trend. It concerns the farmers directly and forces the authorities to arrange for their participation in all phases of improvement, and of course, also in sharing the cost. It is understood that this latter point may be the reason why rehabilitation has been neglected so far; a successful attack on the problem in a few cases, however, might open this important subject to more support.

2. WATER PRICING POLICIES

The trends of irrigation development have confirmed the important role irrigation has to play for the increase of agricultural production and the improvement of the rural environment. At the same time, however, the trend of increasing costs of irrigation development calls in question the economic viability of irrigation projects. Both tend to demand an enlargement of the involvement of the public sector for financing irrigation in order to attain the agricultural and social objectives on the one side and to ease the burden of costs to make irrigated farming attractive on the other. But public financing of development projects is finding its limits by an unprecedented decline of the availability of funds in the developing countries. This resulted in the strongest competition between the sectors, and subsectors of the national economies, and the allocation of public funds to development projects will ultimately be decided on the basis of the cost/effectiveness by which the objectives (also the socio-political ones) can be attained. This need to reach a high level of cost (effectiveness has lead to the two main lines of present trends in irrigation:

- Reduction of the costs and the public share of investments in irrigation development and

- Intensification of production under irrigation.

It is the purpose of this consultation to discuss the influence which water pricing policies can have on the achievement of these two objectives.

The present trends of regional and national irrigation developments show a logical reaction to raising costs; only those opportunities have been selected for the horizontal expansion of irrigation which avoid too heavy a burden of investments; where such opportunities do not exist, priority has been given to the vertical expansion of irrigated production through intensification, instead of an increase of the irrigated area at all costs.

Both trends are mutually complementary and do overlap, thus a component of each can be found in every project to a varying degree. Water pricing policies have a direct influence on vertical increase of irrigated production where they can provide incentives and disincentives for good water management and production practices: their influence on lowering investment cost is more indirect as they can, for example, provide the incentives for saving water which then could be used for the horizontal expansion of irrigation at low investment cost for water.

In view of this, the Consultation will have to examine the role of water pricing policies in relation to the essential elements of both trends. For their essential elements the following check-list can be provided.

It should be recalled that irrigation water charges could reflect:

a. the cost of delivery of water to the field which can be subdivided in:

   - cost of permanent installations and

   - cost of operation and maintenance.

b. The price the farmer can afford to pay for water as a production input.

A water-pricing policy can, through a manipulation of the water charges, encourage or discourage water use, as well as appropriate operation and maintenance, and indirectly subsidize irrigation by transfer of funding from other sources.

With this in mind, it is to be accepted that the enormous costs for large and super-large water development structures or systems must remain outside these considerations.

For the normal size new irrigation development water pricing policy can play an important role in determining the rate of recovery of investment costs through water charges. Moreover, and perhaps even more important, is the determination of the share of the water charge which goes for operation and maintenance of the system, because here the basis will be layed for the proper functioning of the system and the preservation of its value for the future. This part of the water charge can provide one of the desidered links between the individual irrigator and "his" irrigation system.

Water pricing policies have an equally important role for providing incentives and support to improvement and expansion of existing irrigation parameters. Here it is the incentive for judicious water use and introduction of measures for saving water which can come from an appropriate fixing of the price of water. At the same time the introduction of a change for the irrigation water - which previously might have been free and now might be necessary to cover additional investments for the tertiary system and on the farm can be an element to help the establishment of water-user associations.

The same applies to the role of water-pricing policies with regard to the rehabilitation of old irrigation systems. But, quite often, those schemes which now need rehabilitation have deteriorated to this degree by the fact that no organization was in charge of maintenance, and no collection means were available to pay for the necessary repair work, which in some cases even might have been neglected by purpose to obtain subsidies for the rehabilitation.

The water pricing policy for irrigation should also take account of the related measures for maintaining the productivity of the land, such as drainage for salinity control, erosion control and others. Their operation and maintenance should be included in the water charges and administratively under the scheme management.

Finally, the whole question of water-pricing policies within the context of the existing legal framework for land and water property and rights must be given appropriate consideration also with regard to eventually necessary legislative action.

258

IRRIGATION WATER CHARGES AND RECURRENT COST RECOVERY IN PAKISTAN

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SUMMARY

This paper examines the existing level and structure of water charges in Pakistan within the context of issues related to recovery of recurrent costs.

In Pakistan irrigation subsidies have gone up from Rs.578 million in 1981 to Rs.1175 million in 1985. Excessive financial leakages from the irrigation system and very low water charges are two major reasons for consistently increasing revenue-expenditure gap. A major portion (67 percent) of the subsidy is going for operation and maintenance of the public tubewell schemes. Analysis with respect to O&M costs and farmers' payment capacity indicate that farmers can support existing level of O&M funding in non-SCARP areas. In SCARP areas, it appears that the government will have to subsidize the irrigation services forever unless early steps are taken to divest the public tubewell schemes.

If the cost recovery situation is to be improved, water charges should be increased gradually and efforts must be addressed to securing political support. In reality, farmers will accept gradual increases in water charges only if improved O&M services are assured to them. Also, the structure of various types of taxes should be analyzed to see whether some proportion of these taxes can be utilized for supporting the costs of improved O&M services. Flat land pricing policy is proposed to eliminate (or reduce) financial leakages present in the water charges assessment and collection system.

1. INTRODUCTION

1.1 Irrigated Agriculture in Pakistan

Agriculture plays a vital role in the economy of Pakistan. It accounts for 70 percent of national export earnings, 55 percent of the labor force, and 29 percent of gross domestic product. Its growth rate in 1985-86 was 6.5 percent indicating that weather conditions were favorable and availability of key agricultural inputs was satisfactory. A variety of crops are grown in various agro-climatic zones of Pakistan; however, in general, wheat, cotton, rice, sugarcane and maize are the most important crops. Most of the foreign exchange earnings of the country are generated within this sector, mainly through the export of rice and cotton.

- 259

The foundation of Pakistan's agriculture is the irrigated area which is reported to be 15.3 million hectares, accounting for 75 percent of total cultivated area (Government of Pakistan, 1984). About 74 percent of this area is irrigated by canals and 19 percent of the area receives irrigation water from tubewells. Irrigated agriculture contributes about 80-90 percent of Pakistan's agricultural production.

Agricultural production increases of the recent past are attributable to an expansion in irrigated area, since crop yields remained almost constant. The national average yields for all crops are far below the potential which is achievable with the currently available human and natural resources. From the irrigation standpoint, overall scarcity of irrigation water, non-availability of irrigation water at the right time and inefficient utilization of available water are the leading factors responsible for the gap between actual and potential yield levels.

Irrigation water is the vital input for a prosperous agriculture in the country. Presently, agricultural production is severely constrained by the overall scarcity of irrigation water. The supply and demand analysis of irrigation water, conducted by WAPDA (1979), indicates that available water supplies are about 30 percent short on an annual basis. The shortage in rabi season (34.6 percent) is somewhat more severe than in kharif season (25.1 percent)(1). In the rabi season, shortage is acute in the months of February and March when wheat is at heading and flowering stage and irrigation is critical. In the kharif season, large shortages occur in the months of June which delays the planting of cotton, and September which is serious for boll formation of cotton.

1.2 Public Irrigation System

Irrigation water supplies under the public irrigation system are derived both from the surface system and the public tubewells. The surface water for irrigation is obtained from the Indus Irrigation System which is the largest contiguous irrigation system in the world. The Indus System encompasses the Indus River and its tributaries, three major storage reservoirs, 19 barrages/headworks, 12 link canals, 43 canal commands covering about 90,000 chaks(2). The total length of the canal system is about 39,000 miles with water-courses, field channels and field ditches running another 1.0 million miles. Approximately 103 million acre feet (MAF) of surface irrigation supplies are diverted annually into this canal system.

In the public sector, groundwater is obtained from SCARP (Salinity Control and Reclamation Project) tubewells. Government has installed about 12,500 tubewells over 12 completed SCARP projects, covering about 20 percent of the country's irrigated land and costing approximately Rs.6.5 billion at the time of installation (World Bank, 1986). In 1985, about 10 MAF water was available from SCARP tubewells and other public irrigation tubewells.

Both sub-surface and surface drainage facilities are needed in the irrigated areas of Pakistan. Except for rice area commands, sub-surface drainage facilities are required in all the irrigated areas of the country where water table is less than 5 feet. The Government has attempted to handle sub-surface drainage problems through the SCARP programs plus a very limited tile drainage program where applicable. Over the years, a large net work of surface drains have also been constructed in the country to take care of surface drainage problems.

1.3 Private Irrigation System

In Pakistan, there are about 186 thousand privately owned tubewells which can be regarded as country's private irrigation system. These tubewells are located in both canal command and dryland areas. Groundwater pumpage from these tubewells accounts for nearly 80 percent of Pakistan's total pumpage, about 20 percent of the total irrigation supply at the source, and approximately 30 percent of total irrigation supply at the "root zone" (World Bank, 1986).

About 65 percent of the private tubewells are installed in canal command areas and are used as supplementary sources of irrigation; whereas the remaining 35 percent provid^ the principal source of irrigation (WAPDA, 1979).. According to a WAPDA survey (1980), about 88 percent of the investment on private tubewells is contributed by the farmers out of their own resources, 3 percent by government subsidy programs and 7 percent by credit advanced by the Agricultural Development Bank of Pakistan.

The government is also encouraging the installation of private tubewells by providing direct cash subsidies and credit on soft terms and conditions. Direct cash subsidies are available for construction of private sector tubewell facilities and to get power connections for tubewells. Private sector tubewell owners also benefit from implicit operational subsidies because the agricultural tariff for electric energy is less than the actual cost of generation, transmission and distribution.

The subsidy for diesel operated tubewells is provided to the farmers who own, individually or collectively, a minimum of 25 acres of land. In Punjab, the rate of subsidy is uniform for all sizes of tubewells, but varies according to the location of tubewells in different areas. The present rate of subsidy is Rs.20,000 for dryland areas, Rs.18,000 for sailaba (flooded) areas and Rs.16,000 for canal commanded areas.

1.4 Comparative Performance (Public vs Private Irrigation Systems)

In order to shed some light on efficiency aspects of private-vs-public managed irrigation systems, these systems are compared on the basis of the following performance indicators: investment costs, O&M costs, utilization rate and productivity.

One recent study (ACESGI, 1984) reported that, in 1983-84, the capital cost of SCARP water was Rs.115 per acre-ft, while the capital cost of water pumped from private tubewell was Rs.87 per acre-ft (electric tubewell) and Rs.57 per acre-ft (diesel tubewell). The same study reported that, in 1983-84, annual O&M cost of SCARP water was Rs.144 per acre-ft, while the O&M cost of privately pumped water was reported to be Rs.59 per acre-ft (electric tubewell) and Rs.155 per acre-ft (diesel tubewell).

The Central Monitoring Organization (CMO) of WAPDA conducted one study in 1973, to compare the effects of SCARP tubewells and private tubewells in non-

-261

SCARP areas, having almost the identical agro-climatic and soil conditions. This study concluded that:

(i) the rate of utilization for public tubewells ranged from 29-56 percent, and for private wells it ranged between 26-31 percent;

(ii) the cropping intensities achieved under private tubewells were comparatively higher than those attained in SCARP areas; and

(iii) the crops yields under private tubewells were as good, if not better than the SCARP tubewells.

These comparisons clearly indicate that though private tubewells are planned and installed in a haphazard and sub-standardized manner, these yield comparatively better financial and economic benefits to farmers.

1.5 Major Problems of the Public Irrigation System

Improved agriculture sector performance is directly related to improved levels of farmgate water delivery. Therefore, the Government of Pakistan has prepared and implemented, with the assistance of numerous donors, a series of comprehensive programs to improve the performance of the irrigation system. These programs included construction of big dams and link canals; development of groundwater resources; implementation of waterlogging and salinity control projects; efforts to improve the physical and operational characteristics of the irrigation system; and introduction of various institutional development arrangements. As a result of substantial investments in these programs the situation with respect to overall water availability has improved. However, the system is not yet designed to maximize agricultural output. The existing system is still characterized by a number of economic, financial, technical, operational, institutional and managerial problems.

Leading the list of these problems is inadequate operation and maintenance of the system. Inadequate maintenance of the canals results in their frequent breaches and consequent interruptions in water supplies. The performance of SCARP tubewells has also been affected seriously as these are now being operated only at about 35 percent of their installed capacity. The drains have become clogged with sediment and weeds due to inadequate maintenance.

The ability to carry out maintenance is inhibited, to some degree, by financial constraints. Financial constraints are becoming more evident because the revenue generated by the system has not kept pace with the rising O&M costs; the latter tend to rise due to the positive relationship between system's deterioration rate and the age of the system. In addition, very high O&M costs of public tubewells have made additional demands on already scarce financial resources.

Continuous expansion in irrigation and insufficient drainage facilities have caused serious waterlogging problem in the Indus Basin. The areas having a groundwater table within 5 feet depth have now been declared as "disastrous area". This is reported to be about 11 million acres and 5 million acres during October and June, respectively (Government of Pakistan, 1983).

262

The reliability and efficiency of the system at the macro level have declined due to deficient water policies and practices. Lack of integrated management of water, as well as other inputs, by farmers, government agencies and others also prevent higher agricultural production. Due to inadequate management and given the physical characterstics of the system, more than half of the water diverted into the system from surface supplies is lost. These losses, together with unpredictable variations in water supplies, cause considerable uncertainty at the farm level as to whether water will be available at periods critical to crop development.

1.6 Irrigation Development Strategy

In order to address some of the problems outlined immediately above, the Sixth Five Year Plan lays out the Government of Pakistan's (GOP) threefold water strategy for the 1980's. The salient features of this strategy are:

(i) protection of fertile land and infra-structure from waterlogging, salinity and floods by completing repair work on Tarbela and the Indus Basin Programs, giving priority to severely waterlogged areas having saline groundwater and replacing deteriorated tubewells;

(ii) improvement of existing irrigation and drainage facilities by canal remodeling, rehabilitation of the irrigation system, command water management, on-farm water management and reorganization of the institutional framework; and,

(iii) extension of irrigation and drainage through new irrigation schemes, medium sized reservoirs, public tubewells in underdeveloped areas, and new schemes in Baluchistan and the Federally Administered Tribal Areas.

A comprehensive program has been prepared to implement this strategy and an amount of Rs.32.1 billion has been allocated for the development of irrigation sector in the Sixth Five Year Plan. Major portion of the allocations would go to drainage, reclamation and irrigation because large areas are still water-logged despite extensive SCARP programs. The Plan's proposed strategy is to focus on "disastrous" areas where the water table is within 5 feet of the surface. The total allocation for the water sector is almost equally divided between on-going and new projects.

2. WATER PRICING POLICY IN PAKISTAN

2.1 Historical Overview

The first schedule of an occupier's rate was prepared for Upper Bari Doab Canal in 1891 and similar schedules were prepared for different other projects on their completion. The first revision of the rates was done in 1924 when the rates were increased by about 25 percent. In 1934, the rates were reduced due to a slump in the prices of agricultural produce. The reduced rates continued for 20 years in spite of the fact that the prices of agricultural commodities showed an increasing trend. In 1955, the Punjab Government revised the occupier's rate to the pre-1934 level. In 1959, the Government decided to increase water charges on a uniform basis throughout West Pakistan. After 1959, there have been successive increases in water charges of major crops (see Table 1).

263

Table 1 HISTORICAL INCREASES IN WATER CHARGES OF SOME MAJOR CROPS. (Rs./ACRE)

Year	Crops			
	Wheat	Rice	Cotton	Sugarcane
1959	6.00	10.00	9.80	20.00
1963	6.40	10.40	10.40	21.60
1965	7.20	11.20	11.20	24.00
1968	8.80	13.60	13.60	28.80
1969	10.40	16.80	16.80	32.80
1978	13.00	20.00	20.00	41.00
1980	16.80	25.60	26.40	51.20
1981	21.60	32.00	33.60	61.60

In Pakistan, historically, setting water charges for different canals has been affected by factors like operation and maintenance costs, interest on capital costs, repayment capacity of the farmers, quantities of water required for maturing a particular crop and income generated by different crops. A brief review of the history of water charges in Pakistan reveals that the question of raising water rates to make them compatible with other relevant economic parameters has surfaced again and again. Many committees have been formed both at provincial and national levels to rationalize the structure of water charges. The recommendations of these committees have either been accepted partially, or not at all, depending upon how the policy makers viewed the recommendations in the context of the economic and political situation of the country at that particular time.

2.2 Present Status

Presently, water charges are imposed on an acreage basis and vary with the crops grown in each season. These charges are also not uniform country wide and vary among provinces. Acreage basis charges are applied because these are easy to implement and farmers find them easy to comprehend. Water charges are set on an adhoc basis and there appears to be no systematic procedure for increasing them. Though water charges among crops vary considerably, this variation has little relationship to consumptive crop water requirements or income generated by different crops.

Despite the fact that current spending on water supplies varies widely among various canal commands, water charges are generally levied in accordance with the perennial and non-perennial nature of the canals. Moreover, since the cost of water, availability of water and farmer's payment capabilities vary significantly in non-SCARP and SCARP areas, differentiated water charges are levied in these areas. According to the existing policy, water charges in SCARP areas are double than those levied in non-SCARP areas.

2.3 Mode of Assessment

The assessment system consists of detailed written records and every action is cross-checked at one stage or the other. When first designed, the underlying assumption of having such a complicated system was to eliminate or lessen opportunities of corruption for petty government officials. Yet, in practice, there are many opportunities of this kind.

According to the present system, an irrigation patwari (an assessor) assesses the water rates on the basis of crop conditions. This provides him an opportunity to make arrangements between himself and individual farmers. He is a poorly paid official who enjoys significantly high social power within his area of jurisdiction, typically encompassing four or five villages. Small farmers are reluctant to cause him trouble and big farmers can buy him out. A patwari can reduce the farmer's tax by:

(i) falsely claiming hailstorm damage or some other act of God such as flooding or earthquake;

(ii) identifying cultivated land as fallow;

(iii) reporting healthy plants as having been struck by disease; and

(iv) declaring seeds as completely or partially failing to germinate (Johnson et al., 1977).

A recent study by Chaudhry (1985) estimated that the annual financial mis-appropriations resulting from under-assessment were about Rs.60 million in Punjab and Rs.17 million in Sind. Another important irrigation official from the farmer's standpoint is the canal overseer. He can favor the farmers by allowing them to enlarge the size of the mogha (outlet from canals to water-courses). The magnitude of this favor is determined by the number of cultivated acres on the water-course and the degree of mogha enlargement. In sample villages payment have ranged from a minimum of Rs.600 to Rs.7000 (Lowdermilk et al., 1975).

Poorly paid officials of the Irrigation Department, with little promotion prospects, control a commodity which despite being rated as nearly valueless (because of its low price) is an essential and scarce input for the majority of the rural population. The scarcity and essentiality constraints compel the farmers to search for additional supplies of water which opens the doors of corruption for officials of the Irrigation Department.

Although it is impossible to make the revenue assessment system perfect by all standards, efforts can be exerted to eliminate or at least reduce the magnitude of financial leakages resulting from current illicit practices. Elimination of such illicit practices can ensure recovery of sizeable amount of funds which can be used for efficient O&M of the system. In this direction, the flat rate pricing policy can be considered as an alternative to current crop-wise assessment policy.

Among the flat rate pricing options, the flat land water charge has some distinct advantages(3). First, institutional costs of administering this pricing method are very low because it only requires the knowledge of farmers' land holding. Second, the required information is available from land revenue records which are accurate, of long standing, kept current, and understood by all. Third, adoption of this pricing policy will directly result in an annual saving of huge amounts of money presently mis-appropriated from the system due to under-assessment/mis-reporting. Fourth, the new policy would result in saving of costs associated with administering of current pricing policy.

3. COST RECOVERY AND WATER CHARGES

3.1 Cost Recovery Situation

A review of the historical relationship between O&M expenditure and receipts from water charges (Table 2) indicate that both O&M expenditure and recoveries from water charges have been increasing consistently over a period of time but the latter has not increased in the same proportion as the former. In Punjab, cost recovery has dropped from 88 percent in 1974-75 to 58 percent in 1984-85, while cost recovery in Sind has dropped by 27 percent during the same period.

Table 2 OPERATION AND MAINTENANCE EXPENDITURE AND RECOVERIES FROM WATER CHARGES IN PUBJAB AND SIND PROVINCES FOR THE PERIOD 1974-75 TO 1984-85 (MILLION RUPEES).

Year	Punjab			Sind		
	O&M Expenditure	Receipts	Deficit	O&M Expenditure	Receipts	Deficit
1974-75	312.40	275.00	37.40	109.20	73.70	35.50
1975-76	371.10	277.70	93.40	128.00	67.10	60.80
1976-77	390.80	314.90	75.90	171.10	61.60	109.50
1977-78	417.00	360.70	56.30	138.80	86.60	52.20
1978-79	480.70	417.40	63.20	213.70	98.90	114.70
1979-80	645.40	427.70	217.70	235.40	95.00	140.30
1980-81	734.50	473.00	261.50	329.00	131.50	197.40
1981-82	931.50	593.10	338.40	407.30	203.00	204.30
1982-83	1007.30	688.11	319.20	420.20	210.00	205.00
1983-84	1195.30	760.00	435.30	513.40	224.10	288.50
1984-85	1347.30	782.80	564.50	603.62	246.50	357.12

The revenue-expenditure gap of the entire irrigation system is consistently increasing at an alarming rate over the past couple of years. The implicit subsidies (O&M cost of irrigation system minus revenues from water charges) in Pakistan have gone up from Rs.578 million in 1981 to Rs.1175 million in 1985. Excessive financial leakages from the system due to under-assessment/misreporting and very low water charges are the major reasons for consistently increasing revenue-expenditure gap.

A major portion of the subsidy is going for operation and maintenance of the public tubewells schemes. A system-wise analysis of total subsidies

266

indicates that in 1984-85 the subsidy on SCARP tubewells amounted to Rs.788 million as compared to Rs.387 million estimated for the surface system. According to a World Bank Report (1986), Pakistan's SCARPs have become the World's most expensive and costly vertical tubewell drainage program.

The subsidy on various inputs undoubtedly helps in the adoption of new technology. However, in practice, these subsidies are often distributed inequitably. In Pakistan, 74 percent of the total number of farmers are under 12.5 acres and they occupy about 45 percent of the total irrigated area. If subsidy is a direct function of the area irrigated, then an immediate inference can be drawn from these statistics that 26 percent of the total number of farms (above 12.5 acres) are utilizing 55 percent of the total subsidy. The average per farm subsidy has been estimated to be Rs.125 for small size farms, Rs.347 for medium size farms and Rs.769 for large size farms.

Because of the differences in consumptive water requirements of various crops and as such the actual water applied to different crops, the amount of subsidy involved in growing of various crops also varies. This eventually affects farmers decisions regarding selection of crops to grow on their farms. A review of the farm-wise cropping pattern statistics indicates that farmers with large holdings devote more acreage to cash crops (which are usually more water consumptive) while small farmers bring more area under food crops and fodders. This implies that large holdings derive relatively more benefits because they not only get higher subsidy in proportional terms but also by growing cash crops whose water rates are highly subsidized.

The above review of the cost recovery situation does not present a promising picture. If the current recovery patterns continue to persist, the situation will become even worse because, in future years, significantly higher financial allocations will have to be made for annual operation and maintenance of rehabilitated parts of the system. This underscores the need to adopt a water pricing policy that should make the system financially self-supportive and also support overall saving and investment efforts of the country. Such a policy obviously calls for significant increases in the current levels of water charges.

3.2 O&M Spending and Cost of Irrigation Water

An analysis of the cost of supplying irrigation water is presented in this paper for the Punjab and Sind Provinces only since these provinces account for more than 90 percent of the country's total O&M expenditure. During the period 1981-86, on an average, financial allocations for O&M activities have increased at an annual rate of 15.08 percent and 16.18 percent in Punjab and Sind provinces, respectively. This implies that financial allocations have not only increased in nominal terms but also in real terms; since inflation during the same period averaged about 9 percent.

From an O&M spending viewpoint, the irrigation system can be grouped into canals, tubewells, flood protection bunds, small dams and other works. In addition to all these hardware, input and service items, there is an establishment budget -- salaries/allowances for staff/employees. Approximately two-thirds of the overall budget goes for O&M activities of irrigation facilities and one-third for establishment. The share of these components in total PID budgets vary by provinces. In Punjab, the leading share-holder of country's irrigation O&M budget, expenditure for tubewells dominates the O&M portion of the budget, accounting for 66 percent; canal O&M totals 26 percent and flood control and drainage accounts for almost all the remaining 8 percent of O&M expenditure.

The establishment cost covers all staff activities, not just operations and maintenance activities, but the entire set of activities involved with capital development projects, including rehabilitation. Since these other activities tend to consume inordinate shares of staff time, it becomes somewhat arbitrary as to what part of the establishment bill should be charged to routine O&M, per se. It can always be assumed, of course, that capital projects (new canals, rehabilitation, etc.) are intrinsic to the O&M system and staff time on them thus should be included. Indeed, that assumption has generally been made when trying to assess revenue needs of the Provincial Irrigation Departments.

In 1985-86, the average O&M cost of canal irrigation water in the Punjab Province was Rs.20.03 per acre-ft as against Rs.15.79 per acre-ft estimated for the Sind Province. In both the provinces, per unit O&M cost of SCARP water was extremely high as compared to per unit O&M cost estimated for the surface water. The cost of tubewell water was Rs.128.03 per acre-ft and Rs.129.80 per acre-ft in Punjab and Sind provinces, respectively. Cost comparisons on a provincial basis indicated that the cost of supplying per acre-ft of canal water in Punjab was about 27 percent higher than in Sind. However, the per unit cost of tubewell water was almost similar in both the provinces.

3.3 Target Level Water Charges

One important policy question which must be addressed here is: what should be the level and structure of water charges? Assuming current O&M spending levels as cost recovery targets, target level water charges are estimated on the basis of per unit cost of water reported earlier and water actually applied to different crops. The comparison of target level charges with the existing water charges (Table 3) provides inferences about the magnitude of shortfalls in irrigation costs and present receipts on a crop basis.

The analysis reveals that, in both the provinces, if cost recovery is to be accomplished, existing water charges of all crops (except oilseed in non-SCARP areas of the Punjab Province) need to be increased significantly. Moreover, the magnitude of the required increase in the current water charges, to bring these to the estimated level, in SCARP areas is significantly greater than those required in non-SCARP areas.

If water charges are estimated on a flat rate basis, O&M spending for non-SCARP areas of Punjab Province calls for the recovery of Rs.48.24 per cultivated acre as compared to the existing recovery rate of Rs.36.26 per cultivated acre. The estimated target for SCARP areas is Rs.213.51 per cultivated acre as compared to the existing recovery rate of Rs.72.14 per cultivated acre. Cost recovery targets for non-SCARP and SCARP areas in Sind Province suggest levying of Rs.79.90 and Rs.246.55 per cultivated acre, respectively. The present recovery rate in Sind Province is Rs.33.66 per cultivated acre in non-SCARP areas and Rs.54.08 in SCARP areas.

Table 3 ESTIMATION OF WATER CHARGES ON THE BASIS OF ACTUAL WATER APPLIED TO VARIOUS CROPS AND THEIR COMPARISON WITH THE CURRENT WATER CHARGES, 1985-86 (Rs./ACRE)

Crop	Estimated Water Charges		Current Water Charges	
	Non-SCARP Areas	SCARP Areas	Non-SCARP Areas	SCARP Areas
		Punjab Province		
Cotton	38.75	247.74	33.60	66.00
Rice	57.75	369.15	32.00	64.00
Sugarcane	111.37	711.85	64.00	128.00
Maize	32.72	209.12	19.20	38.00
Kh. fodder	31.63	202.18	13.60	27.00
Rb. fodder	38.52	246.24	11.20	23.00
Wheat	25.99	166.12	21.60	43.00
Oilseed	15.47	98.90	23.00	43.00
		Sind Province		
Cotton	68.29	561.38	36.02	72.05
Rice	62.15	510.37	34.37	68.75
Sugarcane	133.46	1097.13	70.40	140.80
Orchards	104.55	859.49	55.00	110.00
Kh. fodder	34.41	282.86	15.40	30.80
Rb. fodder	38.58	317.14	20.62	41.25
Wheat	27.04	222.28	20.62	41.25

Given the warabandi system of water allocation any change in either the level or structure of water charges is not expected to register a significant improvement in economic efficiency(4). However, the likely change in relative profitability of various crops as a result of implementation of actual water applied-based charges may indirectly affect water use (water use shifting from less to more profitable crops). The flat land water charge will encourage the farmers to increase their cropping intensity where profitable to do so. However, it is questionable whether this would indeed be profitable since intensities are already high compared to water availability; so it is not likely that an increase in water-use efficiency would result.

As discussed above, the target level water charges are significantly higher than the existing water charges. But, for many economic and political reasons, it may not be possible to raise the existing water charges to the target level with one stroke. The most appropriate way to reach the target level would be to develop a phased schedule that is based on gradual increases; so that increased charges are accepted by the farmers with less resistance.

3.4 Payment Capacity of Farmers

Farmers' capacity to pay for irrigation water serves as an important criterion in setting the level and structure of water charges. The net income criterion generally serves as a good approximation of a farmer's ability to pay for water charges. Financial costs and returns of selected crops are estimated in Table 4 so as to examine the relationship between current water charges and net per acre income of various crops, and to see whether farmers can afford to pay "target level" water charges.

Table 4 FINANCIAL COSTS AND RETURNS OF VARIOUS CROPS IN PUNJAB AND SIND PROVINCES, 1985-86 (RS./ACRE).

Area/Variable	Crops							
	Cotton	Rice	Sugarcane	Maize/(5) Orchards	Kharif fodder	Rabi fodder	Wheat	Oilseed
Punjab Province								
Non-SCARP								
Total income	2614	2518	3770	1811	1344	2407	2231	1720
Cash production costs	1055	949	1492	678	361	611	800	524
Total production costs	2357	2407	3470	1727	1282	1840	2031	1599
Net returns (CFM)	1559	1569	2278	1133	983	1796	1431	1196
Net returns (RBM)	257	111	300	84	62	567	200	121
SCARP								
Total income	1508	2263	3535	1638	1293	2175	1858	1440
Cash production costs	656	764	1285	548	323	496	610	424
Total production costs	1676	2053	3170	1483	1139	1546	1613	1365
Net returns (CFM)	852	1499	2250	1090	970	1679	1248	1016
Net returns (RBM)	-168	210	365	155	154	629	245	75
Sind Province								
Non-SCARP								
Total income	2232	1848	4761	6719	1120	1976	2059	
Cash production costs	908	812	1819	1308	295	491	731	
Total production costs	1965	1945	4318	4735	1035	1476	1788	
Net returns (CFM)	1324	1036	2942	5411	825	1485	1328	
Net returns (RBM)	267	-97	443	1984	85	500	271	
SCARP								
Total income	1875	1960	4336	5879	1064	1820	1760	
Cash production costs	734	750	1505	1217	255	409	574	
Total production costs	1634	1838	3674	4662	881	1252	1483	
Net returns (CFM)	1141	1210	2831	5480	809	1411	1186	
Net returns (RBM)	241	122	662	1217	183	568	277	

The current water charges constitute a very small fraction of financial net returns estimated through the cash flow method; about 2 percent in non-SCARP areas and 4 percent in SCARP areas in both the provinces(6). However, the current water charges constitute a fairly high proportion of net income when this latter parameter is estimated through the residual budgeting method(7). In that case, on an average, in non-SCARP and SCARP areas, current water charges are about 18 percent and 27 percent of the net returns in the Punjab Province and about 10 percent and 22 percent of the net returns in the Sind Province, respectively.

As it is evident from Table 4, net returns of some of the crops estimated under the residual budgeting method turned out to be negative. It may be pointed out that negative net returns do not necessarily imply a financial loss. As a matter of fact, the negative returns are a result of the dominance of labor in the production function. This implies that a farmer would not, in fact, be able to compensate himself, his family and hired labor at the wage levels assumed in the analysis.

In both the provinces, in non-SCARP areas, water charges of all crops (except rice in the Sind Province), estimated to represent the macro level cost recovery target, are well within the payment capacity of farmers(8). Contrarily, in SCARP areas, target level rates exceed the payment capacity of farmers. This implies that government will have to subsidize the irrigation services in SCARP areas unless early steps are taken to divest the public tubewell schemes. Until such a policy decision is taken, a reasonable increase in the existing water charges will still be required to reduce the overall magnitude of irrigation subsidies in these areas.

Since, in future years, farmer's capacity to pay for irrigation water can alter due to a variety of reasons, there will be a constant future need to examine and monitor closely the relationship between farmer's payment capabilities and increased water charges. Moreover, in view of the government's current stated policy regarding withdrawl of subsidies being paid on agricultural inputs, the future structure of economic incentives must ensure fairly steady growth in farm income. This can be done by increasing the output prices at a faster rate than the rate at which input subsidies are withdrawn, in real terms.

4. BUDGET FOR O&M ACTIVITIES

4.1 Present O&M Budgeting Procedures

Apart from low water charges, methodological deficiencies in present budgeting procedures also contribute to inadequate budgets for O&M funding. The annual O&M budget in Punjab and Sind Provinces is presently prepared on the basis of a "Yardstick Model" which was developed decades ago. Although various parameters of this model have been revised over the years to take into account cost escalation factors, it still has a number of deficiencies. There is no provision in the model for purchase of durable goods or for the maintenance of such goods. Yardstick rigidities do not allow the model to capture the effects of various economic and technological changes which may take place over the long-run.

Rising prices per unit of work, highly constrained budgets and increasing physical requirements has led to a situation in which PIDs are continuously attempting to obtain greater funding from their own Finance Departments. The

7,71'

details of this process naturally varies somewhat between provinces. The effort normally include both the "doctoring" of outdated physical and financial yardsticks and the use of Annual Development Plan (ADP) funds for maintenance. In general, efforts over the 1970's and 1980's to acquire improved O&M funding have tended to be based on "we need twice as much", or "we need 50% more", and the like.

4.2 Full Funding O&M Requirements

Historically, operation and maintenance practices were prescribed quite carefully. These were supplemented by physical and financial yardsticks which were generally acceptable to the Finance Departments. But, that was a time when the canals were by-and-large in regime and operated within their design capacities. Now, they are operated at 150 to 160 percent of their designed capacity. As of the late 1960's and early 1970's, these practices render time sanctioned processes redundant and, in general, no longer workable. This suggests a need to update physical and financial parameters of the yardstick model so that PIDs can prepare O&M budgets corresponding to required technical O&M standards suited to current operating conditions.

There have been a number of efforts to assess new full-funding level O&M requirements in the recent past (9). The Government of Sind (1979) has estimated that full-funding level budget for O&M of canals was more than double the amount provided in the budget (Rs.131 million as against Rs.60 million). WAPDA (1979) has reported that the amount required for efficient O&M of the canal system was Rs.17 per acre as against the actual expenditure of Rs.12 per acre. The World Bank (1982) has estimated that an amount of Rs.25 per irrigated acre would be required annually for efficient O&M activities of canal/drain/bund. A recent attempt by DAI (1984) concluded that full-funding level requirements were about 19-24 percent higher than the current O&M expenditure. The preliminary findings of full-funding level estimates being developed by PRC/Checchi indicate that, on an average, full-funding level budget for maintenance of rehabilitated canals is about 1.5 times greater than the amount currently being allocated for O&M activities.

A review of the recent history of efforts to estimate full-funding O&M indicate that there is such a plethora of different numbers used, different data elements in grouped estimates, different assumptions, assumptions left out or not stated, and so on, that it is quite impossible to trace trends accurately, to make comparisons and contrasts, and to otherwise find out what has been going on. Also, it seems that perhaps the most important problem has been the failure to estimate properly the volume and degree of physical work needed to be done. Moreover, in spite of the work which has gone into these sequence of estimates, there is very little evidence that anyone at policy-making level is paying much attention. Under the circumstances, therefore, it is important that the PRC/Checchi effort be continued since it is attempting to measure full-funding level O&M requirements not only on the basis of improved physical and financial yardsticks, but, to determine the actual physical/technical standards required to maintain rehabilitated parts of the system.

Despite the foregoing morass of non-supporting numbers, one thing is quite evident: full-funding level water charges are going to be significantly higher than the existing water charges. But, as yet, many farmers see little relationship between what they pay as water charges, on the one hand, and what

272

they get from the PID on the other. Today, water charges disappear into an enormous and non-identifiable general revenue fund and farmers have no way of knowing if their money is being spent on the part of the irrigation system they identify with. However, if the water charges are increased, which undoubtedly is a necessary condition to ensure efficient continued operation and maintenance of the restored system, there will be a need to have these earmarked specifically for O&M activities. It may also be pointed out here that water charges should not be viewed as the only source of revenue generation. Various types of other taxes must be analyzed to see whether some proportion of same should support the cost of improved O&M services.

4.3 Farmer's Participation in the System

By and large, the farmer has not participated in the system's conception, design, construction (some employment as a laborer perhaps), or operation. Historically, the farmer has just not been consulted. There is nothing unique about that; there is hardly an irrigation project in South-East Asia in which farmers, the actual end-users, have been asked to participate in planning, design and operations. Yet those persons planning, building and operating do not particularly suffer if errors are made in design, operations, construction, maintenance, or whatever. The farmer does. Thus, the farmer is not widely enthusiastic about paying more for a system in which he has been, for the most part, a residual, is thus hardly surprising.

There is extensive experience to indicate, however, that effective cooperation, certainly at the water-course level, can produce some positive results regarding maintenance and repair, and water savings. Farmers often are prepared to share costs when they can see the direct application of their funds. In principle, then, the payment of more water rates is going to have to be attendant upon greater farmer participation. However, the experiences of the On-Farm Water Management (OFWM) Project in Pakistan shows that this participation is by no means easy.

5. CONCLUSIONS AND RECOMMENDATIONS

Availability of the required amount of funds, as and when needed, for proper operation and maintenance of the irrigation system is one of the necessary conditions to maximize the benefits from an on-going rehabilitation program over a longer period of time. But, as it stands now, the irrigation system is not financially self-supportive because the water charges are very low. This leads to continuous deferred maintenance; eventually resulting in high water losses and unreliable supply schedules. Moreover, the irrigation subsidies, which are distributed inequitably as well, have touched the levels which are unjustified on economic efficiency grounds. In addition, the present level and structure of water charges do not provide meaningful economic signals to farmers because these charges constitute a very small fraction of cash production costs and are not related exactly to yield values. This state of affairs calls for an immediate increase in existing water charges.

In non-SCARP areas, water charges estimated to recover total O&M costs (target level charges) have been found to be within the payment capacity of farmers. Proposed increases in water charges remain within farmer's payment capacity even if the payment capacity is reduced by 50 percent. Therefore, in non-SCARP areas water pricing policy must be based on cost recovery of improved

O&M services. However, water charges should be increased on a gradual basis so that proposed increases are accepted by the farmers with less resistance. In order to implement such a promotional type of pricing policy, efforts must be addressed to securing political support.

In SCARP areas, it is not feasible to implement cost-based water charges because these are three to four time higher than those estimated for non-SCARP areas and are beyond the farmer's payment capacity. However, crop/farm income analysis for these areas indicate that significant increases in current water charges are still possible.

It is a well documented fact now that increasing O&M investments in SCARP tubewells, given current management inefficiencies, can neither be justified on benefit grounds nor on a cost recovery basis. Therefore the government should take immediate steps to divest these schemes. As a matter of fact, for the time being, it may be economically wise to divert the resources being spent on O&M of public tubewells in fresh groundwater zones to more efficient O&M of other components of the irrigation infrastructure which are deteriorating rapidly due to lack of O&M funds.

If the cost recovery objective is to be persued in the long-run, there is a strong need to link the water charges with the benefits conferred by irrigation. The need for developing such linkages can be hardly overemphasized especially when the future O&M costs for rehabilitated parts of the irrigation system are anticipated to be quite high. Therefore, a comprehensive program should be initiated to collect information required to measure the additional net benefits from irrigation.

Due to the presence of certain illicit practices in the current assessment method, considerable amounts are mis-appropriated. In order to eliminate these financial leakages, implementation of flat rate pricing policy is recommended. In addition to the elimination (or at least reduction) of financial leakages, the flat rate policy would also help to save the institutional costs associated with the administering of existing pricing mechanism.

The Government's stated objective is to withdraw the subsidies being paid on agricultural inputs. This will put a downward pressure on farm incomes. Therefore, the structure of economic incentives should be designed in such a manner as to ensure fairly steady growth in farm incomes. This essentially suggests that output prices should increase at a faster rate than the rate at which input subsidies are withdrawn.

The required increases in agricultural production can be realized mainly through an expansion in irrigated areas. But, expansion in irrigated areas directly depends upon availability of additional water supplies, which are expected to come mainly from groundwater development since surface supplies are fixed in nature. Therefore, government should encourage installation of tubewells in the private sector through expansion in on-going subsidy programs and by providing agricultural credit to small farmers on soft terms and conditions.

Water charges should not be considered as the only source of funds required to meet the costs of improved operation and maintenance services. The structure of various types of taxes (agricultural income tax, property tax on irrigated land and usher tax) must also be analyzed in detail in order to see whether some proportion of these taxes can be utilized for supporting the costs of improved O&M services. Moreover, since the excessive use of canal roads/ banks for transportation purposes contribute to their deterioration, some kind of toll tax should be levied on vehicles/commodities passing through these roads.

Methodological deficiencies in present budgeting procedures also contribute to inadequate budgets for O&M funding. These require updating and flexible application so that the effects of various economic and technological changes are effectively captured in the form of improved O&M budgeting. Also, since there is no gurantee that revenues from increased water charges would be reappropriated for irrigation system maintenance, receipts from water charges and O&M appropriations should be internalized. In other words, if it is at all feasible, receipts from water charges should be earmarked specifically for the provision of O&M services.

NOTES

(1) There are two crop seasons in Pakistan: rabi season (October to March) and kharif season (April to September).

(2) Chak is the lowest order command covering, on average, about 400 acres and 35 farm units.

(3) The flat rate system was never tried in the Punjab Province but it remained inforce for quite a long period of time in the Sind Province before it was finally abandoned in 1980. It was abolished because it led to massive stealing of water by influential farmers and unauthorized withdrawls in the head reaches. Failure to curb such illicit practices reflects both administrative inefficiences in the operating agency and a lack of legal enforcement authority. It, by no means, implies that the mode of assessment is inefficient or inequitable.

(4) Warabandi means fixation of turns (wara means turn and bandi means fixation).

(5) Financial costs and returns are for maize crop in the Punjab Province and for orchards in the Sind Province.

(6) Net returns under the Cash Flow Method (CFM) were calculated by substracting the cash production costs from the total income.

(7) Net returns under the Residual Budgeting Method (RBM) were calculated by substracting the total production costs except water charges from the total income.

(8) Since net returns estimated through the residual budgeting method could be safely attributed as returns to irrigation water, these can be approximated as the maximum amount a farmer would be willing to pay for irrigation water.

225

(9) Full funding level O&M requirements can be defined as the amount required to maintain canals in fully operational and effective condition on a sustained basis, after these have been moved to an efficient condition under a rehabilitation program.

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216

FINANCING IRRIGATION PROGRAMS IN THE PHILIPPINES

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SUMMARY

An evaluation of existing irrigation water pricing policies of the National Irrigation Administration (NIA) of the Philippines is made focusing on the recent policy of the Philippine government of requiring NIA to recover the full costs of irrigation construction and operation.

The declining priority for irrigation is reflected in the distribution of irrigation investments relative to the total national budget. This decreased from 5.4 percent in 1979 to 3.3 percent in 1983. In addition, fees collected from water users have remained low compared to the total costs of NIA operations. As a percentage of O&M costs, for example, irrigation fees fell short by as much as P35 per hectare in 1983.

The NIA charges a uniform irrigation fee of 100 kg/hectare in the wet season and 150 kg/hectare in the dry season. These rates, however, vary by system; for example, the Upper Pampanga River Project charges a higher rate of 125 kg/hectare and 175 kg/hectare in the wet and dry seasons, respectively, due to the larger cost of construction and O&M.

Since 1979 irrigation fees contributed about 20 to 30 percent of the yearly income of NIA. Collection rates have also improved from 68 percent in 1979 to over 70 percent in 1983. Several approaches are currently used by NIA to further improve collection rates, such as creation of monetary incentives to NIA personnel and farmers' groups and enforcement of the "lateral turnover scheme".

The paper argues that the problem is not low fee collection but whether such fees are justified. Part 3 suggests that since positive externalities arise from irrigation investments society must share in the recovery of cost.

A practical alternative system of irrigation charges is proposed. The primary consideration should be the capacity-to-pay of water users since many irrigated farm households had incomes which were below the poverty threshold in 1984. The secondary consideration is sustaining current levels of irrigation operations by ensuring that enough funds are available for operating and maintaining existing irrigation systems. Water users should be charged the short-run O&M costs, and by making them pay for these costs, the additional advantage of making water users' associations accountable for maintaining the system

277

facilities is achieved.

1. INTRODUCTION

The need to sustain higher production levels, which have been promoted in part by the increased use of high yielding varieties (HYVs) and modern techniques of production, will create greater pressure for the Philippine government to expand the subsidy for irrigation development and improvement. However, current trends in the pattern and distribution of irrigation investments in the Philippines, and the drastic cutbacks in operating budgets, will have a substantial impact on the expansion of irrigation development activities in the future. These trends include: (1) the new requirement by the Finance Ministry to collect costs of construction and operation and maintenance (O&M) from water users; (2) the declining rate of expansion of target areas for new irrigation; (3) the substantial reduction in the share of irrigation in the national government budget; and (4) the increased emphasis on rehabilitation projects relative to new construction and on small-scale, communal projects compared to large-scale, national systems.

Two issues emerge from these trends. The first issue is related to increasing current collection rates through the improvement of water delivery. Since the present level of fee collection only covers less than 80 percent of actual O&M costs even improved collections will not suffice. Unless subsidies from the national government are forthcoming, NIA will need to reduce its total budget for O&M, but this will have trade-offs in terms of quality of service. New approaches will have to be devised and better institutional arrangements will be needed in improving collection efficiency.1/

The second issue directly concerns the role of government in expanding food production through subsidies for irrigation development. The recent policy of charging higher fees to be collected from farmer participants in government irrigation projects has raised questions regarding both its practicability and justification.

The purpose of this paper is to evaluate current policies related to the financing of irrigation investments through irrigation water charges. A description of irrigation development in the Philippines in terms of types of irrigation systems, levels of investments and subsidies, and procedures for fee collection are discussed in Part 2. In Part 3 an evaluation of the existing policies for water charges is made focusing on specific goals behind water pricing and redefining these goals in the context of national development objectives. Practical alternatives to the current water pricing policy and assessments of farmers' capacity-to-pay are then discussed in Part 4.

2. INVESTMENTS IN IRRIGATION AND POLICIES FOR WATER CHARGES

2.1 Current Status of Irrigation Development in the Philippines

Around 10 million hectares, or one-third of total land area in the Philippines, are considered to be suitable for cultivation. Around 70 percent of this area is currently used for the production of cereals, the major ones being rice and corn. The NIA estimates that 3.1 million hectares of the total cultivated area in the country are potentially irrigable, and at present, about 44 percent or 1.4 million hectares are already under irrigation (Siy 1984).

There are two major types of irrigation systems in the Philippines: (1) national systems that are built, operated, and maintained by the NIA and (2) communal systems, which may have been built with NIA assistance but are operated and maintained entirely by water users groups. Pump irrigation, which draws water from rivers, main canals, or shallow wells, is sometimes used within national system projects or are classified as communal systems. The national systems are usually over 1,000 hectares in size while communal systems are generally 50 to 500 hectares.

Of the estimated 1.4 million hectares presently irrigated, 45 percent or 610,492 hectares are classified as national projects, 41 percent or 568,308 hectares are communal irrigation systems, and 14 percent or 191,394 hectares are using pump irrigation (NIA 1982). As of 1984 the NIA managed the operation and maintenance of 128 national irrigation systems with a total service area of 559,000 hectares. An average of 18,000 hectares per year were irrigated in the period 1965 to 1971. The largest investments in new construction occurred during 1972 to 1980 when total irrigated area was expanded by 583,000 hectares, or an annual increase in irrigated area of 65,000 hectares. However, in 1981 NIA's contribution to new irrigated hectarage was reduced to 47,800 hectares.

Table 1 SHARE OF IRRIGATION IN THE NATIONAL BUDGET, 1979-1983 (in billion pesos)

Year	Total National Budget 1/	Total Investment in Irrigation	Percentage Share of Irrigation in National Budget (%)
1979	34.3	1.86	5.4
1980	39.8	1.71	4.3
1981	54.9	1.78	3.2
1982	59.7	2.04	3.4
1983	61.8	2.08 2/	3.3

Source: 1/ National Economic and Development Authority, Philippine Statistical Yearbook

2/ National Irrigation Administration, Annual Report 1983.

The trend of declining priority for irrigation is reflected in the distribution of irrigation investments as a proportion in the national budget from 1979 to 1983 (see Table 1). As can be gleaned from the table, the percentage share of irrigation investments declined from 5.4 percent in 1979 to 3.3 percent in 1983. As a consequence of declining funds for irrigation development, both donor agencies and the NIA have agreed that irrigation investments would be more cost effective if rehabilitation is emphasized over new construction. In recent years, NIA has in fact adopted this direction in response to budget cuts. In 1984, for example, the generation of new areas for irrigation accounted for only 34 percent and 53 percent of the new area targetted under national systems and communal systems, respectively. Much of NIA's efforts shifted towards rehabilitation of existing projects. Table 2 contains the accomplishment targets for the agency for all types of projects for the period 1982 to 1983 and 1989 to 1990.2/

2.2 Funding for Irrigation Development and Operations

2.2.1 External Funds

The various activities of NIA are financed from several different sources: equity contributions from the national government, loans and grants from international agencies, collection of irrigation service fees, amortization payments from construction loans, and payments from the sale or rental of equipment.3/

The equity contribution from the national government is P10 billion per year but only 7.6 percent of this annual capitalization was released in 1983. A substantial drop in equity of P205 million (or 2 percent) occurred in the following year, or a decline of 76 percent.4/ In 1984 the operating income of NIA reached P431.3 million, about 23 percent or P98.9 million of which came from the payment of irrigation fees.

Table 2 ACTUAL AND PROJECTED IRRIGATION DEVELOPMENT FOR DIFFERENT TYPES OF SYSTEMS, 1982-83 and 1989-90 (in thousand hectares)

	National Systems		Communal and Pump Systems	Total
	Diversion	Reservoir		
ACTUAL (1982-83)				
Service Area	343.4	162.6	813.6	1,319.6
Irrigated Area:				
Total	423.2	279.1	1,047.0	1,749.3
Wet Season	241.7	146.3	595.3	983.3
Dry Season	181.5	132.8	451.7	766.0
Percent Area Coverage	62	86	64	

280

Table 2 continued ...

	National Systems		Communal and Pump Systems	Total
	Diversion	Reservoir		
PROPOSED (1989-90)				
Service Area	605.8	202.7	937.5	1,746.0
Irrigated Area:				
Total	739.1	324.4	1,198.1	2,261.6
Wet Season	430.1	162.2	683.2	1,275.5
Dry Season	309.0	162.2	514.9	986.1
Percent Area Coverage	61	80	64	65

Source: National Irrigation Administration, Corporate Plan, 1983-1998.

Foreign loans are the largest source of funds for irrigation projects both in the conduct of feasibility and technical appraisal and in the construction of main headworks and conveyance structures. The total income of the agency from foreign sources amounted to P1.08 billion in 1984 or 66 percent of the total NIA budget for that year (see Table 3).

2.2.2 NIA-Generated Revenues

Since 1979 revenues generated from NIA activities have contributed about 20 to 30 percent of the yearly budget of NIA. Total revenues in 1984 reached P431 million or 26 percent of the P1.6 billion budget of NIA (refer to Table 3).

The income collected from water charges accounted for 23 percent of revenues in 1984. The amount of fees collected is low when compared to the total NIA investment. For example, the total cost of construction, rehabilitation, and improvement of irrigation systems in 1984 was P1.18 billion, but total fees collected were only P98.9 million, or a capital cost recovery rate of only 8.4 percent (NIA 1984a).

Collection rates with respect to fund releases for O&M, however, have improved, accounting for 68 percent of total funds allocated for irrigation in 1979 to 72 percent in 1983 inspite of the drop in collection rates in 1981 and 1932 (see Table 4). The low collection rate in 1982 resulted in a deficit of P42/hectare for O&M expenditures. In 1983 the shortfall in O&M costs was about P35/hectare (NIA 1985).

- 281'

Table 3 NATIONAL IRRIGATION ADMINISTRATION (NIA) BUDGET (CY 1984)

	Amount (in thousand pesos)	Percent
A. Total Funds Allocated From:		
1. General Appropriations		
Corporate Equity	205,000	12.5
Communal Irrigation Program	88,200	5.4
Calamity Fund	6,838	0.4
2. NIA Operating Income	255,000	15.5
3. Foreign Loans	1,088,981	66.2
	1,644,019	100.0
B. Total Expenditures		
1. Current Operating Expenses		
Personal Services	192,000	11.7
Operating expenses	62,000	3.8
2. Capital Expenses		
Foreign Loan/Assisted Projects	1,263,031	76.8
Locally Funded Projects	126,988	7.7
	1,644,019	100.0

Source: National Irrigation Administration, Annual Report 1984.

2.3 Irrigation Water Charges

Prior to the creation of NIA as a semi-autonomous government corporation in 1963, irrigation water fees were collected by the Irrigation Division of the Bureau of Public Works (BPW) for all types of irrigation systems. In 1952, fee collection in small, communal systems and pump projects was undertaken by the newly organized Irrigation Service Unit (ISU) of the Department of Agriculture and Natural Resources. The responsibility for fee collection was later transferred to NIA in 1966.5/

282

Table 4 OPERATION AND MAINTENANCE COSTS IN NATIONAL IRRIGATION SYSTEMS, 1979-1984

Year	Service Area (in thousand ha.)	Total O and M Fund Releases At the System Level (in-million pesos)			O and M Fund Releases Per Hectare	
		Personnel	Others	Total	Current Pesos	1984 Pesos*
1979	477.2	58.95	7.20	66.15	139	320
1980	472.0	76.70	9.05	85.75	182	364
1981	492.3	93.06	10.39	103.45	210	380
1982	508.6	93.76	14.38	108.14	213	355
1983	549.9	86.61	14.38	100.91	184	275
1984	559.4	103.57	28.78	132.35	237	237

* Current pesos converted to 1984 using Implicit GDP Deflator (ADB, 1985)

Source: National Irrigation Administration, (1985); as cited in Small, et al. (1986), Table A1.28, p.26

2.3.1 Irrigation Service Fees

A uniform rate of P12/hectare/year was collected from all water users from 1947 to 1964. The fee was increased in some newly opened national systems but the general increase in fees occurred in 1966 at a rate of P25/hectare in the wet season and P35/hectare in the dry season. Non-rice and corn lands paid P20/hectare.

The cash payments were converted to payments in kind starting in 1975 -- 100 kg/hectare in the wet season and 150 kg/hectare in the dry season for all types of systems. A higher rate of 175 kg/hectare was collected in irrigation systems located in Central and Northern Luzon and Mindoro to offset regional disparities in irrigation service (Siy 1984).

For the non-rice and corn lands, comprising a small 4 percent of total irrigated area (20,557 hectares) in 1982, a lower fixed rate equivalent to three-fourths cavan or 37.5 kg/hectare was collected. Pump irrigation systems had an average fee of 250 kg/hectare (Cabanilla 1984). Table 5 provides information on the actual amount of irrigation water charges for selected pump and gravity national systems by type of crop.

Table 5 CURRENT IRRIGATION WATER CHARGES FOR SELECTED PUMP AND NATIONAL SYSTEMS FOR RICE AND ANNUAL CROPS (in kgs./hectare)

System	Rice Crop			Annual Crops
	Wet Season	Dry Season	Third Crop	
Pump Systems:				
Bonga Pumps 1-3	400	600	600	-
Solana-Tuguegarao	400	600	600	-
Angat-Maasim	150	250	250	300
Libuanan-Cabusao	300	300	300	-
Central Luzon Groundwater	375	475	475	-
Cagayan	375	475	475	-
National Systems:				
Upper Pampanga	125	175	175	300
All Other Systems	100	150	150	250

Source: National Irrigation Administration (1985).

2.3.2 Cost Recovery

In general, the policies of NIA regarding water charges have been directed towards: (1) the recovery of full costs of O&M and (2) the return of the entire costs for construction of irrigation facilities. The Philippine government subsidizes interest payments on the loan and other incidental expenses associated with pre-construction activities (e.g., design and appraisal).

The fixed costs are discounted over a period of 50 years at interest rates of 8 and 12 percent per year. Table 6 contains an example of annual and seasonal costs for selected national systems throughout the country.

284

Table 6 WATER CHARGES COVERING INITIAL CONSTRUCTION COSTS AMORTIZED OVER 50 YEARS (DECEMBER, 1985)

Region/System	Annual Cost/Hectare Interest Rate:		Seasonal Cost in Cavans/Hectare (50 kg.=1 cav.) Wet Season Interest Rate		Dry Season Interest Rate	
	8 %	12 %	8 %	12 %	8 %	12 %
I. Ilocos						
Laoag-Vintar	84.49	124.47	0.34	0.51	0.79	1.16
Pasuquin	11.95	17.60	0.05	0.07	0.12	0.17
Dingras	11.51	16.96	0.05	0.07	0.10	0.14
Sta. Maria-Burgos	-	-	-	-	-	-
Sta. Lucia-Candon	67.64	99.65	0.26	0.38	1.78	2.62
Tagudin	25.14	37.04	0.10	0.14	0.23	0.34
Amburayan	26.32	38.77	0.10	0.15	0.20	0.30
Masalip	243.28	358.38	1.01	1.49	1.32	1.95
II. Cagayan						
Abulog-Apayao	115.26	169.79	0.65	0.95	1.10	1.63
Banurbur	63.31	96.20	0.26	0.39	0.48	0.71
IV. Southern Tagalog						
Palico	154.47	227.55	0.62	0.92	0.80	1.18
Agos	90.74	133.67	0.36	0.53	0.57	0.84
Dumacaa	41.71	61.44	0.26	0.38	0.27	0.39
Hanagdong	24.77	36.49	0.11	0.16	0.17	0.25
V. Bicol						
Daet-Talisay	117.70	173.38	0.57	0.83	0.78	1.15
Mahaba Nasisi	102.18	150.52	0.29	0.43	0.63	0.92
Ogsong	121.64	179.19	0.08	0.12	0.75	0.16
Hibiga	32.90	48.46	0.03	0.04	0.20	0.30
Cagaygay	61.00	89.86	0.27	0.40	0.40	0.59
San Francisco	99.92	147.20	0.46	0.67	0.72	1.06
VI. Western Visayas						
Pangiplan	66.82	98.43	0.61	0.89	0.81	1.19
Bago	101.05	148.86	0.59	0.86	0.79	1.16
Sibalom-San Jose	19.99	29.45	0.10	0.14	0.20	0.30
Aklan RIS	110.36	162.57	0.42	0.62	0.53	0.77
VIII. Eastern Visayas						
Hindang Hilongos	96.45	142.08	0.37	0.54	0.47	0.70
Binahaan North	101.54	149.59	0.51	0.75	0.80	1.18
Binahaan South	96.17	141.67	0.48	0.71	0.76	1.12
Tibak Soong	37.47	55.19	0.19	0.28	0.30	0.44
Guinarona	161.63	238.10	0.81	1.19	1.28	1.86

785

Table 6 continued ...

Region/System	Annual Cost/Hectare Interest Rate: 8 %	12 %	Seasonal Cost in Cavans/Hectare (50 kg.=1 cav.) Wet Season Interest Rate 8 %	12 %	Dry Season Interest Rate 8 %	12 %
IX. Southern Mindanao						
Salug	50.87	74.94	0.25	0.36	0.31	0.45
XII. Central Mindanao						
Libungan	55.57	81.87	0.25	0.37	0.41	0.60
Kabacan	89.37	131.65	0.47	0.69	0.59	0.88
ALL SYSTEMS	81.30	119.76	0.39	0.50	0.60	0.89

Source: National Irrigation Administration, (1985)

The average annual cost of construction (fixed cost) is P81.30/hectare and P119.76/hectare at 8 and 12 percent interest rates, respectively. This is equivalent to 0.39 cavans/hectare and 0.58 cavans/hectare in the wet season, respectively, for interest rates of 8 and 12 percent.

The average rehabilitation cost is P8,037/hectare at a yearly cost of P656.97/hectare at 8 percent interest rate and P967.80/hectare at 12 percent interest rate. These costs, when converted to cavans of rice, amount to 3.21 cavans/hectare (at 8% interest) and 4.74 cavans/hectare (at 12% interest) in the wet season and 4.94 cavans/hectare (at 8% interest) and 7.28 cavans/hectare (at 12% interest) in the dry season (see Table 7).

Table 7 WATER CHARGES COVERING REHABILITATION COSTS AMORTIZED OVER 50 YEARS (DECEMBER, 1985)

Region/System	Annual Cost/Hectare Interest Rate: 8 %	12 %	Seasonal Cost in Cav/Hectare (1 cav.=50 kg.) Wet Season Interest Rate: 8 %	12 %	Dry Season Interest Rate: 8 %	12 %
I. Ilocos						
Laoag-Vintar	1523.92	2244.91	6.20	9.13	14.17	20.87
Pasuquin	1385.19	2040.54	5.59	8.23	13.67	20.14
Dingras	595.46	877.18	2.44	3.60	5.07	7.47
Sta.Maria-Burgos	1187.97	1750.01	4.48	6.60	-	-
Sta.Lucia-Candon	587.19	865.00	2.25	3.31	15.43	22.73
Tagudin	539.76	795.14	2.08	3.06	4.95	7.30

- 286

Table 7 continued ...

Region/System	Annual Cost/Hectare Interest Rate: 8 %	12 %	Seasonal Cost in Cav/Hectare (1 cav.=50 kg.) Wet Season Interest Rate: 8 %	12 %	Dry Season Interest Rate: 8 %	12 %
Amburayan	657.14	968.05	2.60	3.83	5.11	7.52
Masalip	650.70	958.56	2.71	3.99	3.54	5.21
II. Cagayan						
Abulog-Apayao	512.94	755.61	2.88	4.24	4.92	7.24
Banurbur	397.19	585.11	1.60	2.36	2.94	4.33
IV. Southern Tagalog						
Palico	805.17	1186.11	3.26	4.80	4.19	6.17
Agos	642.34	946.25	2.57	3.78	4.02	5.92
Dumacaa	596.69	839.23	3.51	5.16	3.65	5.38
Hanagdong	413.58	609.25	1.80	2.65	2.81	4.14
V. Bicol						
Daet-Talisay	615.52	906.74	2.96	4.36	4.07	5.99
Mahaba-Nasisi	743.73	1095.60	2.14	3.15	4.56	6.72
Ogsong	1743.46	2568.32	1.17	1.72	10.71	15.78
Hiliga	809.91	1193.10	0.66	0.98	4.98	7.33
Cagaygay	708.73	1044.04	3.19	4.70	4.63	6.81
San Francisco	396.98	584.80	1.81	2.67	2.86	4.21
VI. Western Visayas						
Pangiplan	302.24	445.24	2.74	4.03	3.64	5.37
Bago	176.77	260.40	1.02	1.51	1.37	2.02
Sibalom-San Jose	596.23	878.32	2.91	4.28	6.07	8.94
Aklan RIS	510.94	752.68	1.95	2.87	2.43	3.58
VIII. Eastern Visayas						
Hindang Hilongos	343.06	505.36	1.31	1.93	1.69	2.49
Binahaan North	721.74	1063.21	3.62	5.33	5.71	8.42
Binahaan South	3811.67	5615.03	19.13	28.18	30.13	44.39
Tibak Soong	872.18	1284.82	4.38	6.45	6.89	10.16
Guinarona	3143.93	4631.37	15.78	23.24	24.85	36.61
IX. Southern Mindanao						
Salug	1133.33	1640.06	5.37	7.91	6.72	9.91
XII. Central Mindanao						
Libungan	788.56	1161.65	3.55	5.23	5.80	8.54
Kabacan	423.36	623.67	2.20	3.25	2.78	4.09
ALL SYSTEMS	656.97	967.80	3.21	4.74	4.94	7.28

Source: National Irrigation Administration, (1985)

287

The O&M costs can be broken down into three major categories: (1) personnel expenditures, (2) energy costs associated with the operation of existing irrigation facilities, and (3) transaction or extension field costs (includes office maintenance, field visits, and supplies). In a survey of 32 national systems throughout the country conducted by NIA, the average O&M costs amounted to P261.70/hectare in 1984 or about 1.28 cavans/hectare in the wet season and 1.97 cavans/hectare in the dry season. The average cost for O&M in communal systems was only P67/hectare in the same year (Cruz, et al. 1986). On the other hand, O&M costs for pump systems are about 3 to 5 times higher than national and communal systems.

Table 8 provides actual O&M costs per hectare for the wet and dry season in the sample national systems surveyed by NIA in 1985. These costs are generally larger than the P150/hectare figure computed by Cabanilla (1984) for national gravity systems.

Table 8 WATER CHARGES COVERING OPERATION AND MAINTENANCE COSTS (DECEMBER, 1985)

	System Name	Service Area	Actual O and M Cost Per Ha.	Seasonal O and M Cost (Cav.Ha.) Wet Season	Dry Season
I.	Laoag-Vintar	2377.00	570.00	2.32	5.30
	Pasuquin	684.00	570.00	2.30	5.63
	Dingras	1018.00	570.00	2.34	4.85
	Sta.Maria-Burgos	959.00	293.00	1.11	NA
	Sta.Lucia-Candon	1534.00	293.00	1.12	7.70
	Tagudin	1409.00	293.00	1.13	2.69
	Amburayan	3613.00	239.00	.95	1.86
	Masalip	1512.00	345.00	1.44	1.88
II.	Abulog-Apayao	10310.00	216.00	1.21	2.07
	Banurbur	930.00	266.00	1.07	1.97
IV.	Palico	852.00	465.00	1.88	2.42
	Agos	1081.00	539.00	2.15	3.37
	Dumacaa	2511.00	364.00	2.24	2.33
	Hanagdong	264.00	364.00	1.58	2.47
V.	Daet-Talisay	2917.00	279.00	1.34	1.84
	Mahaba-Nasisi	1440.00	293.00	.84	1.80
	Ogsong	336.00	293.00	.20	1.80
	Hibiga	410.00	293.00	.24	1.80
	Cagaycay	1927.00	232.00	1.04	1.51
	San Francisco	586.00	816.00	3.73	5.87
VI.	Pangiplan	1884.00	208.00	1.88	2.51
	Bago	12700.00	170.00	.99	1.32
	Sibalom-San Jose	4400.00	268.00	1.31	2.73
	Aklan RIS	3916.00	326.00	1.24	1.55
VIII.	Hindang-Hilongos	678.00	65.00	.25	.32
	Binahaan North	1610.00	316.00	1.58	2.50

- 288

Table 8 continued ...

System Name	Service Area	Actual O and M Cost Per Ha.	Seasonal O and M Cost (Cav.Ha.) Wet Season	Dry Season
Binahaan South	850.00	316.00	1.59	2.50
Tibak Soong	1200.00	316.00	1.59	2.50
Guinarona	440.00	316.00	1.59	2.50
IX. Salug	5710.00	224.00	1.08	1.35
XII. Libungan	7840.00	203.00	.91	1.49
Kabacan	4951.00	200.00	1.04	1.31
ALL SYSTEMS	82909.00	261.70	1.28	1.97

Source: National Irrigation Administration, (1985).

2.3.4 Fees for Water Rights

Additional fees for water rights have been collected starting in 1976 by the National Water Resources Council (NWRC), which is an autonomous agency in charge of the management of all water resources in the country.6/ The additional fees collected by NWRC correspond to charges for securing a legal right to water use, which is expressed in a specific duty of water as measured in liters per second per hectare (lps/hectare). A P100 application fee is paid in addition to the annual water rights fee of P0.50 for every liter per second withdrawal of water per hectare up to 30 liters. The fees increase as more water is withdrawn from the source -- P0.75/lps/hectare up to 50 lps and P1.00/lps/hectare for water use exceeding 50 lps. Total income of NWRC from water fees in 1982 was P0.31 million, which is significantly lower than the amount collected by NIA in the same year (Cruz, et al. 1986). A summary of irrigation-related water fees is presented in Figure 1.

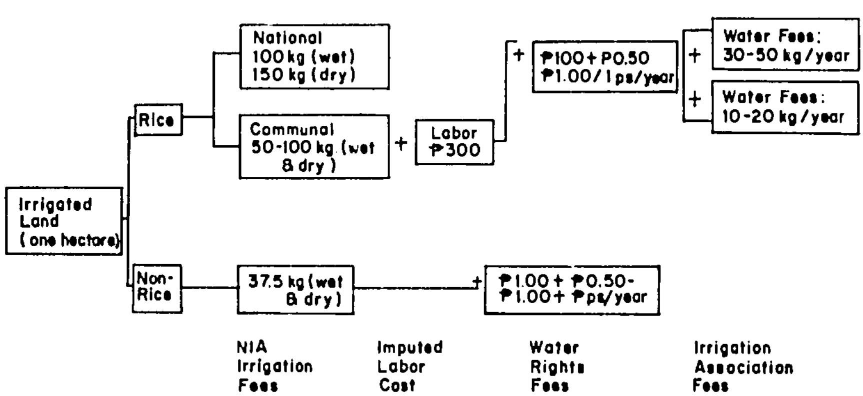

Figure 1. Irrigation Water Fees For One Hectare of Land

281

2.4 Collection Rates

NIA's record of irrigation fee collection has improved from 50 percent of total collectibles in 1969 to over 66 percent in 1974. In 1975, however, when the rates were increased, the fee collection rate dropped to only 31 percent, although this has since increased to almost 70 percent of current collectibles in 1983 (NIA 1984).

Galvez and associates (1979) estimated that about 40 percent collection rate was the minimum needed just for payment of salaries of NIA field personnel. The study attributes the low collection rates and cropping intensities to declining irrigation service efficiency. Based on the sample farms surveyed, deteriorated irrigation system capacity accounted for 41 percent of the variation in fee collection efficiency.

Other factors which explain the poor collection rates are: (1) the low paying capacity of farmers due to any or a combination of the following -- low price of paddy at harvest time, low yields, debts or rentals of land and interest on credit, high production costs, and crop damage; (2) the difficulty of bringing to court delinquent farmers in order to enforce collection; and (3) the attitude that still remains among a significant number of farmers that irrigation service is or should be free since it is being furnished by the government.

Thus, in order to further reduce deficits incurred in operating national systems, NIA has launched a program to convert small and financially marginal national systems into communal systems and, in effect, transfer total responsibility and ownership of these systems to water users' organizations.7/ NIA estimates that between 1983 and 1990, a total of 55 national systems with a total area of 31,360 hectares will be converted into communal systems. In support of this strategy, NIA is now developing and testing different approaches to building farmers capacities to take over the management of these systems.

2.4.1 NIA Collection Schemes

Several collection schemes are being tried out by NIA which have resulted in some degree of improvement in collection rates. One example is the incentive bonus which was devised in 1980 as a reward system for NIA personnel with collection rates exceeding 70 percent of the total collectibles. Under the incentive plan, a 10 percent and 15 percent bonus of the amount in excess of the 70 percent and 80 percent of the principal, respectively, is given to NIA personnel on a cash reward basis. In addition, the entire irrigation district is given a Viability Incentive Grant (VIG), which is a cash reward for units with incomes greater than expenses during a specified operating year.

Monetary incentives are also given to farmers' groups that are able to assume responsibilities for the collection of water fees and the maintenance of system facilities. One arrangement, described as the "lateral turnover" scheme, envisions the compensation of farmers' groups for canal maintenance at a rate of P6,000/year for every 3.2 kms. of canal. The traditional mode of canal maintenance has been for NIA to hire and pay a ditchtender to perform the necessary cleaning. The shift to a lateral turnover agreement reduces NIA costs for system maintenance and permits the irrigation association to raise some funds of its own. In addition, NIA offers the farmers' groups a special

-290

commission for reaching particular collection targets.

Another scheme which is being implemented in a small national system in the Bicol region entrusts the association with full responsibility for system maintenance. The association does not receive direct compensation but is entitled to a larger percentage of total collections. For example, the association can receive 35 percent of total collections for amounts within 50 percent of total collectibles. If the association is able to exceed a collection rate of 50 percent, it is entitled to 65 percent of anything it can collect beyond the target of 50 percent of collectibles.

Within pump systems that are managed by the NIA, a joint operation scheme has also been proposed. Under this scheme NIA operates and maintains the pumps while the farmers' association takes full responsibility for canal maintenance and water distribution. Farmers are required to pay the standard NIA rate for pump systems but the incentive for the farmers to improve collection efficiency is that the association will be entitled to 50 percent of the surplus of total collections over the expenses for operating the pumps. In the case of deficits, losses will be carried over in the next year.8/

3. ECONOMIC CONSIDERATIONS IN WATER PRICING

The efforts of the Philippine government in collecting fees for irrigation services are motivated by complex, sometimes conflicting, objectives. The common perception of these objectives for water pricing has been discussed primarily in terms of ensuring efficiency or reducing waste in the allocation of resources for irrigation and in the utilization itself of water supplies (marginal cost pricing). In Part 2 it was pointed out that the current goal of water pricing in the Philippines is the recovery of the costs incurred by the government for construction and O&M of irrigation systems. These two objectives will be discussed in detail, and it will be shown that, in fact, they both follow from an essentially irrigation-supply vs. benefit or demand perspective.

In addition to these goals which explicitly concern irrigation pricing approaches, the discussion is complicated by the fact that the irrigation development program itself is part of a much larger universe of government concerns which are primarily social benefit- or demand-oriented. These programs, emphasizing growth in food crop agriculture, are aimed at ensuring low food prices for a growing (and increasingly urban) population. Indeed from this perspective, the fundamental approach for evaluation has to view the development and management of irrigation systems as part of a general program that includes, among others, land resettlement, promotion of new technologies, and subsidies for agricultural credit (see, for example, Hayami and Kikuchi 1978, ILO 1974).

In this section we review the economic bases for the marginal cost and cost recovery approaches to irrigation pricing in addressing the two specific goals above. We then expand the discussion to situate the issue of pricing within the context of agricultural development and the role of irrigation. This will establish the important implications of assessing benefits in a development context and the need for public finance and equity considerations in rationalizing the approach to irrigation charges for the Philippines.

3.1 Marginal Cost Pricing as Basis for Water Charges

The marginal cost approach presumes that the primary motivations for water allocations or for the irrigation service itself are based on efficiency considerations. The argument from economic theory is that the supply curve of water is derived from the cost of providing additional increments of water. Therefore given the demand for water, the fee (P2) should equal the marginal cost of providing that amount demanded (Carruthers and Clark 1982). If the fee is less than this cost (P1), there will be inadequate supply; if the fee is greater than the cost (P3), there will be excess water supply as indicated in Figure 2.

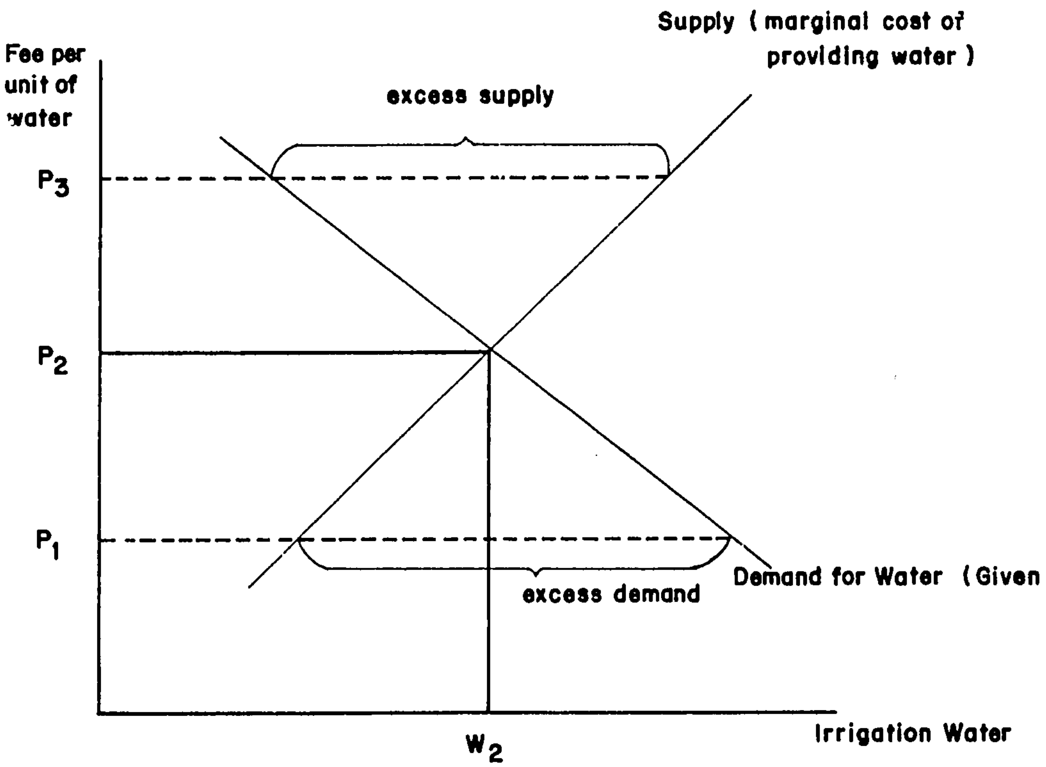

Figure 2. Marginal Cost Pricing of Irrigation Water

292

From the short-run perspective (with infrastructure fixed), this approach disregards construction cost and looks at the pricing issue given the existing system capabilities. However, the interesting feature in investments for gravity irrigation is precisely that construction costs are such a disproportionately large component of total cost. It has even been argued that true short-run marginal cost is close to zero (Carruthers and Clark 1982), the implication being that short-run marginal cost-based fees should then be very low. This means that marginal cost pricing techniques are of limited relevance if we are talking of the short-run, and this irrelevance goes beyond the usual issue of the problem of getting good water measurements. There is really no need to do volumetric measurements since the short-run marginal cost-based price will be very low anyway.

Another way of looking at this is that the economic pricing issue must be more directly concerned with the efficiency not of short-run marginal use of water but with the efficiency of constructing a system. After all, it should be clear that an irrigation system should be operated if so much cost has already gone into its construction. It should also be noted here that, for precision, we need to make a distinction between the water management convention of lumping costs into a construction category vs. an O&M category. These categories are not directly comparable with the economic concepts of capital cost and variable (or operating) cost: construction and maintenance costs are part of the capital account and operating costs are limited to those that are incurred for the current production period. If we take this strict view, this further supports the contention that a very low nominal (or even zero) fee should be charged.

Since it is the construction cost component that is important then it is the long-term perspective that is useful in marginal cost pricing. The concern here is on the expansion of the irrigation network. A long-run marginal cost curve may be interpreted as the additional cost (with expenditures made on different years properly discounted) per hectare of irrigation facility. The long run marginal cost curve may initially decline as economies of scale and learning-by-doing benefits are captured in the irrigation development program (e.g., Carruthers and Clark 1982, Easter 1985, Taylor 1979). Eventually, however, the long-run marginal cost will tend to increase as the ideal project sites are exhausted and the standard upward-sloping portion of this curve will be the relevant one on which to base the pricing of irrigation services.

Since the long-run marginal cost curve represents construction cost and since a pricing sytem based on this curve (with limited consideration of demand) has the goal of paying for such costs then we may conclude that the relevant marginal cost pricing approach is really similar to the cost recovery approach. Indeed part of our argument below will show that both approaches are essentially supply-side types of approaches while a more relevant fee system needs to explicitly incorporate demand- or benefit-side considerations.

Before proceeding to the discussion of demand-side issues, we need to clarify why, if long-run marginal cost pricing has really been followed, water charges in the Philippines tend to differ among irrigation systems. (This is not generally true in other countries where charges tend to follow one rate as discussed by Small, et al. 1986). The reason has to do with the financial perspective that the NIA is constrained to take, given the requirement that it recovers the cost of irrigation from its farmer clientele. Even if we can conceptualize a national long-run marginal cost curve, it is more reasonable to view the NIA as a multi-location agency. It determines the hectarage to develop per location based on site-specific long-run marginal cost curves and the demand for irrigation. The scale of operations is then chosen to minimize the average cost per hectare of irrigation development, and this is made the basis of cost recovery charges per location. It is therefore to be expected that the fees among systems will differ if a financial management perspective is required and actually applied. In countries where the fees do not significantly differ among systems, Carruthers and Clark (1982) correctly point out that social or political decisions dominate financial considerations (see also Wade 1982, Small, et al. 1986).

3.2 Demand Side Considerations in Irrigation Pricing

The demand for the construction of irrigation systems may be defined in terms of the demand of farmers for a specific factor input. It may also be based on the demand for irrigation by government as a component of a general food production program. Hayami and Kikuchi (1978) have shown that this latter role, as a contributor to the over-all agricultural food production effort, has been dominant in motivating irrigation development policy in the Philippines. Major increases in irrigation investment in the Philippines are correlated with periods of rice shortages and high prices. Mangahas (1985) has argued that this is primarily part of an urban and a consumption bias in policy-making that emphasizes the need for low food prices. The implication here is that the stimulus for irrigation construction is for national or social benefits that go beyond the demand of farmer-irrigators.

The reason why irrigation development has become a key component of the food production program is quite clear. Hayami and Kikuchi (1978) point out that irrigation investments in the Philippines are induced by favorable returns to irrigation development in contrast to the limited potential of continuing agricultural expansion with the increasing scarcity of available land. Large returns to irrigation are made possible by the complementary availability of new rice technology and the increased utlization of fertilizers in rice production (see Table 9).

The government priority for food production should not imply that farmers have no demand or derive no benefit from irrigation development. Indeed to arrive at a practical basis for irrigation charges, we need to explicitly analyze the benefits of irrigation from the view of government or society in general and from the perspective of farmer-irrigators in particular.

The complication here, of course, is how to distinguish between private and social benefits from irrigation. Identifying private (farmer-irrigator) benefits is a straightforward procedure that is normally the subject of financial appraisal. Estimating indirect benefits (those benefits that go beyond what irrigator-beneficiaries capture) is much more difficult. These indirect benefits include gains from the marketing, processing, and consuming sectors, and they are usually referred to as positive externalities of a project. Increased employment in both the farm and non-farm sectors has also been documented in the Philippines as an indirect effect of irrigation development (ESIA-WID 1983). Bell and Hazell (1980), analyzing the indirect benefits from the Muda irrigation project in Malaysia, have concluded that such benefits are

Table 9

ESTIMATES OF THE RATES OF RETURNS TO INVESTMENTS IN IRRIGATION CONSTRUCTION AND LAND OPENING, 1970 CONSTANT PRICES

	Irrigation 1/				Land Opening 2/	
	Traditional Varieties		HYV		Rice Case	Corn Case
	5N	15N	20N	60N		
Benefit/Cost Ratio:						
1949-53	2.5	2.6				
1953-57	2.3	2.4				
1958-62	1.8	1.9				
1963-67	1.9	1.9				
1968-72	1.6	1.7	3.1	3.4		
1970-74	1.4	1.5	2.9	3.1	0.9	1.3
Internal Rate of Return (%):						
1940-53	23	24				
1953-57	21	22				
1958-62	19	19				
1963-68	19	19				
1968-72	18	18	32	36		
1970-74	15	15	28	32	9	13

1/ Refers to NIA-system projects completed during the five years shown. 5N, 15N, 20N, and 60N refer to nitrogen inputs in kg. per hectare.

2/ Refers to government land resettlement projects completed in 1973. Rice case assumes one crop of upland rice planted in a newly-settled area. Corn case assumes two crops of corn planted in a newly settled area.

Source: Yujiro Hayami and Masao Kikuchi (1978), Table 1, page 72.

of the same range of magnitude as the direct benefits that go to farmer irrigators.

If we therefore expect that irrigation projects will be developed only on the basis of the farmer-irrigators' demand for the service (and therefore willingness to pay fees), then less than the socially appropriate level of irrigation development will take place. The reason is that irrigators' demand (based only on their direct benefits for irrigation) will not include additional social demand (based on the positive externalities mentioned above).

Figure 3 illustrates the socially appropriate or optimal level of irrigation that can be provided. As discussed previously the supply curve of

295

irrigated area is upward sloping due to the increasing cost of irrigation development. The demand curve for irrigation is based on the private benefits that irrigators can get from development, and this together with the supply curve, determine a private equilibrium level of irrigation development at H2 hectares with P2 as the development price.

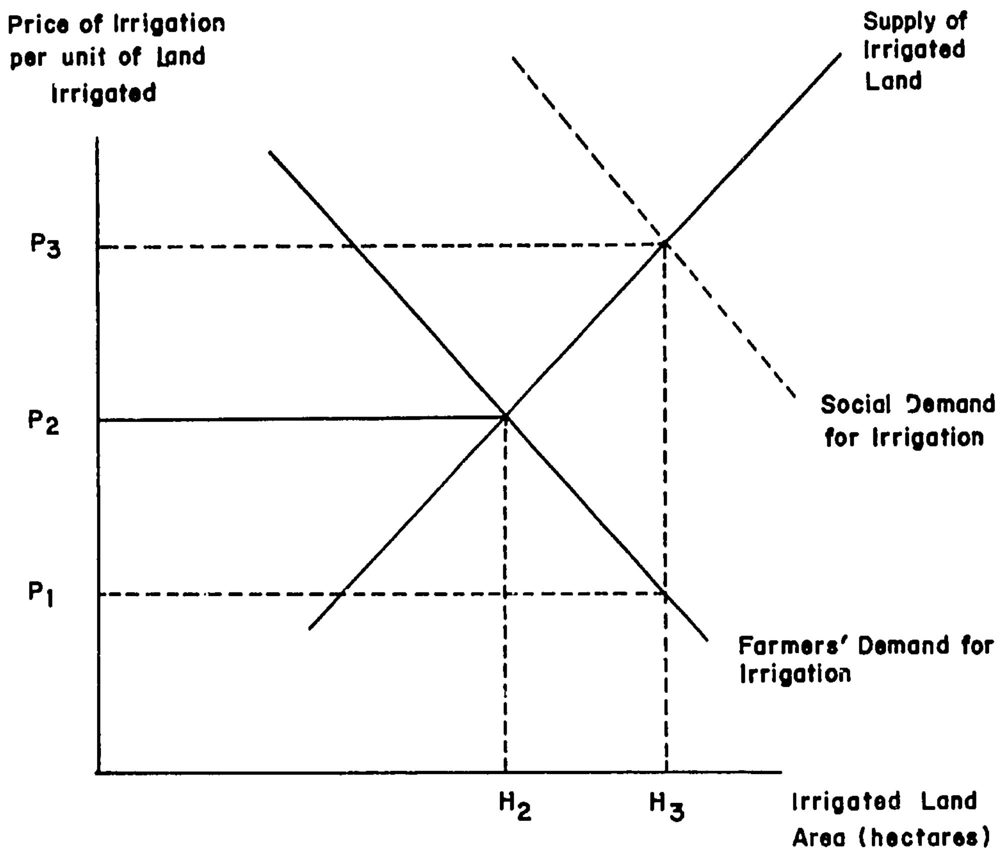

Figure 3. Social vs. Private Levels of Irrigation Development

296.

However, because of positive externalities, social demand is much higher than private demand for irrigation. The dotted social demand curve includes the private irrigators' demand plus the demand arising from the benefits of positive externalities from irrigation. The socially optimal level of irrigation therefore is H3 hectares at a price P3. However, private users will only be willing to have irrigation development up to H3 if the price to them were P1. If forced to pay the price P3, they would reduce their demand for irrigation to H1. Thus the government must subsidize the amount (P3-P1)H3.

Obviously, if the government were not to provide this subsidy, users will not be willing to pay the amount charged (P3) for the particular supply of irrigation (H3). However, the problem is that irrigation systems, once constructed, assumes a public goods nature, which makes exclusion of some farmers for non-payment difficult. Hence, in practice, farmers will make use of the irrigation system, but the required price P3 cannot be enforced, giving the economic basis for the problem of low collection rate.

The direct implication of this discussion on setting up a fair and realistic irrigation fee scheme should be clear. The public finance perspective shows that since a project is justified on the basis of the broad assessments of social benefits and costs, and that at least some of those benefits are of the positive externalities type then the manner of actually paying for the project cannot be accomplished by trying to recover full cost only from the farmer-irrigators.

The ideal procedure in getting society to "pay" for having this project is through the taxation system. This means that all beneficiaries of a project are not to be charged for the full amount of specific costs incurred since these costs do not directly reflect social benefits. They are to be taxed for specific net benefits or net productivity improvements that they get with the project. In the case of farmer-irrigators, these benefits to be taxed correspond to increases in land rents that follow from improvements in land productivity due to the project.

Note that project beneficiaries in this class of development schemes will not generally be limited to actual irrigation system participants so that the base for taxation is much broader than the base for irrigation charges. This is only proper since, after all, the benefits of irrigation, spilling over into agricultural development, reach a far wider beneficiary group than the group of farmer-irrigators.

Also, since there are many indirect beneficiaries of an irrigation system (e.g., from agro-industrialists who get expanded business opportunities to urban consumers who receive lower prices), it would be unfair to have only the direct users bear the full burden of project costs. Finally, it is quite conceivable that the tax effort will be limited just to capturing enough of the gross benefit to have a viable repayment program for whatever loans were incurred for the project, with some net benefit for particular groups being left substantially untaxed. Of course, in cases where major income distributional goals motivate government programs, taxation of the better-off beneficiary groups may be expanded to the limit with the proceeds earmarked for redistribution (through subsidies) to specific groups.

297

4. PRACTICAL IMPLICATIONS FOR IRRIGATION CHARGES

Explicitly incorporating demand or benefit-side considerations in the discussion of irrigation development provides a more realistic approach to the practical problem of determining systems and levels of charges. While the recognition that loan repayment forms part of the whole process of irrigation development is important, it does not follow that the direct beneficiaries of projects must be solely responsible for the full recovery of costs. This limited view corresponds with a financial perspective which a private developer takes when underwriting a private irrigation project.

In the Philippines this financial perspective has been applied by the NIA, given the government requirement that it covers all its capital and operating costs. The need for a public finance perspective in contrast to the financial perspective, however, highlights the importance of relaxing this NIA requirement. Indeed, there should be a clear policy that full cost recovery is not the responsibility of NIA, given that its management and supervisory scope does not encompass all the beneficiaries of irrigation development. Its proper scope is project administration or the construction and operation of irrigation projects. The function of public finance which negotiates and pays for the loan is a much broader one, requiring broad taxation as well as subsidy-granting powers, and this is usually taken to be within the purview of the Finance Ministry.

In practice, the NIA fee-collecting role should only be a component of a larger taxation (or subsidy) program associated with irrigation development. Also, we submit that some of the equity-oriented approaches to other components of the agricultural development effort of the government should also be relevant for determining charges for irrigation.

For example, the research and development costs incurred for new agricultural technologies and for their dissemination are of the same nature as irrigation development costs in that they also contribute to agricultural food production and benefit a fairly wide spectrum of the economy. This is an interesting case of contrast since with the provision of the new food crop technologies the government has always taken a public goods approach: although farmers may be deemed the key beneficiaries, the cost of the program is supported from general government revenues because of the substantial social benefits that also arise from the program. If government should take this particular extreme of completely subsidizing the cost of new technologies, why should it take the other extreme of completely charging farmers for the full cost of irrigation development?

Part of the answer is due to different potentials for the identification and taxation of the beneficiaries of these programs. Beyond this problem, however, an important reason is that the equity aspect of development financing seems to have been disregarded in the case of irrigation. Combining this equity motive with the public finance approach that we have presented can form a sound and practical basis for a system of irrigation pricing.

4.1 Capacity-to-Pay as Primary Consideration

In such a system, the first test for the charging of fees should be farmers' capacity to pay. Although it has been presumed that owners of irrigated farms are generally better off than other farmers because of the higher yields that they get, in fact irrigated farms may be much smaller in hectarage. Total output and ability to support minimum household consumption needs may be limited by the small landsizes and inadequate land distribution (tenure) policies so that irrigated farms are not really that much better off (Quisumbing and Cruz 1986, Mangahas 1985).

Different calculations of net benefits from irrigation are available for the Philippines. A NIA (1985) survey of 32 national systems indicates an average net return above all costs of P2,369 and P2,589 per hectare for the wet and dry seasons, respectively (see Table 10). A similar figure is provided by Small and associates (1986) using indicative cost and return estimates for family owned resources. Based on their calculations the average net return from irrigation is P4,958/hectare for the entire year. Net returns for the wet and dry seasons are P2,884 and P2,765 per hectare, respectively.

Table 10 NET RETURNS TO IRRIGATED RICE FARMING BY REGION, WET AND DRY SEASON, 1984

Region/Season	Production Cost (₱/ha.)			Irrigation Fee (₱/ha.)	Gross Returns (₱/ha.)	Net Returns (₱ /ha.)	
	Cash/ Kind	Non- Cash	Total			Above Cash Cost	Above All Cost
I. Ilocos							
wet season	6336		6336	-	10227	3891	3891
dry season	3881	638	4519	-	6590	2709	2709
II. Cagayan							
wet season	2590	-	2590	210	5271	2681	2681
dry season	3455	-	3455	398	7258	3803	3803
IV. Southern Tagalog							
wet season	4987	-	4987	236	7898	2911	2911
dry season	4181	-	4181	285	6718	2537	2537
V. Bicol							
wet season	4344	-	4344	109	4849	505	505
dry season	4375	-	4375	181	5850	1475	1475
VI. Western Visayas							
wet season	5751	-	5751	75	7946	2195	2195
dry season	4795	-	4795	159	7233	2438	2438

Table 10 continued ...

Region/Season	Production Cost (₱/ha.) Cash/ Kind	Non- Cash	Total	Irrigation Fee (₱/ha.)	Gross Returns (₱/ha.)	Net Returns (₱ /ha.) Above Cash Cost	Above All Cost
VIII. Eastern Visayas							
wet season	2585	-	2585	197	4765	2180	2180
dry season	2589	-	2589	236	5728	3139	3139
IX. Southern Mindanao							
wet season	5520	456	5976	-	9734	4214	3758
dry season	4332	-	4332	315	8917	4585	4585
XII. Central Mindanao							
wet season	5409	-	5409	-	10830	5421	5421
dry season	4339	-	4339	329	8998	4659	4659
ALL REGIONS							
wet season	4642	456	5098	161	7467	2825	2369
dry season	4205	638	4843	253	7432	3227	2589

Source: National Irrigation Administration, (1985), Table 9, p. 22

The net returns using assumptions of full cost recovery were also made by Small, et al. (1986) for both low and high investment costs and an average O&M cost of P314/hectare. If water charges are increased so that 100 percent of capital and O&M costs are recovered, the net return from irrigated rice production decreases from P4,958 (using the current charge of 250 kg/hectare/year) to P3,942, assuming a low investment cost of $1,000/hectare. With a high investment cost of $2,500/hectare, the net return to water users is further reduced to P2,262/hectare.

The yearly income of water users of P4,000 to P5,000 is only slightly higher than the national poverty food threshold of P3,120/family and below the total threshold of P5,262/family (Abrera 1976, Quisumbing and Cruz 1986). The estimated net benefits for irrigated ricelands, assuming a full cost recovery scheme, will place family incomes within the bottom 30 percent income bracket for rural areas in 1984.

Table 11 compares capacity-to-pay estimates among irrigated rice farms with national poverty thresholds for the rural areas. In general, the poverty incidence rate for irrigated farms is slightly lower for all regions except for Ilocos and Cagayan where the poverty incidence rates for irrigated farms are higher than the average for the entire rural population. The differences in poverty incidence, however, are small so that it would be wrong to conclude that irrigated rice farmers are that much better off than their rural counterparts.

<u>Table 11</u> COMPARATIVE EVALUATION OF CAPACITY-TO-PAY AS MEASURED BY NET BENEFITS AND POVERTY THRESHOLD

Region	Net Returns from Irrigated Rice Farming (₱ /ha.) 1/		Poverty Line Per Family (in ₱)	Poverty Incidence (%)	
	₱ /ha.	Net Cash Income 2/		Rural Population 3/	Irrigated Rice Farms 1/
I. Ilocos	3300	8265	7464	37.6	42.3
II. Cagayan	3242	8316	7464	44.9	46.9
IV. Southern Tagalog	2724	7911	8448	47.0	33.5
V. Bicol	990	5863	7260	56.4	45.7
VI. Western Visayas	2317	6924	7656	49.4	49.8
VIII. Eastern Visayas	2260	7016	7200	56.0	32.5
IX. Southern Mindanao	4172	9325	8124	41.2	30.5
XII. Central Mindanao	5040	10001	7332	28.4	22.3
ALL REGIONS	2479	7523	7716	47.5	40.1

1/ Based on a survey of 32 national irrigation systems.

2/ Net cash income = gross receipts less production costs (cash) for the entire household for one year.

3/ The estimated rural poverty line per family is ₱ 4,529.00

Source: National Irrigation Administration (1985) for columns (1), (2), and (5); World Bank (1985) for columns (3) and (4) as cited in Quisumbing and Cruz (1986).

In fact, according to a 1985 NEDA survey, about 21 percent of the poorest (or bottom 30 percent) of families have irrigated farmlands (NEDA 1985). Of the rice and corn farmers within this bottom group, those with irrigated lands comprise an even greater 32 percent. In terms of capacity to pay, about 92 percent of these low-income families consider their incomes to be inadequate even for basic necessities such as food expenditures (NEDA 1985).

These figures indicate that policy-makers should not automatically presume that farmer beneficiaries of irrigation projects can afford to pay higher water fees. Even in cases where there are clear additional benefits that these farmers receive from the project, for some of these farmers benefits may not be enough to bring them above the subsistence threshold level where new incomes will not just be consumed by priority requirements for food and other necessities.

As a practical matter then, the government cannot expect that irrigation fees will be paid if farmers get benefits from the system and if these benefits are at least equal to the fees. As long as the farm households are below required subsistence levels, any new income from improved farm productivity will be allocated first toward meeting basic food and other necessities. This means that capacity to pay considerations should take priority over the presence of benefits as the basis for irrigation fees.

In addition, even if we presume that basic subsistence needs have been attained, the level of irrigation fees should not necessarily attempt to capture all farmer benefits. The presence of substantial positive externalities or benefits that accrue to society in general argues for charges that can actually be significantly less than the construction cost recovery level. Other beneficiary groups can share in the cost. Also, from the income distribution viewpoint, the low variation in poverty incidence among rural occupations and subsectors reflects the complex nature of the Philippine agricultural situation. The predominance of small sized landholdings and the pervasiveness of tenancy will be important considerations if income distribution were to be achieved in the policy for water charges.

Although no direct quantification is available from Philippine data to establish the proportion of cost that should be charged to non-farmer beneficiaries of irrigation development, estimates of economic rates of return that are substantially larger than costs of loans (Hayami and Kikuchi, 1978) and findings from the Muda project in Malaysia (Bell and Hazell,1985) suggest that the current attempts in the Philippines for full cost charges from farmer-irrigators only represent an inequitable policy. This is especially so if we consider that the excessive charges on farmers mean that the much better-off marketing and urban consumer sectors are being subsidized.

To summarize, a practical and equitable financing approach cannot place the full burden for irrigation development on farmer-irrigators. The charges that should be levied on farmers should depend on capacity to pay since, from a pragmatic perspective, fees that cut into the farm households subsistence requirements cannot be collected. From an equity standpoint, even if there is farmer capacity to pay, the full benefits that accrue to him should not be completely taxed away through charges but should only cover short-run operating costs. By charging for the operating costs, farmers retain responsibility for sustaining the system. If this scheme is followed it should not be unreasonable to expect that the charges that NIA will have to levy on farmers will be quite small.

- 302

NOTES

1. New approaches to fee collection involving irrigation associations and changes in agency procedures are discussed extensively in Coward and Uphoff (1985).

2. The NIA was able to restore 73,260 hectares (or about 173%) of their 42,360 hectare goal for rehabilitation of national systems in 1981. Likewise, rehabilitation projects in communal systems reached 16,000 hectares or 133 percent of their 12,000 hectare goal for 1981. In 1982, the NIA was able to generate, through national systems projects, 72,426 hectares of new area or 67 percent of its target, but it restored or improved 53,918 hectares, which is 174 percent of its target for rehabilitation projects. Communal systems generated 26,634 hectares of existing systems. While they were able to meet 85 percent of their targets for generated areas under communals, they accomplished 90 percent of their target for rehabilitation. This indicates a clear pattern of giving priority to rehabilitation projects in the allocation of resources.

3. In 1982, there was a significantly large 12 percent increase in the NIA budget, the increase in funds comprising project allocations for the completion of the massive Magat Multipurpose Project. The next year, the percentage increase in NIA's operating capital declined, signalling the start of the government's retrenchment policy.

4. The peso-US dollar exchange rate is currently about P20 to US $1.00.

5. The NIA is authorized "to charge and collect from beneficiaries of the water from all irrigation systems constructed by or under its administration, such fees or administration charges as may be necessary to cover the cost of operation, maintenance, and insurance and to recover the cost of construction within a reasonable period of time to the extent consistent with government policy ..." (Republic Act No. 3601).

6. The water permit that is issued is for a specific duty of water and for rice irrigation the measurement is for one liter per second per hectare. Sandy soils are charged a higher fee.

7. The financially marginal systems are systems which would still incur deficits even at 100 percent collection rates. The priority systems for conversion are those with service areas of 1,000 hectares or less. Beginning in 1983, NIA plans to convert an average of 6 to 7 national systems each year into communal systems.

8. This scheme, however, has not been particularly attractive to farmers because pump systems have generally suffered deficits and cost of operating the pumps have been rising steadily.

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305

IRRIGATION WATER CHARGES IN CHINA

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. INTRODUCTION

China has a very long irrigation history. For example, the famous Dujiangyan irrigation works has been operating continuosly for more than 22.3 centuries since its construction and is still efficiently irrigating its 587,000 ha of land. China's irrigated area is very large too. Official statistics show that there are 44.45 million ha., or 45% of the total cultivated land is under irrigation.

According to the irrigation water used, the total irrigated area can be divided into 5 different groups: area irrigated with the water comes from reservoirs; diverted from rivers; pumped from surface water; pumped from underground and miscellaneous. Their relative percentages are 30%, 27%, 19%, 18%, and 6% respectively. The main irrigated crops are rice, wheat, maize and cotton.

Rice is the dominant crop in South China where climate is warm and humid. Wheat, maize and cotton are the main crops in North China where the climate is semi-arid to semi-humid, and water resources are not very rich.

Irrigation in North China under usual conditions can increase the crop yield by quite high percentages, and may double the yields in dry years, while in wet years it may not have any benefits. In North-east China where the winter is quite cold and the summer is rather warm, the profit of growing paddy rice is substantially higher than growing other crops, so rice becomes the dominant irrigated crop, although it is not the main crop there. The North-west part of China is quite arid, some parts are so arid that practically no cropping is possible without irrigation. There, the water for irrigation chiefly comes from melting snow and glaciers on the high mountains where the annual precipitation is much higher than that in the arid plains. However, this kind of water resource is limited.

2. PRESENT FINANCING AND COST RECOVERY PRACTICES

Chinese irrigation facilities, aside from very small ponds, dikes and simple wells possessed by individuals, all belong to the public. All the big and medium types of irrigaton works are national properties, and are managed by government water conservancy organizations. The small ones are generally owned by local collective organizations of farmers. In the construction of a national project, as a rule for last 3 decades, the government water conservancy unit constructs the main canals and structures with the farmers' contribution of most of the labor needed; farmers construct the tertiary canals and on-farm works with building materials (steel, cement and wood, etc.) provided by the government.

Due to th fact that within the last 3 decades the farmers received only some limited allowance for their labors, it has been estimated that, if one considers the difference between the normal wage the farmers could earn and the allowance they really got as their investment, then the farmers' share of the investment is about equal to the share of the government in most cases. The small irrigation projects have to be approved by the government water conservancy organization first, then, the owner can, generally, get some loans somewhere to construct the project, and sometimes the water conservancy organization may provide the owner with building materials as subsidies.

It should be noted that many water conservancy projects have multipurposes. In addition to the irrigation fuction, they may have other functions like flood control, hydro-electric power generation, fisheries, etc. In such cases, the irrigation water charge is not the sole source of conservancy incomes. They can collect water charge from other water uses too.

2.1 Examples of Charging Mechanisms

After completion of construction of an irrigation project, farmers will begin to irrigate their land, and the management office of that project will start to collect water charges from the beneficiaries. That has been common in China for a very long time. The forms and rates of water charges vary with different projects under different conditions. The irrigation water charge per ha in rice dominant Dujiangyan system, for example, was 57.5-60-75 kilograms of husked rice plus 1/2 day of labor for annual repairs through the 1940's to the begining of the 1980's.

The cotton dominant irrigation area, Jin-wei canal of Shaanxi province, used to charge farmers 3.75-7.5-I8.75 kilograms of lint per ha during the I930's and 1940's. In 1956, it was changed to 10.5 yuan per ha of irrigation land as a basic charge which should be paid whether it is actually irrigated or not, plus 7.5 yuan per ha for each actual irrigation. That means, if a hactare of cotton land is irrigated twice in that year as the normal practice, the water charge will be 10.5+2(7.5)=25.7 yuan. In general, these water charges equaled to approximately 1%-3% of the value of local normal yield or gross income of that crop at the time when the water charge rate was fixed.

It is obvious that these irrigation water charges do not cover the investment recovery. It takes care of only the O & M expenditures under normal conditions, and, at most, adds some money to be used for overhaul. Although the Dujiangyan system, the Jin-wei canal and some other irrigation works have supported normal operation with such irrigation water charges, there are quite a number of irrigation works in poor finacial state, due to the fact that the rate of water charges is to low and/or it is not fully collected. The result is that the facilities have not been well maintained and operated. Some of them were so poor that they had to ask the government to give them more subsidies.

2.2 Changes in Charging Philosophies

In 1979, China started her great economic reforms. In 1981, the reforms of water charges, including the irrigation water charge began. At the begining of that year, the former Ministry of Water Conservancy (now M. of W.C. and Hydro-electric Power) conducted a nation-wide investigation on water charges. Since the end of 1981 till the summer of 1985, MWCHP has held many special conferences to discuss and study the water charge problems. And finally in July, 1985, the

301'

State Counci¦ issued the document "The Principles of Determination, Calculation, Collection and Use of Water Charge of Water Conservancy Works". That marked the begining of a new period in the course of water charge reforms.

A fundamental question in irrigation water charge reforms is the question of traditional concept. For thousands of years, the chinese people considered the water conservancy works as works of public welfare; they did not have any idea of recovering the investment. But now, the construction of irrigation project has been considered just as economic enterprises like factories or mines. It has to be scientifically appraised that it is economical, feasibile, and its investment can be recovered within a resonable period. It is a principle that all the economical enterprises should be able to recover their investment, only then the extent of economic construction can be larger and larger, and the people can get more and more real benefit.

If an enterprise cannot get back its investment within a reasonable time frome, how can we develop the next enterprise? If the water conservancy projects cannot recover their investment, how can they construct their further projects? For these reasons, the system of collecting water charges issued by the State Council says, all the water supplied by water conservancy organization should be paid. It says also that the rate of water charge should be determined on the basis of cost calculated. Since farmers contributed their labor without receiving any pay in constructing the water conservancy projects within the last 3 decades, the rate of irrigation water charge should be lower than those of other uses--deduct the part of farmers' labor investment in calculating the cost of irrigationg water and determing the rate of its charge, while all the investments should be included in calculating the cost of water for other water uses.

2.3 Setting New Fees

The reform of water charge will also promote the economical utilization of water resources. As the growth of national population and economic construction has been going forward, the shortage of water resources, especially in Northen China, becomes seriously conspicuous. The old system of low water ch rge and the method of fixing the rate of water charge only on irrigated area leads to wasting water and increasing the seriousness of water resource shortage. So the State Council document declares:

1. In general, the water charge should be calculated based on a progressive rate of water charge for the amount of water used.

2. For agriculture use, it is better to take the combined system to count the water charge---part of it is counted based on the area of irrigation land; that is called basic charge. The other part of the water charge is counted on the amount of water used. Furthermore, it is recommended to use different water prices to calculate the second part of the water charge in different seasons. For example, the Jinwei Canal has used another system of collecting irrigation water charges since 1980: basic charge = 6 yuan per ha, plus varying fees for the amount of water used in different seasons: 9 cent/M3 for water, 10.5 cent/M3 for spring and 12 cnet/M3 for summer. The document also allows the use of a progressive rate of water charge for water used exceeding a difinite water rate at places short in water resource.

2.4 Remaining Problems With Fees

There are 19 provinces, cities and autonomous regions that have enacted new systems of collecting water charges since 1982 (see Table 1). The situation is better than before, but there are still many problems to be solved.

Shanxi, a province in North China, for example had, in I981 a total amount of water supplied by the provincial water conservancy organizations of 5,400 million M3, of Which, 5,000 million M3 or 93% was for irrigation. The prices of water supplied for different uses were: 0. -0.5 cent/M3 for irrigation, 2.0- .0 cent/M3 for industrial and domistic uses of cities and towns. Meanwhile, the costs of water for these water supplying facilities were 3.4-4.I cent/M3, according to the calculations made. It is obvious then, there were I.0-2.0 cents deficit for every M3 of water supplied for industrial or domestic uses, and 3.0-3.7 cents short per M3 of water supplied for irrigation use. The differences between the water cost and the water price, which was paid by the government water conservancy organization, were gone to become subsidies to the water using farmers, factories and urban dwellers. Then in 1982, they changed the prices of ater to: 6-10 cent/M3 for industrial and domestic use, 0.8-I.5 cent/M3 for gravitational irrigation, 2-8 cent/M for pumped water irrigation with a lift of 50-300 M. The total income of water charges collected according to this new system is 2.5 folds compared with the old system. Yet the 0.8 cent/M3 irrigation water charge is only enough to support O & M that year, and 1.5 cent/M3 still couldn't cover investment recovery, although it might help to pay for repairs or overhauls. The price of water 0.8-1.5 cent/M3 equals approximately to 37.65-70.65 yuan/ha, or about 2.0-4.0% of gross value of crops produced per ha irrigated under normal conditions. This is about in the suitable range of irrigation charge.

This example shows clearly that although the water conservancy organization of Shanxi Province has raised their income from water charges to 2.5 fold as by executing the new system of collecting water charge, yet they are still unable to start recovering the investment. That is only an example. We can find by comparing Table 1 and Table 2 that there are many cases that the new prices for irrigation water are still lower than the theoretical water charges which include full costs of supplying water. In some cases, the differences between hese two figures are quite large, indeed.

It is clear, then, we are still on the way to water charge reform. There is still a long way to go.

3. CONCLUSION

First of all, we have to give more explanations in the ideological field. It is very difficult to change a traditional idea that has lasted thousands of years. The cadres of new Chinasince 1949 have devoted their effort to bring benefit to people, and many of the rural people are still poor and backward and needs help, furthermore, most of the irrigation works were built by large amount of farmers' labor without giving the farmers any pay. All these make the situation more complicated and more difficult to convince both the caders and farmers.

Secondly, try to lower the water cost. The more the cost is reduced the easier the recovery of the investment. There are many things we can do. First, it is feasible to reduce the number of staff members working in management offices and cut down the a ministative expenditures in many cases. We can take all possible steps to reduce the loss of water in conveyance and application (to increase the water efficency); this is the most practical and important task for most of the irrigation areas. It is now proposed and encouraged in China that all the water conservancy organizations develop their diversified businesses to earn some money in order to increase the total income sufficient for O & M expenditures and investment recovery. There are still other choices and possibilities.

Thirdly, in extenuating circumstances, it is possible that the cost of water of a particular irrigation works will be too high to be charged fully on water users, if we develop irrigation there. In fact, we have such irrigation schemes. Some of them are gravitational irrigation areas in mountain areas. This kind of irrigation works has not only very high investment per unit of irrigated land, but also O&M expenditures are quite high because they have to build a lot of complicated structures to keep the gravitational water running. There are some areas irrigated with water pumped up hundreds of feet. In such cases, the power expenditure can be high enough to cost several tenths of the gross value of crops produced on that field, although the price of electricity for agricultural use is far lower than those for other uses. And there are some other cases. These and other reasons raise irrigation costs. This leads to the question, "are these irrigation projects really worth construction and maintainence?" Generally, this question should be answered independently by the economical benefit of these projects, but in some special cases this question should be answered by the overall benefits of these projects. If it is decided that these projects are to be constructed in high cost situations, it may be necesary to have some subsidies. It probably will be better that these subsidies take the "open" form than that of a low water charge.

Besides the questions mentioned above, there still remains another question to be solved properly---to ask water users to pay "resource fee" for water used in places short in water resources. In China, only the users who divert or pump water from reservoirs or "reservoir---regulating" rivers have to pay such a fee. Many people agree that persons who pump water from underground in these regions not rich in water resources should pay such a fee too, but there has been no action taken yet. It is growing clear that if water users were asked to pay resource fees for the water they use, they would definitely improve their water use techniques in order to increase the water use efficiency; consequently the overall water supply condition will be improved.

TABLE 2. COST OF WATER CALCULATED
FOR SOME WATER SUPPLY SOURCES

Province or City	Name of Water Supplying Works and Water Price cent/M
Guangdong	Longjing 0.447, Gongping 0.815
Guangxi	Qiaoxing 0.01, Jiangkou 0.470 Dajian 2.005.
Yunnan	Feijinghai 0.595, Songhuaba 2.11
Guizhou	Maomaodon 2.835, Guijiahu 1.867 Gongnongpin 8.594*
Hunan	Baima 1.1, Red Flag 4.202
Jiangxi	Bingyuan 0.498
Fujian	Xixi 1.34, Dongchuan 1.422, Jinjiang 3.642*
Zhejiang	Hongqiao 6.131, Hengjin 0.285 Qiantangjiang 6.322*
Jiangsu	Zaoguazha 0.338, Shahe 0.69
Anhui	Guniubei 1.57, Huanglishu 2.708, Zuozhen 2.16*
Hubei	Majiahe 3.781, Shitasi 1.372.
Sichuan	Quanmin 3.47, Yuejin 1.151
Shandong	Jindou I.776, Longmenkou 1.833
Henan	Yinhuang 0.547, Zhifang 7.476
Shaanxi	Jinwei 1.533. Dongfanghong 3.587*
Shanxi	4 areas 2.116, 10 areas 4.956 9 stations 6.369*
Hebei	Huangpizhuang 0.679, Wushi 1.21
Tianjin	Yuqiao 0.4!7, Beidaguan 3 .745, Dangu 2.859*
Beijing	Guanting Miyun 1.985
Liaoning	Dalingtun 1.21, Nanhexan 2.255*
Jilin	Longtou 3.148, 9th Station 0.967*
Heilongjian	Yinren 1.56, Yuelai 2.515*
Inner Mongolia	Yinjinhe 1.308, Dunkou 1.945*
Ningxia	Sanying 6.819, Tongxin 9.IO*
Gansu	Suleihe 0.89, Yuanyangchi 0.86 Jintaichuan 7.5*
Qinghai	Beichuan 1.055
Xinjiang	Baichengzi 1.012

*pumped water

.311

IRRIGATION WATER CHARGES IN NIGERIA

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1. BACKGROUND

Nigeria with a population of about 100 million is blessed with a vast land mass of about 98.3 million ha, of which 72.4 percent (1.2 million ha) are cultivable (see map). The enormous land mass is subject to vagaries of climate which mark out the country into three district rainfall and forest zones: the evergreen deciduous forest in the South, the Middle Savannah zone and the Sudano-Sahelian grass land in the extreme Northern part of the Country. Rainfall varies from 3,000mm in the coastal areas to about 1500mm in the middle zone and around Jos and Mambilla Plateaux decreasing to as low as 500mm in the extreme North. Evaporation on the other hand, increases as one moves northwards due to longer hours of sunshine and higher mean air temperatures.

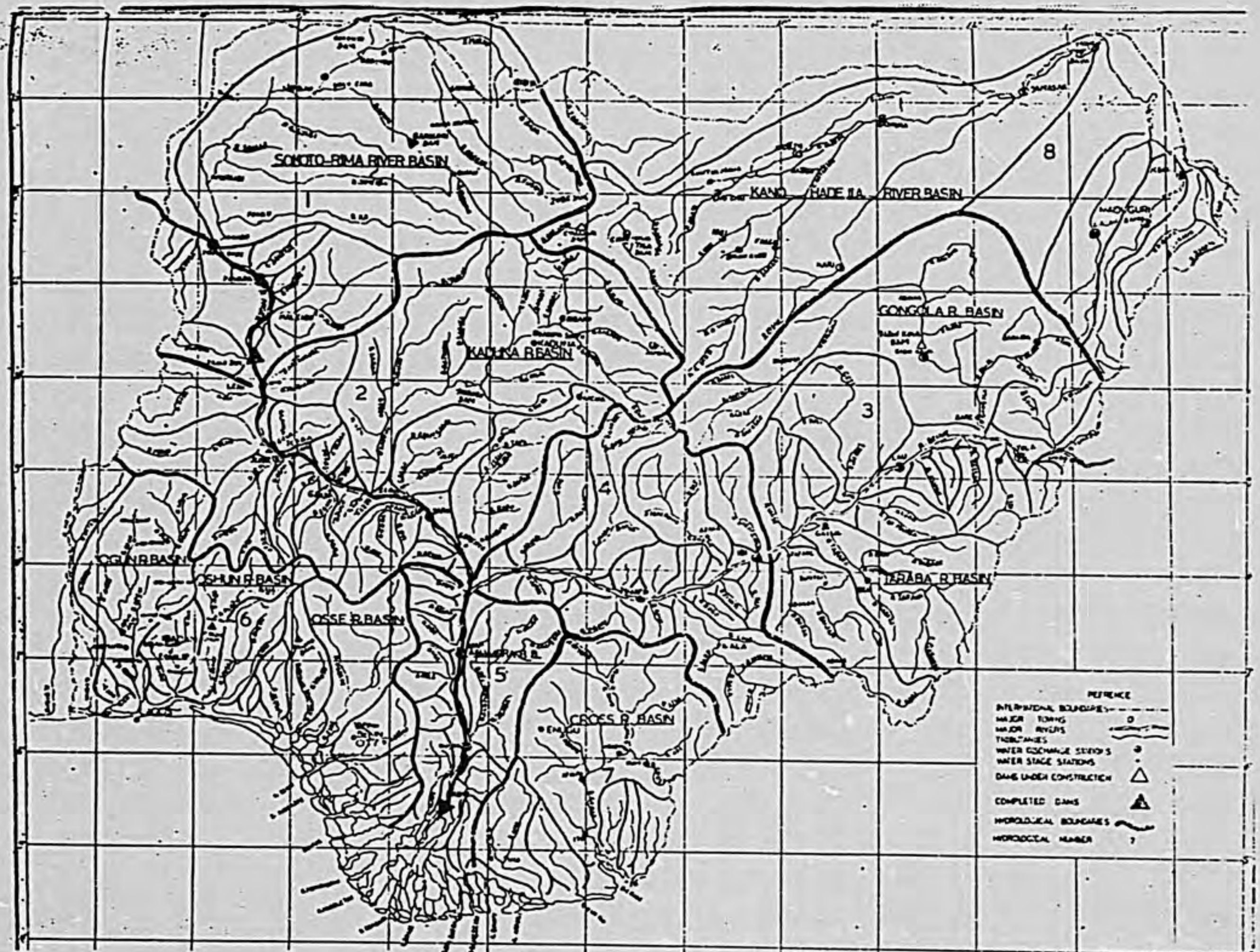
As would be expected from the low rainfall figures in some areas, severe and prolonged droughts often occur, most especially whenever the annual rainfall deviation is up to 20 percent with at least 5 consecutive rainless days during the wet season. Droughts sometime ravage the whole country and is in actual fact known to conform with the 30/10 yearly Sahelian drought cycle. During such occurrences a nationwide crop failure is experienced as a result of lack of sufficient water for plant growth and nourishment, culminating in a country-wide food shortage.

Therefore, in an attempt to obviate the devastating effects of drought, a policy on crop irrigation has been evolved. This is a common practice in the semi-arid areas of the North where dry season is comparatively prolonged (i e. September to May). The dry season is of shorter duration in the South and Middle zone (i.e. October to March) where supplemental irrigation is often practiced and encouraged by the Government.

In order to support government policy on self-sufficiency in food production, effort is increasingly geared towards putting more land under cultivation through irrigation practices. Predominant among crops put under irrigation are sorghum, millet, maize, wheat, rice, cowpea, groundnuts, vegetables, etc. With the emphasis the government now places on local sourcing of raw materials for Industry, other agricultural crops e.g. cotton, citrus, rubber, plantain, etc., are also put under irrigation.

Shadouf irrigation had been the traditional method in practice along the banks of perennial rivers mostly for vegetable production. This is found to be labour intensive land not much and could be put under irrigation with this old traditional method. The government, in a bid to improve the irrigation management practices of farmers, recently introduced modern concepts of surface and sprinkler irrigation systems. Which method is used depends on the topography and other factors of the project command area.

- 7/2


SOKOTO-RIMA RIVER BASIN
KANO HADEJIA RIVER BASIN
GONGOLA R. BASIN
KADUNA R.BASIN
OGUN R.BASIN
OSHUN R.BASIN
OSSE R.BASIN
CROSS R. BASIN
TARABA R.BASIN
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REFERENCE
INTERNATIONAL BOUNDARIES
MAJOR TOWNS
MAJOR RIVERS
TRIBUTARIES
WATER DISCHARGE STATIONS
WATER STAGE STATIONS
DAMS UNDER CONSTRUCTION
COMPLETED DAMS
HYDROLOGICAL BOUNDARIES
HYDROLOGICAL NUMBER

313

The aggregate total of the areas under Shadouf (small-scale) irrigation is estimated to be about 805,000 ha in 1978, while the corresponding figure for the formal or large scale irrigation projects was only about 14,000 ha on the same date. In spite of substantial investments of capital and planning attention made by the government, this figure has only now attained a 50,000 ha level. Further investment of capital and attention continues to be devoted to formal irrigation and under the just completed 4th National Development Plan, it was the intention of the Federal Government to put about 1 million ha of land under irrigation. Although this is far from being realized, it shows the importance which the government places on irrigation development.

A number of agricultural action programmes coded variously as "Operation Feed the Nation," Green Revolution," "National Accelerated Food Production Programme," etc., have been successively pushed by the government in order to sensitize the people about the need for agricultural production. A massive response is noticed in other areas of agriculture, but not in crop irrigation. Not even big-time farmers (individuals and companies) ventured into this area because of the required vast capital outlay and the long gestation period of irrigation projects. The long and short of this is that investment in modern , organized irrigation in Nigeria is still the exclusive prerogative of the Federal and State governments. The situation may change in due course with greater awareness for markets for raw materials being demonstrated by industrial firms.

2. FINANCING IRRIGATION INVESTMENTS IN PUBLIC IRRIGATION SCHEMES

The introduction of formal irrigation in Nigeria is a very recent innovation with no track record of seasoned experience. The government has therefore not formulated any policy on financing of irrigation investments either for public or private irrigation schemes. Whatever large scale irrigation projects exist now is wholly financed by the Government. Financing ranges from the construction of headworks, pump-house, irrigation canals, etc., to their operation and maintenance. The Government makes available, annually, financial allocations to executing agencies such as River Basin Authorities at the Federal level and the Ministries of Agriculture at the State level. The bulk of this finance is derived from our earnings from crude oil which accounts for more than 90 percent of our total revenue. Local taxes are therfore not specifically imposed on direct beneficiaries of irrigation projects, other than a nominal fee charged on farmers within the irrigation project commnad areas.

In view of the fact that the Government has no policy on financing of irrigation projects, there is also no clear cut policy on recovery of investment cost. Irrigation projects are rather treated like a social welfare scheme similar to education and health, instead of being treated purely on economic viability. The River Basin Authorities are empowered under an enabling degree to (in consultation with the Government),charge a fee for services provided, including those of irrigation water projects. Each River Basin Authority therefore decides on the appropriate irrigation water rate. Generally speaking, all the River Basin Authorities charge between N15 - N100 per hectare of irrigated land ($1 = N$1). There is no clearly defined criteria in arriving at these rates, and the fees charged are not in any way related to the cost of providing irrigation water. In actual fact if all the cost of investments were to be recovered in a large scale irrigation project, a sum ranging between N800 and N2,000, would be charged per hectare of irrigated land. Compared with

314

this economic cost, the fee (i.e. N15 - N100/ha) charged to farmers is very insignificant.

This nominal fee is collected through deduction at source from proceeds realized from the sale of crop production of individual farmers. The River Basin Authorities assist the farmers in harvesting, processing and marketing the produce. The charge on inputs (e.g. fertilizers, pesticides, irrigation water, etc.) supplied to the farmers are also deducted from the proceeds.

This is a very effective method in that it assists the government agencies in recovering all tho fees chargeable to farmers, if the proceeds from the farmer's farm outstrips the fees. It only follows that if the sales value of crops is less than the fee charged to a farmer, that the government agency bears part of the losses. On the other hand, this result may be somewhat justified, inasmuch as the purchase prices of the River Basin Authorities are usually less than ruling market prices. The revenue losses sustained by farmers make them feel reluctant to sell their produce to the River Basin Authorities.

3. PAYMENT FOR WATER ABSTRACTION

It could be said here that water resources planning management and development in Nigeria is still in its formative stages. Effort is being geared towards its maturation within a very short term. Part of this effort is formulation of water legislation to give legal backing to all our water resources planning, management and development activities. The draft water law has already been sent to the Ministry of Justice for approval and final enactment.

At present no permission or license need be sought, and no charge is imposed on surface or ground/water exploitation and abstraction. When the water law comes into force, however, it is expected that water uses would be streamlined to be in proportion to users' requirements.

The enabling law exempts some water users from paying charges, this includes fishing. livestock, navigation and domestic purposes. The Minister of Federal Ministry of Agriculture. Water Resources and Rural Development, acting on behalf of the Federal Government is however empowered to authorize agencies to impose charges on services' including contributions to the cost of works associated with the provision of such services and paid for with public funds. Irrigation water comes under this category. The finer details like the modeling of the charge and the duration would be worked out whenever the water law is formally passed. The laws will further strengthen the River Basin Authorities and the States' Ministry of Agriculture (who are executing agencies of irrigation schemes) in imposing water assessments.

4. POLICIES RELATING TO FINANCING OF PRIVATE IRRIGATION SCHEMES

The decline in oil revenues has resulted in a dwindling foreign exchange reserve. The regular flow of raw materials for our manufacturing industries has thus been impeded. The situation now warrants industrialists to look inwards for the local supplies of their raw materials, most of which are agro-based. This has led to the recent development of large scale farms by subsidiaries some multi-national companies, such as Nigerian Breweries Ltd, Leventis Group, etc. This spate off farm developments is expected to pay off and will soon reverse the trend of our being net importers of food materials.

Almost all these companies and cooperative societies still depend on rainfed agriculture; irrigation infrastructures are just being developed for them. The Federal Government has no financial policies to specifically stimulate irrigation investments by private individuals or groups. There are, however, some established financial policies for agriculture as a whole in which irrigation forms a component. Some of the policies which could encourage the growth of private irrigation schemes through improved access to credit facilities include:

(i) Establishment of Agricultural Credit Guarantee Scheme, under which all commercial banks are required by law to dedicate 5 percent of their loan portfolio to agriculture.

(ii) Commercial banks are to operate a low interest rate (9 percent, which is 4 percent less than than the commercial rate) on all agricultural loans.

(iii) The Nigerian Agricultural and Credit Bank (NACB) has also been established exclusively for the promotion of agriculture and provides short, medium and long term credit to individual farmers, cooperative organizations, limited liability companies and government agencies. Under their small-holder scheme, NACB can lend N5.000 to small-holders without collateral. A local guarantor of adequate standing is, however, required.

Under the recently introduced general economic policy framework. Emphasis is shifted from further development of oil industry to agriculture and the latter is further being stimulated through:

(i) A 30 percent levy imposed on all imports except agricultural equipment and materials.

(ii) Proceeds from the 30 percent levy on imports are to be used to strengthen non-oil exports especially agricultural exports.

(iii) Simplification of import licensing.

(iv) Introduction of export credit guarantees.

(v) The reduction of petroleum subsidy by 80 percent and savings realized used to establish "Directorate of Foods, Roads and Rural Infrastructure" in th President's Office.

All these measures and more are aimed at stimulating agricultural production, generate employment, etc., and these in turn directly or indirectly stimulate the establishment and financing of irrigation schemes.

Private irrigation schemes, apart from the traditional Shadouf method are literally non-existent. Public irrigation schemes are also very new. There is therefore no basis for comparison between the two. The establishment of large government irrigation schemes has generated public criticism for its lack of adequate planning, slow progress and waste. The projects are rather ambitious and money sunk in each scheme is rather phenomenal in order to derive full advantage of the economies of scale. The efficiency in managerial skill, staff experience, etc., make this goal unattainable in many project areas. Proceeds from water charges imposed are insignificant compared with the costs of investment, operation, and maintenance of irrigation schemes.

5. OPERATION AND MAINTENANCE IN PUBLIC IRRIGATION SCHEMES

There is no policy now for the operation and maintenance of public irrigation schemes. One is however being formulated which will take particular note of the poor economic base of our smallholders who produce about 97percent of our food output. The plan still being formulated is for the Government to bear the cost of headworks and irrigation infrastructures, while operation and maintenance costs are to be borne by the farmer-beneficiaries.

The nominal charges of N15 - N100 by the River Basin Authorities in no way represents the full cost of operation and maintenance of existing irrigation schemes. The River Basin Authorities and the Irrigation Divisions of the States' Ministry of Agriculture are not given a cost recovery mandate.

Some rates are fixed at N15/ha whereas project operations and maintenance cost is about N200/ha. The implication is that the full operations and maintenance cost are being borne by the Federal and State governments through annual budget allocations. There are uncertainties attendant to this annual allocation, as a slump in the revenue base of the government also affects the actual appropriation to the Agencies. Budgets are therefore subject to cuts depending on the financial situation of the Government.

As stated earlier cost recovery policy has not been embarked upon, but full recovery of operation and maintenance costs is likely to be favoured in view of the financial predicament of the governments of the Federation. It has however not been easy to compute the full operation and maintenance costs due mainly to our lack of experience on management of irrigation schemes.

Experience of seasoned experts from other countries put this cost between 2 - 4 percent of investment cost. This will include energy, normal repair, replacement of equipment, and vehicles. It has been estimated that operation and maintenance costs in Nigeria would be between N200 - N600/ha depending on the irrigation methods used. Costs that are not directly related to the specific irrigation projects are however not included. Such expenses as for extension services, overall financial and administrative functions, salaries for staff associated with other projects are excluded.

The operation and maintenance cost of pumped irrigation schemes is about N500 - N600/ha for large irrigation projects. This takes account of fuel and maintenance for operation of diesel pumps. The gravity distribution system is less costly and is generally between N200 - N250/ha, when cost of agriculture extension workers associated with the project are added.

6. FARMERS' ABILITY TO PAY FOR WATER CHARGES

The impact of irrigation is felt through the realization of increased crop production. Most farmers could boast of crop productions (e.g. rice) of about 3.5 tons/ha. For double cropping, which characterizes most irrigation schemes, about 7 ton/ha per annum is realizable. With the current domestic market price of rice, a handsome income of more than N7,000.00 is possible. Even allowing for labour opportunity cost and overheads, a farmer of this status with income of N7,000/ha/annum, would not find the recovery of the cost of operations and maintenance would not constitute a problem: it can only reduce the profit margin by a negligible fraction.

It is therefore very easy for farmers to refund to the project costs of operating and maintaining the structures. Available statistical data, from some government farms bear this out. The hectarages cropped, outputs, as well as estimated revenue from the River Basin Authorities are computed as in the attached table. using government guaranteed minimum prices.

In order to stimulate people's interest in the development of Agriculture. the government has extended protection on the sector through:

(i) Minimum guaranteed prices.

(ii) Marketing board purchases.

(iii) Import quotas and tariffs.

(v) Import subsidies.

All matters relating to crop pricing are determined by a Technical Committee on Producer Prices (TCPP). Their decisions are subject to the approval of price Fixing Authority in the person of the Head of State.

Subsidies are given for pesticides, herbicides, fertilizers and other farm chemicals. Agricultural credit is also given at subsidized interest rates under the Agriculture Credit Guarantee Scheme Loan Fund established in 1977. These subsidy measures are aimed at further reawakening the interest of the public in boosting food production, generating employment in the rural areas, stem the tide of rural-urban migration, and also improve the income base of the rural dwellers.

Apart from the flat rate income tax on individuals' no tax is charged on farm produce and no charge is imposed on the utilization of the land. In actual fact, the government keeps the land in-trust for the people and are "leased" to farmers on payment of token charges. When the subsidies, tax reliefs, and token charges on land and water are put together, the fees paid are quite insignificant compared with the revenue generated from crop production.

318

Annex: Production, Output and Revenue Figures of Irrigated Crops in Nigeria

River Basin Authority	Crops	Area Planted (ha)	Output Tonnes (ha)	Yield Tonnes/	Gross Revenue
1. Gongola-Jamaare	Wheat	3,845.49	11,535	3.0	5,767.500
	Tomatoes.	1,634	57, 90	36	7,434,700
2. Sokoto-Rima	Maize	6,115.91	2,230	2	2,446,000
	Cow pea	859	668	0.78	490,980
	Sweet Pot.	2,843.10	36.950	13	7,990,000
	Rice	127.49	381	3	190,500
	Groundnut	55.20	110	2	49,500
	Wheat	211.71	414	1.9	207,000
3. Upper Benue	Cotton	1,779	2,849.49	1.60	1,993,243
4. Upper C-Cshum	Rice	108	270	2.5-	94,500
	Maize			3.8	
5. Anambra	Rice	2,417	7251	3	3,625,500
	Maize	21	42	2	4,830
	Casava	22	220	10	2,200
6. Imo	Rice	90	270	3	135,000
	Maize	100	200	2	23,000
	Cassava	50	500	10	50,000
	Veg t bles	10	360	36	22,000
7. Niger DeltA	Rice	143	429	3	214,500
	Plantain				
	Palm Oil	9,500			
8. Benin	Maize	240	480	2	55,200
	Rice	75	225	3	112,500
9. Lower O-Oshun	Maize	93	186	2	21,390
	Rice	52	156	3	78,000
10. Lower Niger	Maize	500	1,000	2	115,000
	Yam &				
	Cassava	250	2.500	10	250,000

319

IRRIGATION WATER CHARGES IN THE OASES OF SOUTH TUNISIA

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'Directeur Général'
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1. GENERAL

The area covered by the oases in southern Tunisia is estimated at about 20 000 hectares. No food plants can be grown in this area without irrigation. The main crop is the date palm, however, many other varieties of trees and vegetable are also grown.

Most of these oases were planted many years ago around natural springs. The farmers have organized themselves into water associations in order to operate and maintain the irrigation and drainage networks. Maintenance of the system is usually done at the end of each season (December/January) and the farmer himself participates or hires a worker to do the work with the team which is in charge of the maintenance. The number of workers or the number of days of work are determined according to the water rights of each farmer. The farmers also have to contribute to the operation of the irrigation network in another way. This is through the payment to the water master who is in charge of controlling the water rotation. He is usually paid by having the fruit of a certain number of date palms, depending on the water rights of the farmers.

However, the piezometric level of the water table has been going down for the last 25 years and the flow of the natural springs has decreased drastically to the point where most of these traditional oases were threatened. In view of this situation, the Government decided to undertake an overall study of the area in what is called the Master Water Plan of the South. Two important development programmes were defined within this plan according to the water resources of the area. The first programme deals with the rehabilitation of the traditional oases and the second concerns the establishment of new oases.

320

2. POLICY REGARDING THE RECOVERY OF INVESTMENTS IN PUBLIC IRRIGATION SCHEMES

All the projects which will be implemented within the development programme defined by the Master Water Plan are considered as public irrigation schemes. The total cost of these programmes is estimated at about 250 million dollars. The investments include:

- drilling of about 150 deep wells;
- implementation of the irrigation network at the farm level;
- implementation of the drainage network at the farm level.

All these investments will be made by the Government without any recovery. This is because this area of the country is considered as less developed with regard to the other regions.

However, all the on-farm investments are expected to be made by the farmer, and he will be able to obtain credit through the special fund for the development of agriculture (FOSDA). The farmer will have to finance 15% of the cost, 15% will be given as a subsidy and 70% as a mid-term credit with a rate of interest of 7.5%.

According to the first results obtained from the implementation of the first phase of the Master Water Plan, the increase in the revenue of the farmer due to the additional water plus the drainage system, is very impressive (3 to 4 times the previous revenue), and the farmer may be able to participate in paying back at least part of the investments. A study is being undertaken by the Ministry of Agriculture in order to determine the way in which farmers could contribute to the recovery of investments made.

3. PAYMENTS FOR THE ABSTRACTION OF WATER

No payment is required for the abstraction of underground water in Tunisia, but special permission is necessary to drill to a depth of over 50 metres or more. Nevertheless, in some areas where there are problems of draw-down or saline water intrusion, the Government does not encourage the farmers to drill. In such cases, private irrigation systems are not financed through the special fund for the development of agriculture.

4. PRESENT POLICY REGARDING FINANCING OF IRRIGATION INVESTMENTS IN PRIVATE SCHEMES

Besides the public irrigation schemes, there are three types of private schemes:

- Small farms of about 1 to 3 hectares irrigated by shallow dug wells;

- Small agricultural companies (10) of about 30 to 50 hectares irrigated by one deep well in each company;

- One large agricultural company (STIL) of about 2000 hectares irrigated by about 40 deep wells.

As far as the first two types are concerned, their projects are financed in the same way as the on-farm investments in the public irrigation scheme. For the single large company involved in land development in southern Tunisia, its investments are financed through the normal banking system.

5. PRESENT POLICY WITH REGARD TO O&M EXPENDITURE

Maintenance costs are calculated on the basis of the initial value of the investment as shown below:

- Deep well	0.5%
- Pumps and other irrigation equipment	3%
- Irrigation network	1%
- Drainage network	3%
- Feeder roads	5%

For operational expenses, there are two important items: energy for the pumping station and manpower for the operation of the pump and the irrigation network. The energy is calculated on the basis of the power of each pumping station and the number of hours it functions per day. The manpower is usually based on a rough estimation depending on experience and the specific situation of each oasis.

Operation and maintenance of the public irrigation schemes are done by carried out Government agencies (OMVPI Gafsa-Jérid and OMVPI Gabès-Médenine).

These two agencies also collect the charges. Usually the water charge has to be paid before receiving the water. In actual practice, the water master of each oasis gets an order to deliver water from the operation service and the order to deliver cannot be given unless the farmer has paid in advance for his water rotation.

The price of the water is subsidized by the Government. The subsidy represents about 50% of the total cost of the operation and maintenance of the irrigation system. However, it is quite difficult to separate the operation and maintenance costs. Generally, there is not a big difference between the estimated

222

operational costs and those actually needed. However, there is a very large difference between the estimated maintenance costs and those really needed. This situation is due to the fact that the operation costs are readily accepted at the budget discussion because they represent real accounts that the Government agency has to pay at the end of each month, whereas the maintenance costs could be postponed to the next year.

The main components of O&M costs for the two Government agencies in charge of the oases for the year 1982 are presented in the following table (the figures are in 1000 dinars):

	Gafsa-Jérid		Gabès-Médenine	
Operation		501		352
- staff	99		124	
- energy	402		228	
Maintenance		121		65
- staff	76		48	
- repairs	45		17	
Total		622		417

The farmers participate in O&M decisions in two ways. They are represented on the agency board where most of the decisions regarding O&M are taken and through the farmer organizations of each oasis. The irrigation schedule is prepared by the agency with the collaboration of the farmers' associations.

Any decision to stop the delivery of water in order to undertake emergency repair work is also taken after consulting with the affected association.

6. CONCLUSION

It has been noticed that, in the case of the oases of southern Tunisia, participation of the farmers in the O&M expenditures is less obvious than it used to be 25 years ago. This is because most of the projects that have been implemented are relatively technically complicated. As a matter of fact, most of the technical studies were made with the objective of reducing the investment cost without taking into account the O&M problems of the project. Moreover, the projects were conceived in such a way that they can only be operated by the Government water agency. As a consequence, the farmers can hardly participate in the operation of these projects.

More attention should be given to the aspects involving the farmers in the preparation of the technical and social studies for public irrigation schemes.

Table 1 PRICE OF ONE CUBIC METRE PER MILLIMES

	At present	Five years ago	Ten years ago
Gafsa-Jérid	10	4	2
Gabès-Médenine	15	8	4
Jendouba	15	10	-
Kairouan	15	10	4
Siliana - le Kef	15	10	-
Medjerda	17	14	6
Nabeul	20	14	4
Kasserine	15	6	4

Table 2 COSTS AND REVENUE FOR ONE HECTARE OF A MODERN DATE PALM PLANTATION

Revenue		3650 Dinars
- dates	3500 Dinars	
- other	150 Dinars	
Production costs		1350 Dinars
- manpower	800 Dinars	
- water	200 Dinars	
- fertilizer	250 Dinars	
- other	100 Dinars	
Net revenue		2300 Dinars
	Which is about 3000 US Dollars	

Irrigation Water Pricing in Zimbabwe

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ABSTRACT

The Zimbabwe Government attaches great importance to irrigation development to enhance and stabilize crop production which is affected considerably by unreliable seasonal rainfall and periodic droughts. Approximately 150 000 ha of crops are irrigated per year. The Ministry of Energy and Water Resources Development (MEWRD) currently supplies 369 10 m of water for irrigation The annual unit cost of supplying water ranges from Z$50 to Z$326 per $10^3 m^3$ for schemes supplied from MEWRD boreholes. For water from MEWRD dams the unit cost ranges from Z$18 to Z$633 per $10^3 m^3$. Government policy up to now has been that commercial farmers and government estates pay water charges that cover capital investment on a historic cost basis amotized at 9.75 percent for 40 years; plus the recurrent cost estimated at 1,0 percent of total capital costs. Due to increasing investment costs, a proposed approach is to charge a uniform blend price throughtout a water region.

Prior to 1983, irrigatiors on public irrigation schemes paid water charges that covered 10-12 percent of the annual O & M cost of a scheme. Capital costs were considered as government grant. Water charges were based on water circulation rotation and crop values. A new payment structure instituted in 1983 was designed to have farmers in the same scheme pay uniform charges based on security of water supply and crop gross margins. A current proposal is to base water charges on average net profitability of the two main crops, maize and beans.

In 1985, the government established a Z$18 million Irrigation Fund to encourage commercial farmers to invest in irrigation development and for the rehabilitation and development of public schemes in the peasant sector.

It is recommended that beneficiaries of irrigation water supplied from public financed water resources must contribute to recovery of initial investment costs and the annual O & M. The water charge has to be uniform for all water users and be based on the farmers' ability to pay.

1. INTRODUCTION

This paper is aimed at discussing the current status of irrigation water pricing in Zimbabwe. This is a timely topic for Zimbabwe which is currently reviewing policies with regard to irrigation development and water pricing. An inter-ministerial sub-committee, the Water Pricing sub-committee, has been deliberating since late 1985 on alternative approached to water pricing. This has been prompted by government's desire to promote irrigation development through public and private investment.

The paper first outlines why irrigation development is important in Zimbabwe. Tne current status of irrigation is outlined, including the farming systems, administrative organisations, water resources availability and use. These discussions are intended to give sufficient background for the reader to understand the rest of the paper. Section 3 examines cost of water resources development while section 4 looks at payment for abstraction of surface and underground water. Policy for financing water resource development are covered in section 5, while section 6 examines policies concerning recovery of operating and maintenance expenses in public schemes. Section 7 discuss incentives for irrigation investment by farmers. Conclusions and recommendations are given in section 8.

2. BACKGROUND INFORMATION

2.1 Importance of Irrigation in Zimbabwe

Irrigation development is essential in Zimbabwe because annual rainfall is generally low, unevenly distributed and unreliable. Only 37 percent of the country received more than 700 mm annual rainfall which varies between 300 mm in the low lying areas to over 1 000 mm on the central water shed. Monthly rainfall reliability is significantly lower than the seasonal total and rainfall reliability decreases in general from north to south of the country.

Total annual rainfall and its distribution vary greatly from year to year and within the country. It is estimated that 75 percent of the country is subject to such conditions that make dryland crop production risky. The country experinces recurrent droughts and in some parts of the country 'mid-season droughts' are permanent features of the rainfall season.

Maize, the staple diet, is very sensitive to drought, while wheat, grown in the cool dry winter months, is entirely dependent on irrigation. Poor rainfall seasons and/or drought conditions affect water availability for winter irrigation. Therefore, with the bulk of agricultural production currently under dryland production, reliance on rainfall introduces elements of food security risk. Irrigation is therefore important for crop production stability. It is used to supplement rainfall in order to offset a late start, or mid-season drought or an early cessation of the main rains thus lengthening the growing season. Irrigation is essential for the growing of vegetable, winter and perennial crops (sugar cane, tea, coffee and citrus)

The Zimbabwe government attaches great importance to irrigation development. The first Five Year National Development Plan, 1986 - 1990, envisages that irrigation will play an important role in the transformation of the rural sector. To encourage irrigation development, the government established a Z$18 million National Farm Irrigation Fund from which farmers will borrow at low interest rate to finance investment in irrigation facilities.

2.2 Current Status of Irrigation in Zimbabwe

2.1 Land Under Irrigation

Zimbabwe has an estimated 151 000 ha under irrigation. These are distributed as follows:

Farming Systems Type	Ha	Percent
Large Scale Commercial Farms	93 000	61.8
Plantations and Estates	30 000	19.9
Commercial Settler	11 500	7.6
ARDA* Estates and Settler Schemes	11 000	7.3
Communal Areas: AGRITEX** Scheme	4 400	2.9
Private	700	0.5
Total	150 600	100

Notes: *ARDA - Agricultural and Rural Development Authority

**AGRITEX - Department of Agricultural Extension and Technical Services

There are two main farming sub-sectors in the country:

i) Large scale commercial farming by farmers on freeholder land title, and

ii) Subsistence and commercial farming by peasant farmers residing in areas designated as Communal Farming Areas.

327

Under the large scale commercial farming sub-sector are individual farmholders, estates and plantations owned by agro-companies. Individual farmholders irrigate from 20 ha to 200 ha. Irrigation is mainly as a supplement to the normal rainfall in order to extend the crop growing season or offset mid-season drought. Method of irrigation is mostly overhead sprinkler irrigation. Crops grown under supplementary irrigation are maize, soyabeans, cotton, groundnuts, tobacco, tea, coffee, citrus and vegetables. wheat and barley are entirely grown under irrigation in winter. Crop yields achieved through irrigation are shown in Table 1.

Estate and plantation irrigation is mostly for sugar cane, cotton, and citrus production mainly in the low lying south eastern part of the country. Both flood and overhead irrigation methods are employed.

State farming including irrigation is run by the Agricultural and Rural Development Authority (ARDA). ARDA run irrigation scheme range from less than 100 ha to over 2 400 ha. Crops grown on commercial basis include cotton, coffee, tea, wheat, barley, rice, beans and tobacco.

ARDA has also the responsibility for developing and managing scheme on which farming families selected from communal areas are allocated plots for purpose of irrigation farming. These are referred to as settler schemes. These range in size from 0.1 to 2 ha per plot. Some ARDA estates have plotholders who are out-growers.

There are some 74 irrigation schemes established in the communal areas between 1912 and 1980, (Blackie, 1984). These are referred to as communal area schemes and range in size from 2 to 400 ha. individual plot sizes vary from 0,5 to 2 ha. A variety of crops is grown including maize, cotton, wheat, beans, vegetables and others. Production is either for subsistence or marketing. The levels of production and irrigation efficiency range from good to very poor. These schemes are under the supervision of the extension department, AGRITEX. Irrigation method is mostly flood irrigation.

This paper will refer to ARDA, settler and communal schemes as public irrigation schemes. Irrigation by large scale commercial farming units will be referred to as private irrigation.

2.3 Adminstrative Institutions Involved in Irrigation

Several different institutions are involved in irrigation development and management.

328

i) Department of Water Resources Development, in the Ministry of Energy and Water Resources Development (MEWRD), is responsible for all water resources development for urban domestic and industrial water use and irrigation water and water supply in rural areas. The department is responsible for dam siting and construction, and borehole drilling. MEWRD dams supply water to commercial farmers and also to field edge for Communal Areas Irrigation schemes.

ii) The irrigation Branch in the Department of Agricultural Extension and Technical Services (AGRITEX) has several roles

a) Overall responsibility over irrigation development
b) Planning and designing irrigation schemes
c) Training and extension of all farmers involved in irrigation
d) Has overall responsibility over irrigation schemes in communal areas (i.e. non-ARDA schemes).

iii) The Agricultural and Rural Development Authority (ARDA), a parastatal in the Ministry of Land, Agriculture and Rural Resettlement is responsible for the state irrigation schemes and for development and management of settler irrigation schemes.

iv) The Regional Water Authority

The function of this body is to operate and distribute water from two major dams in the eastern part of the country.

In principle the activities of the different organisation are co-ordinated by an inter-ministerial committee, the Irrigation Liaison Committee. The committee gives general policy guidelines for irrigation development, though it does not have executive powers.

v) Water Users' Associations

At the field level, on public schemes, plotholders elect an Irrigation Management Committee. This functions as a water users' association by liaison and assisting in the management of the irrigation schemes. Emphasis is on water use discipline.

229

2.4 Legislation

Legislation, the Water Act, exists for the control and regulations of surface water use and its distribution. For irrigation purposes distinctions are made with regard to sources of water for irrigation. Stored water refers to water impounded from riverflow. Agreement water referes to water abstracted from public financed dams. The other distinction is underground water. Riparian owners must obtain a water right before they can abstract or impound water from a river for irrigation uses. The water right grants permission to abstract a given quantity of water per year. Water rights are granted by the Adminstrative Court - formerly there was a water court for the purpose.

2.5 Water Resources and Use for Irrigation

Estimates of the surface water resources availability and current utilization in Zimbabwe are (Mitchell, 1986):

Total Surface water run-off per annum	20 000 $10^6 m^3$
Potential water that can be developed after losses	9 580 $10^6 m^3$
Present consumptive use	2 660 $10^6 m^3$
Balance available	6 920 $10^6 m^3$

Twenty-eight percent of the potential water available is presently being used. Development of the remaining seventy-two percent is becoming difficult and costly since the more accessible and economic dam sites have already been constructed.

The Ministry of Energy and Water Resources Development supplies 743 10 m per year of water for all purposes made up as follows:

	$10^6 m^3$
Mining, Towns and Urban Authorities	374
Large Sclae Commercial Farming	136
ARDA, Communal Area Schemes, RWA	233
TOTAL	743

RWA = Regional Water Authority

3. COST OF WATER RESOURCES DEVELOPMENT

The government finances all public water resources development. Estates and large scale farmers have in the past financed large scale irrigation dams through consortiums or as part of on-farm investment.

330

3.1 Annual Unit Cost of Supplying Water

The theoretical unit costs of producing water, estimated using average figures for dam size, dam construction costs and borehole drilling costs as at March, 1986 are:

Annual Unit Cost of Supplying Water to Field Edge (or Town Edge):

	Z$ per 10^3 m^3
Borehole with handpump	160.00
+ labour	326.00

	Z$ per 10^3 m^3
Medium borehole scheme:	
2 x 7,5 m /hr - diesel powered	237.00
Large borehole scheme:	
4 x 1 000 m /hr - diesel powered	61.00
electrical	50.00

Dams:

Dam Capacity 10^6 m^3	Storage Ratio	Z$ per 10^3 m^3
0.1	1.0	633
0.1	0.1	112
1	0.1	50
10	1.0	75
10	0.1	25
100	1.0	35
1 000	1.0	18

(Source: Mitchell, 1986).

The per unit cost include capital recovery and operations and maintenance costs of the capital works (i.e dam or borehole construction, conveyance structures and pumping equipment). Annual capital costs are amortized at 9.75 percent per year over 40 years which is approximately 10 per cent of initial outlay.

3.2 Recurrent Costs

Recurrent costs (operation and maintenance costs) of the capital works (i.e dams, boreholes, machinery and conveyance structures) are estimated to be as follows:

		Per Cent of Capital Cost/Year
1)	Maintenance cost	0.5
2)	Pumping costs (diesel and electricity) }	
3)	Transport and wages (of water Balliff and General workers) }	0.5
	Total O&M costs	1.0

4. PAYMENT FOR ABSTRACTION OF SURFACE AND GROUNDWATER

4.1 In the Private Commercial Farming Sector

For riparian owners the payment for abstracting or impounding riverflow water is the application fee for the water right. Since the water right is granted to the farm or physical land and not the individual farmer for as long as there is no infringement on the right, it means the application fee is a one time payment. There is no payment for underground water which is regarded as non-public water.

Application Fees for Water Right to Abstract Surface Water

	Z$
Application for use of public water for irrigation	10.50
Application for apportionment or allocation of scheduled irrigable area	10.50
Application for apportionment or allocation on sub-division of land	10.50
Application for revision of water right	10.50
Application for extension of time	6.50
Application for use of some farm's water right	21.00

These charges have been in existence at the above levels for at least the past 15 years.

4.2 In the Communal Areas

Water rights are invested in the community and held in trust in the name of the Minister of Energy and Water Resources Development. Any individual or organisation wishing to abstract water for a private irrigation scheme must apply to the Ministry through the local administrative structures, e.g. District Administrator. However, there is an anomaly with the large scale commercial sub-sector. Communal area farmers on some public irrigation schemes using water abstracted from flowing rivers pay water charges higher that the water right application fee paid by their counterparts in the commercial subsector.

5. POLICIES WITH REGARD TO FINANCING OF PUBLIC WATER RESOURCE DEVELOPMENT

It is government policy that all water consumers pay for the capital and operating and maintenance costs of water supplies. Urban and industrial consumers purchase their water through the urban and local authorities. Farmers purchase water on individual basis.

5.1 Capital and O & M Costs Recovery in Public Schemes

Until recently capital, operating and maintenance costs for supplying water to public irrigation schemes have been regarded as a government grant or subsidy with no attempt to recover any of these costs from irrigators. The justification has been that most plotholders would not afford to pay for the water. Moreover, irrigation development in Communal Areas was seen as a social investment for rural development and income distribution. Exceptions, however, were plot holders who had purchased their plot but still drew water from the public scheme and plotholders on ARDA co-estate irrigation schemes. These were expected to pay for water at the total per unit cost of supplying water to the schemes.

It is planned that in future all farmers are to pay the total costs so as to reduce government subsidies.

5.2 Cost Recovery From Private Commercial Farmers using Water drawn from Public Dams

For the large scale commercial farmers, government policy have been that they pay a fee that covers capital investment on a historic cost basis plus the recurrent costs (operating and maintenance costs) of government financed water supplies. The water charge, for water supplied from MEWRD dam, was calculated as follows:

$$\text{Water Charge} = \frac{\text{Amortized Capital Costs* + O \& M of dam and conveyance*}}{\text{Total Water Available for Supply to all Consumers}}$$

Notes * Capital Costs amortized at:

(i) 9.75 %/year for 40 years for dams and

(ii) 9.75 %/year for 10 - 15 years for pumps and other equipment.

This method for calculating recovery costs has been used by MEWRD effectively until recently when new major dams have been constructed up to 40 years ago have been paying from Z$2.000 to Z$8.00 per $10^3 m^3$. Costs of these old projects were initially low and some have been fully depreciated. Therefore, water charges have been low, mostly made up of O & M. New dams commissioned since 1980 have introduced anomalies. This is as a result of high construction costs. For example per unit cost of water from recently constructed dams range from Z$15.00 per $10^3 m^3$ to Z$66 per 10 m per annum respectively. If the principle of having farmers pay for capital and O & M costs is maintened, it means some farmers would be paying very little (those utilizing older water schemes) while other utilizing newer water schemes would be paying high rates.

It was deemed unjustifiable to set different rates for new and high costs water projects. A stage was reached where ther MEWRD was having difficulties selling water to farmers for irrigation. Furthermore since the late 1970s there was little invest in irrigation by commercial farmers as irrigation became less viable.

5.2.1 Uniform Water Price Proposal

In 1985, the Irrigation Liaison Committee established a sub-committee, the Water Pricing Sub-Committee, to review the situation and make recommendations on how to price water without anomolies. The sub-committee has proposed that a uniform price be levied for water. This would be a blend price calculated as follows:

Blend Price = Per unit cost of Water = Summation of Amortized Capital and O & M costs for all Existing Public Constructed Dams / Summation of live yield of water from all existing Public Constructed Dams.

Using this formula a blend price of Z$11.00 per $10^3 m^3$ as unit cost of water was obtained. This is to be paid by all farmers irrespective of their location in the country and irrespective of the actual cost of supplying water to them from a given water project.

A further suggestion is that there be a differential blend price payable by farmers who use water for full irrigation and those who need it for supplementary irrigation purposes only. The latter are mostly in the high rainfall areas located in natural regions I and II. The former are in the drier part of the country (natural regions III, IV and V. The rationale for a differntial blend price is that farmers in the high rainfall areas use less water and therefore it costs less per total amount used for a given crop per season compared to those who need water for full irrigation. It is therefore, suggested that the country be divided into two water regions for the purposes of differential irrigation water pricing:

a) Water Region A is that part of the country with rainfall greater than 750mm per annum. This is mostly in natural regions I and II. The blend price for this region is Z$12.00 per 10 m per year.

b) Water Region B is mostly natural regions III, IV and V or those areas of the country with annual rainfall lower than 750 mm. The blend price is Z$10.00 per 10^3 m^3 per year.

For practical reasons, it has been decided tnat Water Region A be those farming areas that draw water for irrigation from the Manyame and Mazowe Rivers. The two rivers, located in the northen part of the country, are the major irrigation rivers. The rivers run through the part of the country with annual rainfall in the region of 750 mm and above.

Water Region B is the rest of the country.

It is being suggested that sugar cane be exempted. Sugar can grown in the low veld, the drier part of the country, is entirely dependent on irrigation. Most water used is from dams constructed 20 to 40 years ago. It is viewed that charging a higher water price would offset the economics of sugar production.

5.2.2 Problems with the above methodology

Problems arising are:

i) For new dams being or to be constructed, investment costs are such that it will not be possible to supply water at less than Z$30/$10^3$ m^3. This means that each time a new dam is commissioned the cost of water (blend price) goes up. The amount of increase depends on the size and water yield of the new dam. For example the Mazvikadei Dam, presently under construction for Z$25 million, will supply 100 10·m per year at a cost of Z$30 per 10^3 m^3 per year when completed in 1988. It will affect the blend price as follows:

	Water Supply $10^3 m^3$	Unit Cost of Water Z$		Total Cost Z$
Current	369	11.00	=	4 059
Mazvikadei	100	30.00	=	3 000
	469			7 059

New Blend Price = 7 059 / 469 = Z$15.05

The ability of farmers to absorb increasing water cost is being studied by the Ministry of Lands, Agriculture and Rural Resettlement. The government is wary of a situation of increasing irrigation costs for farmers. Apart from discouraging farmers from investing in irrigation it puts the government into two conflicting situations. First, government may have to subsidise irrigation costs. This is unacceptable since the government is trying to reduce subsidies. Secondly, the government will be pressured to raise crop prices to maintain farm viability. This is not a preferred alternative as it has adverse effect on consumer prices.

ii) The second problem is one of cross-subsidization. In a given water region, the water rate would be equal no matter what the actual cost of supplying water to the individual irrigation scheme or farm. This means that there is going to be an element of cross-subdization among irrigation schemes or farms. Cross-subsidization may also occur between the two proposed water regions.

An assessment therefore, needs to be conducted to determine the level of cross-subsidization which may introduce conflicts among users.

6. POLICIES WITH REGARD TO O & M EXPENDITURE WITHIN PUBLIC IRRIGATION SCHEMES

This section refers to irrigation schemes in communal areas and settler irrigation scheme managed by ARDA.

6.1 Prior to 1980/81

Up to 1980/81, irrigators paid the following water charges based on water circulation rotation, value of crops grown and on whether the whole scheme or part thereof was lined or not (Zimbabwe Government, 1983):

Frequency of Water Circulation	Water Rates Per Hectare		
	Crop Growing All Year	Summer Crop Only	Winter Crop Only
	$	$	$
10 days less	70	40	30
Between 10 and 14 days	35	20	15
15 days or more	6	6	6

The water charges were paid in cash and in advance on July 1 of each financial year. The charges were collected by the managing agent of a scheme. The charges were calculated to recoup 10 - 12 percent of the annual O & M costs of the scheme. The remainder was subsidised by government. Operating and maintenance costs were made up of salaries and wages of extension workers, water balif, irrigation managers, maintenance of pumping equipment and canals, etc. These varied with schemes.

Capital redemption for the initial investment costs were not incorporated in the charges. These were regarded as government grants. The rationale was that the irrigators would not afford to pay the economic rate for water which was calculated at between Z$50/$10^3$ m^3 to Z$80/$10^3$ m^3.

The annual recurrent budget for O & M costs of schemes in communal areas was estimated at above Z$1 million (1984 figures). Operating and maintenance costs range from Z$153 to Z$738 per hectare according to irrigation and pumping method (Table 2). That ARDA and communal areas scheme have high O & M costs per hectare (Table 3). This is a reflection of the size of public paid personnel involved in irrigation management and extension at the scheme level.

6.1.1 Problems Arising out of the above Methodology

The following problems were encountered:

i) For some schemes, farmers in the same scheme paid different amount of water charges. This arose from the fact that parts of the scheme fell into different categories in terms of water circulation frequency. There were also cases of arbitrary decisions in the amount levied on individual farmers in a given scheme.

For some schemes, water supply was unreliable resulting in farmers not getting enough water when their irrigation turn came, yet they had paid in advance.

331

ii) The differential rates paid and unreliable water supply encouraged malpractices such as illegal abstraction upstream of weirs and canals; water piracy; and over irrigation.

6.2 1983 to 1986

In 1983 the then Department of Rural Development proposed a new payment structure for O & M recovery. The overal objective for the new rates were (Zimbabwe Government, 1983):

i) to improve discipline among irrigators and change attitude towards a limited natural resource,

ii) to provide an incentive for increased production, .

iii) to raise the proportion contributed by irrigators to running costs to between 20 and 25 percent so as to reduce government subsidies, and

iv) to remove the anomaly whereby farmers in the same scheme paid different water charges.

The new payment structure was based on the gross margin principle and took into account the security of water supply to the scheme:

Nature of Water Supply	Rate	Water Charges/ha/year Full year Crop Growing	Summer Crop Only	Winter Crop Only
		$	$	$
Assured Water Supply	A	145	90	55
Periodic shortages Experienced	A	72	45	30
On Sand Abstraction Scheme*	C	30	30	30

*also applied to schemes allowing growing of one crop per year only.

Irrigators in the same scheme were to pay the same rate. The basis for calculating the water charges though based on the ability to pay was literally arbitrary. Gross margin budgets for the various crops and/or crop combinations were developed and a figure for water charges was thrown in. This figure was raised by arbitrary amounts to determine how irrigation costs affected enterprise profitability. Calculations stopped at $145 per ha per year.

An exception was made for those schemes considered to be high risk, mostly located in the drier parts of the country (South-east and South-west). These are mostly sand abstraction schemes. A five day reticulation system is essential and mechanical pumping failure would result in 20 percent or more crop loss. Some of these schemes are in remote and inaccessible parts of the country. They have therefore limited markets for their produce. The recommendation was that such schemes be subsidised to a greater extent.

The Z$145 per ha per year was not an economic rate, neither does it cover all the O & M costs. It was assessed that small scale scheme irrigators were in no position to pay an economic rate due to the following factors:

i) Most crops grown are not high value crops and therefore, do not generate sufficient income to cover a greater portion of O & M costs,

ii) Size of holdings are small (0,1 ha to 1,0 ha) thereby restricting crop choice, and

iii) Some schemes being far from markets, transport costs prohibit production of marketable crops, eg green vegetables, tomatoes, green maize etc. As a result irrigatiors concentrate on subsistence crops whos surpluses would be sold locally.

6.2.1 Current Proposals

The Water Pricing sub-committee has proposed the following:

i) To maintain the gross margin concept for calculating water charges.

ii) To incorporate the opportunity cost of labour at either Z$103 per month being the lowest minimum wage in the urban sector or Z$153 per month being the minimum wage for general workers in the agro-industry, e.g processing factory, sugar, tea and citrus plantations.

iii) To base calculation of the final figure on the average net farm profitability of a group of irrigators growing a set of common crops:

$$\text{Net Profitability} = \frac{\text{Average Farm Profitability For average Farms} + \text{Average Farm Profitability For Better Farms}}{2}$$

139

iv) Final payable figure for water charges to be arrived at by sensitivity analysis.

Main crops considered at the moment are maize and beans. Such crops as vegetables, green maize and fruit will be considered once a methodoloty on how to handle them is established. Data available on level of production of these crops is unreliable. Marketing is also a problem.

6.2.2 Possible Problems

Problems foreseen with the suggested methodology include:

i) Updating of water cost in an environment of increasing input costs and changing crop prices,

ii) Having farmers accept increase charges each year or when they occur, and

iii) In some schemes, the cropping pattern on which the gross margin budgets are based are not those actually practised.

6.3 Farmers Ability to Pay

The gross margin principle is preferred because it provides a framework for evaluating farmers ability to pay. When water charges were raised to Z$145/ha, the justification was that irrigators were capable of paying. This was assessed from the fact that irrigators were capable of earning net income between Z$1 200/ha and Z$2 000/ha per year or season (Table 4). This was estimated to be twice the net farm income under dryland cropping.

The gross margin calculations took into acount all input costs other than the opportunity cost of labour. It is only now that attempts are being made to incorporate opportunity labour costs. The rationale is that earnings in the irrigation schemes should at least be greater that or equal to government determined minimum wages.

Prices of the main crops are controlled by government which also sanctions increase of input prices. Therefore the issue of maintenance charges is of concern to government. At the current moment government is anxious to reduce the level of subsidies to the agricultural industry. It would welcome reduction in government contribution to O & M within the irrigation schemes.

7. INCENTIVES AND FINANCING OF IRRIGATION INVESTMENT IN PRIVATE SCHEMES OR FARMS

It is estimated that the capital cost for installing an irrigation system on a farm is Z$127.36 per 1 000 m^3 of water (for storage, pumps and supply lines). The annual irrigation cost is estimated at Z$20.05 per $10^3 m^3$ per ha (AGRITEX, 1986). As with public water works debt servicing constitutes the major portion of the initial outlay while energy costs form the greater proportion of annual irrigation costs. All these create disincentives for farmers in irrigation development.

In 1985, the government established a National Farm Irrigation Fund (NFIF) to encourage farmers in all subsectors to invest in irrigation development on their properties. The fund is worth Z$18 million of which Z$12 million is earmarked for the large scale commercial farmers and Z$6 million is for rehabilitation and development of smallholder irrigation schemes in Communal Areas. Farmers borrow from the fund at 9.5 percent per year interest rate, This is 50 percent lower than the interest rate charged by commercial banks for irrigation finance.

A proviso by government at the moment is that the large scale commercial farmers, who make use of the Fund, allocate water use to wheat irrigation. This is aimed at increasing wheat production in order to reduce wheat imports.

It is expected that in future smallholder farmers in public schemes in communal areas would borrow from the Fund to construct on-farm works.

8. CONCLUSION AND RECOMMENDATIONS

Investment in irrigation development is costly. In Zimbabwe, it costs between Z$15 and Z$100 per 1 000 m^3 to supply water from dams recently constructed or to be constructed. The government's desire is that farmers and users of water pay the full cost of water to cover initial outlay and operating and maintenance costs. In addition farmers pay operating and maintenance for on-farm irrigation facilities. Irrigation investment by farmers and government in public irrigation schemes is therefore, unattractive. This has promoted government to review irrigation development policy, examine water pricing policy and establish a national irrigation fund.

There is dilemma regarding how much of the cost of irrigation is desirable or possible to recover from the farmers. Conflict arises from the need to have beneficiaries contribute to recovery of initial and O & M costs. The charge should be large enough so that the irrigation system is self-financing but small enough so that farmers have the ability to pay it.

From Zimbabwe's experience, the recommendations for tackling the dilemma are:

i) Beneficiaries must contribute to recovery of water resources development costs, including the operating and maintenance costs. Therefore, water charges must be fixed at a level sufficient to cover these costs.

ii) The rate should encourage economics in water use but should not act as a disincentive to farmers to use or invest in irrigation. Therefore, water charges have to be related to farmers' ability or capacity to pay.

iii) A uniform rate should be levied for all water users with subsidies for those farmers in irrigation schemes that need government support to be viable.

iv) Appropriate level of water charges in public schemes should be based on a certain percentage of the gross value of the farmers' increased production attributed to irrigation.

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342

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343

TABLE 1

APPENDIX

Zimbabwe: Average Dryland and Irrigated Crop Yields, 1970 - 1979

(kg/ha)

	Communal Farming Areas		Commercial Farming Areas	
Crop	Irrigated	Dryland	Irrigated	Dryland
Maize	5 494	656	7 000	4 732
Wheat	2 256	–	4 700	–
Cotton	1 887	822	3 500	1 650
Groundnuts	1 687	581	2 500	1 710
Sorghum	2 020	516	2 700	1 854
Soyabeans	2 036	n/a	2 000	1 601
Potatoes	4 183	n/a	30 000	n/a
Beans	1 200	800	n/a	n/a

Notes: 1) n/a = not available

2) There is no dryland wheat production

(Source: Central Statistical Office, 1970 - 1979)

TABLE 2

Operating and Maintenance Costs per Type of Scheme, 1984, Zimbabwe

(Per Hectare)

Type of Scheme	Z$
a) Gravity with no pumping	153
b) Pumping from source then gravity	384
c) Pumping from source then sprinkler	462
d) Sand Abstraction then gravity	738

(Source: Kukuni, 1984)

TABLE 3

Average Operating and Maintenance On Various Irrigation Schemes, 1984

(Per Hectare)

Scheme	Z$
ARDA Schemes	10 000 - 15 000
Communal Schemes	271
Commercial Farming Unit	145

(Source: Rukuni, 1984)

344

APPENDIX

TABLE 4

Returns and Costs of Summer and Winter Irrigated Crops
at Sanyati Irrigation Scheme, 1984/85, Zimbabwe

(Per Hectare)

	Summer	Winter	
	Cotton	**Maize**	**Wheat**
Yield kg/ha	2 520	5 494	3 330
	Z$	**Z$**	**Z$**
GROSS OUTPUT	1 890	989	942
CASH COSTS			
Land Preparation	72	32	57
Seed	5	20	55
Fertilizer	190	216	289
Insecticides	99	-	-
Water Charges	90	55	55
Hired Labour	10	-	-
Marketing	2	1	74
Other	46	41	32
Total Cash Costs	514	365	562
Gros Margin	1 376	624	380
Average Area (ha)	0,65	0,65	0,65
Crop Gross Margin (Z$)	894	406	247

Whole Farm Gross Margin	
Summer Crops	Z$ 894
Winter Crops	653
Farm Gross Margin	1 547

Notes: See Table 5

(Source: AGRITEX Farm Management Data)

345

APPENDIX

TABLE 5

Returns and Costs of the Main Irrigated Crops on Large Scale Commercial Farming Units, Zimbabwe, 1984 - 1985

(Per Hectare)

	Cotton	Maize	Wheat
Yield (Kg/ha)	3 000	6 500	4 700
	Z$	Z$	Z$
GROSS OUTPUT	2 250	1 170	1 330
VARIABLE COSTS			
Labour	167	68	62
Fuel	148	131	130
Seed	27	36	56
Fertilizer	245	292	386
Herbicides	57	28	21
Insectcides	132	28	5
Insurance	3	6	84
Irrigation	91	101	150
Harvesting & Marketing	377	218	158
Other	27	18	20
Total Variable Costs	1 274	926	1 072
GROSS MARGIN	976	244	258

Notes:

	Cotton Z$	Maize Z$	Wheat Z$
Price	0.75kg	180/tonne	283/tonne
Irrigation Water (10^3 m^3 /ha)	4.5	5.0	7.5
Water cost/10^3 m^3	20.25	20.25	20.25

(Source: AGRITEX Farm Management Data 1986).

APPENDIX

TABLE 6

Zimbabwe: Public Irrigation Scheme Development Costs
(1984 Estimates for Mushandike Settler Irrigation Scheme).

(Per Hectare)

	Z$
A. WATER SUPPLY	
Main Canal Lining	408
Secondary Canal Lining	41
Sub Total	449
B. IN-FIELD COSTS	
Tertiary Canals	1 423
Canal Gates	16
Canal Formers and templates	5
Measuring Flumes	1
Roads	6
Access Road Bridges	1
Fencing	25
Demarcation	18
Land Preparation	36
Blair Toilets	8
Sub Total	1 539
C. SERVICE DEVELOPMENT COSTS	
School Buildings	318
Irrigation Officer's House	25
Clerical Assistant's House	11
Extension Worker's House	22
Water Guard's Housing	44
Telephone Installation	2
Administrative Centre	82
Sub Total	504
D. CONTIGENCIES (PRICE PLANNING AND PHYSICAL - 10%)	249
Total Development Costs (A + B + C + D)	2 741

(Source: Rukuni, 1984)

IRRIGATION WATER CHARGES - CYPRUS

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ABSTRACT

Irrigation water charge in Cyprus is becoming a very important aspect of the water resources development because water is both very expensive and very precious. Due to this a charge has to be fixed for financial and economic reason such that:

(a) For financial reasons, enough money has to be raised to pay the cost (or part of the cost) of the operation, maintenance and management, of the work and to pay for the capital cost, the interest on capital and insurance costs, incurred for providing the water to the consumer.

(b) For economic reason, so that it will encourage the consumers to use the irrigation water with the most efficient and productive ways thus achieving the objectives of the project and avoid wastefull use of it.

Based on the above two conditions, aiming at optimum utilization of the available water resources, certain procedures, guidelines and criteria have been adopted for fixing the water charges taking into consideration the irrigators interests and the economic and financial requirements. Because the cost of the irrigation water in Cyprus is comparatively high a subsidy ranging from 35% to 100% of the water cost is allowed by the Law, giving great flexibility to the Government to fix different charges for different projects according to the criteria. The procedure for water charge fixing for the Government Waterworks is very slow and tedious since the proposed charges must be approved by the Council of Ministers and ratified by the House of Representatives.

The charge collection is another issue which presents some problems related to the timely collection of the charges. The existing procedure although considered satisfactory for some time now and for some projects, is now proving unsatisfactory and the proposed revisions must be adopted to enable the project authorities to collect all the charges and in time.

The problems related to the water charge fixing procedure and the charges collection along with other administrative and legal aspects related with the management of the water resources are expected to be overcome by the creation of a Water Entity now under consideration by the Government of Cyprus.

1. BACKGROUND INFORMATION

1.1 General

Cyprus is the third largest island in the Mediterranean sea, with an area of 9250 square kilometers, situated in the north-eastern end of the East Mediterranean sea. The topography of the country is marked by the presence of two mountainous regions, the northern sedimentary range along the north coast which rises up to 1000 m avove mean sea level, and the other in the southeastern part of the island which rises up to 2000 m above mean sea level. Between these two ranges is the main agricultural plain, between Morphou bay in the west and Famagusta bay in the east, known as the Mesaoria plain with a total area around 259,000 Ha. Other good agricultural lands are situated on the coastal areas which are mostly flat and situated at elevations less than 200 m above mean sea level.

1.2 Land use in Cyprus

According to the land use map of Cyprus which was prepared in 1975 the land use of Cyprus is classified into six categories as shown on table 1.

Table 1 LAND USE CATEGORIES IN CYPRUS

Categ. No	Land Use Category	Area (Ha)	Percentage
1	Cultivated land	424,110	45.83
2	Carob land (not cultivated)	69,000	7.46
3	Forest (Main)	116,000	12.54
4	Scrub (low density)	142,140	15.36
5	Barren uncultivated land	110,000	11.89
6	Built up areas	64,000	6.92
	Total	925,150	100.00

From the Table it is seen that of the total area 424,010 Ha or 45.83 percent of the total area is cultivated land (this category includes all irrigated and dry farming land). From this cultivated land 43,610 Ha i.e 10.29 percent of the total cultivated land or 3.87 percent of the total area of the island is under systematic irrigation while another 18,000 Ha are under spate-irrigation (direct irrigation from inundation of river flows which takes place in the wet months), where the rest is under rainfed irrigation. Table 2 shows a summary of the use of the cultivated land by crop, area and percentage. The figures refer to the year 1979 and cover all of the Cyprus area.

1.3 Climate

The climate of the island is of the typical meditterranean type with mild and rainy winters and hot dry summers. Temperatures reach an average minimum of 9 C in December, being the coldest month of the year,

7349

and an average maximum of 35 C in August being the hottest month. Average annual rainfall is around 500 mm, 80% of which falls between the months of November through April. Though precipitation increases with altitute most of the cultivated land is found in the low rainfall zone, lying about 200 m above mean sea level. The country faces a severe draught once every ten years and a moderate one once every three years. Sunshine is abundant during the whole year, air humidity is slightly low most of the time with very low values at mid-day in the central plains and the winds are generally mild to moderate with variable direction.

Table 2 CULTIVATED LAND USE BY CROP

Item	Category/Crop	Area (Ha)	Percent of Total Irrigated	Percent of Cultivated
I	Irrigated Land			
1.1	Citrus	16,240	37.24	3.83
1.2	Avocados	50	0.11	0.01
1.3	Deciduous fruit	5,485	12.88	1.29
1.4	Deciduous stones	435	0.79	0.08
1.5	Table grapes	3,010	6.90	0.71
1.6	Bananas	284	0.65	0.07
1.7	Vegetables	16,811	38.55	3.96
1.8	Industrial	185	0.42	0.04
1.9	Fodder crops	1,200	2.76	0.29
	Total Irrigated	43,610	100.00	10.29
II	Spate Irrigation Land	18,000	--	4.24
III	Rainfed Land			
	Vines, Cereals, Carobs, Olives, Almonds, etc.	362,400	--	85.47
	Total Cultivated Land	424,010	--	100.00

1.4 Population

Total population of the country in 1973[1] was 634,000 or 68 persons per square kilometer, of which 57.8% was living in rural areas and 42.2% in urban aıeas. In the same year employment in agriculture amounted to 40.3%.

1.5 Water Resources

Available water resources of the island are exclusively dependent on rainfall plus any recycled water from domestic effluent or desalinated water. From the total quantity of 4,600 million cubic meters of water that fall on the island, 350 million cubic meters are disposed as groundwater, 600 million cubic meters are disposed as surface runof where the remaining, is lost as evaporation and evaportranspiration. Of the groundwater available all the quantity is pumped for irrigation and domestic water supply where from the surface water 100 million cubic meters are intercepted and stored in the dams mainly for irrigation and to a small extend for domestic water supply.

Cuprus is made up of 39 watersheds in all and has no perennial rivers, i.e. any water that has to be used for summer consumption has to be stored during the winter months, hence the large number of dams on the island. The groundwater being at present the major source of water is pumped by thousands of privately owned shallow wells and deep boreholes, dugged or drilled in the major aquifers of the island.

1.6 Irrigated Crops and Types of Irrigation

Agriculture has always been one of the most important sectors of the economy of the island. The average annual contribution to the GDP for the two years period 1971-72 was 18.7% being the primary sector but in the period 1981-82 the contribution reduced to 10%, due to the Turkish Invasion which brought a serious setback to the agricultural sector.

Although the agriculturally cultivated land comprise around 45.83% of the total area of the island the irrigated land is only a very small portion (see Tables 1 and 2) this being mainly due to the shortage of the water resources.

As it is seen from Table 2 the irrigated land is cultivated by a variety of permanent and annual crops whose water requirements are high, where the majority of the remaining cultivated land is rainfed and planted mostly with cereals, vines, carobs, olives and almond.

Irrigated agriculture in the island has been practiced for over 2000 years and the irrigation practices in the past have been very inefficient. However, the irrigation systems now used Cyprus are characterised as improved with high application efficiencies and their adaptation emphasizes the scarcity and value of the irrigation water. Such methods are the drip system, the mini sprinkler, the sprinkler, the hose basin and some other methods less efficient. The choice of the irrigation methods is based on a) the source of irrigation water, b) the flow rate available, c) the type of crop, d) the soil characteristics, e) the pressure available, f) the climatic conditions, and g) other economic and social factors.

2. WATER LESGISLATION AND GOVERNMENT POLICIES FOR THE RECOVERY OF IRRIGATION INVESTMENT

2.1 Water Laws, water policies and water administration

As many as a dozen or more major laws enacted through a period of 50 years and over, form what is today the water legislation of the country. These are the Laws that were passed on to the new Republic in 1960 by the British Colonial. Accoriding to the laws legal authority on water matters as it appear on Figure 1 is divided over many Ministries where administration is spread over a wide spectrum of government departrmnts. As is seen from the chart of figure 1, four Ministries are in some way or another involved in policy making where the major roles are carried out by two Ministries, the Ministry of Agriculture and Natural Resources which shoulder the responsibility for the overall policy on water matters and the Ministry of Interior which is responsible for the application and administration of the water laws. This complex situation is made still worse by the existence on most rivers and streams of numerous private water rights which are recognized by law and the constitution as private property.

The main water laws associated with the development and utilization of irrigation water are the following:

- Irrigation Division Law: This deals with the formation of an Irrigation Division by at least ten (10) proprietors, (owners of land) for the purpose of constructing, operating, improving, maintaining or repairing irrigation works and/or for the protection of their water resources or their water rights. The water resources, according to the law, are allocated (belong) to the land and not to the proprietor.

- Irrigation Association Low: This law provides for the formation of an Irrigation Association by at least seven (7) proprietors (owners of water) for the same purposes as the Irrigaiton Division. In this case the water belongs to the proprietor and not to the land.

- Wells Law: This law gives the power to the Government to control the sinking or construction, widening, deepening, or cleaning of a well or borehole and for imposing conditions as to the use of wells and/or boreholes.

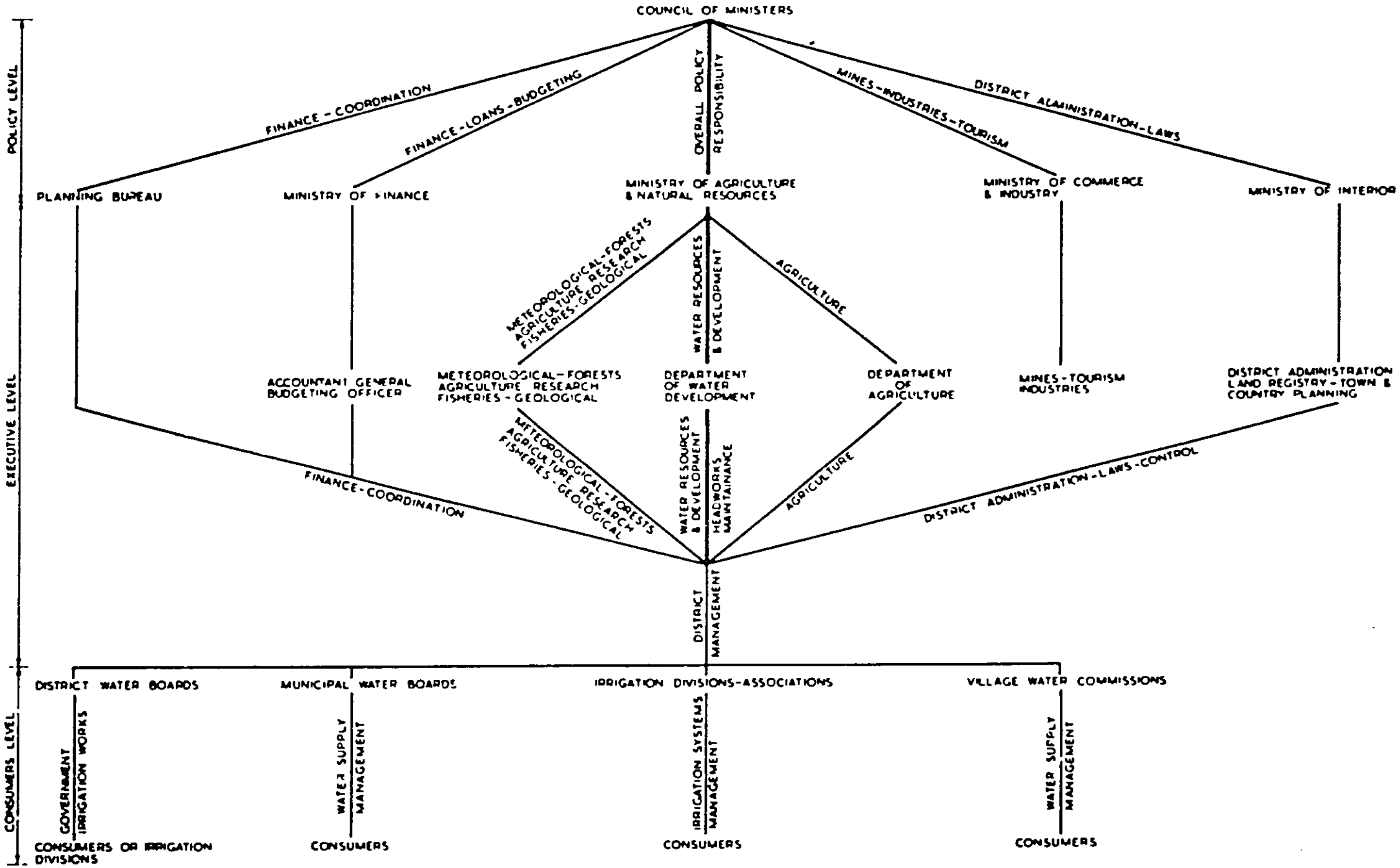
- Water Development Law: This Law gives the power to the Government to declare certain regions as Water Development Areas for the conservation and better use of water resources in the same area or for the effective execution of an island wide policy relating to water.

- Government Waterworks Law: This vests in Government all underground water, all water running to waste from any river spring or watercourse and all other waste waters. It also provides for the determination of water rights and gives to the Government power to plan, design, construct, maintain, operate and manage any water project. The Law became effective in 1929.

- Public Rivers Protection Law: This Law gives the power to the Governmment to declare any public river or portion of a public river to be protected against damages to banks, removal or carrying away of gravel, sand, soil or other material from any river and the dumping of any rubbish or other refuge in the river.

- Groundwater Special Measures Law: This Law was enacted in the late sixties and gives more power to the Government for enforcing measures towards better control of the extraction of groundwater and the efficient use of it.

-135



WATER DEVELOPMENT - ORGANIZATION CHART

Figure I

2.2 Public Irrigation Works Investment

For the optimum exploitation and beneficial use of the scarse and valuable water resources and for maximizing the benefit from its use and for making possible the expensive irrigation projects the irrigation development in Cyprus is taking the form of Public Works whose construction is undertaken by the Government. Private irrigation is practiced only from individual shallow or deep wells and from private small springs whereas, where big money investments are required such projects are built by the Government in accordance with one of the two main Laws, the Government Waterworks Law, or the Irrigation Division Law.

Funds for financing the public and village projects are appropriated from the Government Development Budget and ultimately come from tax revenues or borrowing from other national or international lending agencies such as the World Bank, the Kuwait Fund, etc., which add to the national debts. The cost sharing practice divides the burden for this cost between the benificiaries and a subsidy from the tax payer and the portion of the fund to be repayed by the beneficiaries and the method of repayment depends on the policy of the Government and of the legal status of the Project (Government or Irrigation Division Law Project).

i. Irrigation Division Law - Small Projects (Village Projects). This law gives the power to a group of at least ten (10) land owners, with the consent of the Government, to form an Irrigation Division with the purpose of constructing, operating, imporving maintaining or rehabilitating of irrigation works, or for the protection of their water rights. This law is applicable to surface or groundwater and it is used for the construction of <u>usually small irrigation projects</u> for one or more communities. The Irrigation Division Members elect an Irrigation Committee which undertakes to carry out the objectives and purposes of the Division including the operation, maintenance and management of the projects, the receipt of loans and collection of water charges or other charges for the purposes of the Division. The Committee may appoint any person for carrying out the tasks of the Committee.

   Projects constructed in accordance with this law are considered public with a considerably high Government subsidy for the capital costs and for the maintenance costs. On the side of implementation of such projects the Government undertakes the planning, design and construction of the works, offering 100% finance, with 2/3 to 3/4 of the cost offered as a grant and the remaining offered in the form of a long term, low interest loan with a three year grace period. Upon completion of te construction the works are turned over to the Irrigation Division which undertakes its operation, maintenance and management under the guidance of the Government. However due to the difficulties that are faced by the committees with the recruitment of specialized labourers and for safety reasons the maintenance of there schemes is left to the water Development Department. The operation and management costs are covered fully by the Irrigation Division beneficiaries where the maintenance costs are subsidized by the Government by 2/3 of the total cost. The works constructed under this law usually include the headwork

357

(dam, pond, borehole, etc.) and the distribution system (primary, secondary and teritary pipes including valves, water meters etc) extending up to the farm outlet. The on farm distribution system is the responsibility of the private individuals.

ii. Government Waterworks Law - Major Projects. This law vest in Government all groundwater, all water running to waste from any river, spring or watercourse and all other waste water, and gives the power to the Government to plan, construct, operate, maintain, manage, rehabilitate and improve any waterworks. It also gives to the Government the right to decide the extent of such works, to aquifer and requisition immovable property or water right for the purpose of waterworks construction. The law provides procedures for water right determination and sets guidelines for water charges fixing. The waterworks constructed in accordance with this law are public and all capital and annual costs are financed by the Government from public funds. The maintenance and operation of such scheme is undertaken by the Government and the beneficiaries pay to the Government a water charge which is fixed by the Council of Ministers and is revised periodically.

The planning, desing, construction, and maintenance of the Government waterworks is done by the Water Development Department where the operation and management is either entrusted to Government Control Committees (Waterworks Committees) or to the Water Development Department depending on the systems complexity. The works constructed under this law include the headworks (dams, wells, pond, etc.) and the distribution systems up to the farm outlet. The responsibility of the on farm irrigation system lies with the land owner or the beneficiary.

2.3 Public Irrigation Works Development

The groundwater resources of the country being much easier and cheaper to develop were the first to develop. Development was very quick by the sinking of thousands of boreholes by private individuals without any Government assistance. Public water development involving small dams and open channel distribution systems started back in 1940 but it was not until 1960 when the first large scale irrigation projects were constructed. Figure 2 shows the actual development in surface water storage of the Public Projects for the years 1961 to 1986 as well as the programmed development up to the year 1990.

2.4 Policies for the subsidy and recovery of the investment

The majority or almost all of the public irrigation project in Cyprus are composed from a storage dam and a collective distribution system. Since irrigation works construction is a costly[2] venture and the cost of water per cubic meter stored is amongst the highest in the world the Government has decided to subsidize the irrigation water by adopting different policies for works constructed under the two different laws. Accordingly the policies for the subsidy and investment recovery for the public works are the following:

Figure 2

DEPARTMENT OF WATER DEVELOPMENT

PROGRESS IN DAM CONSTRUCTION

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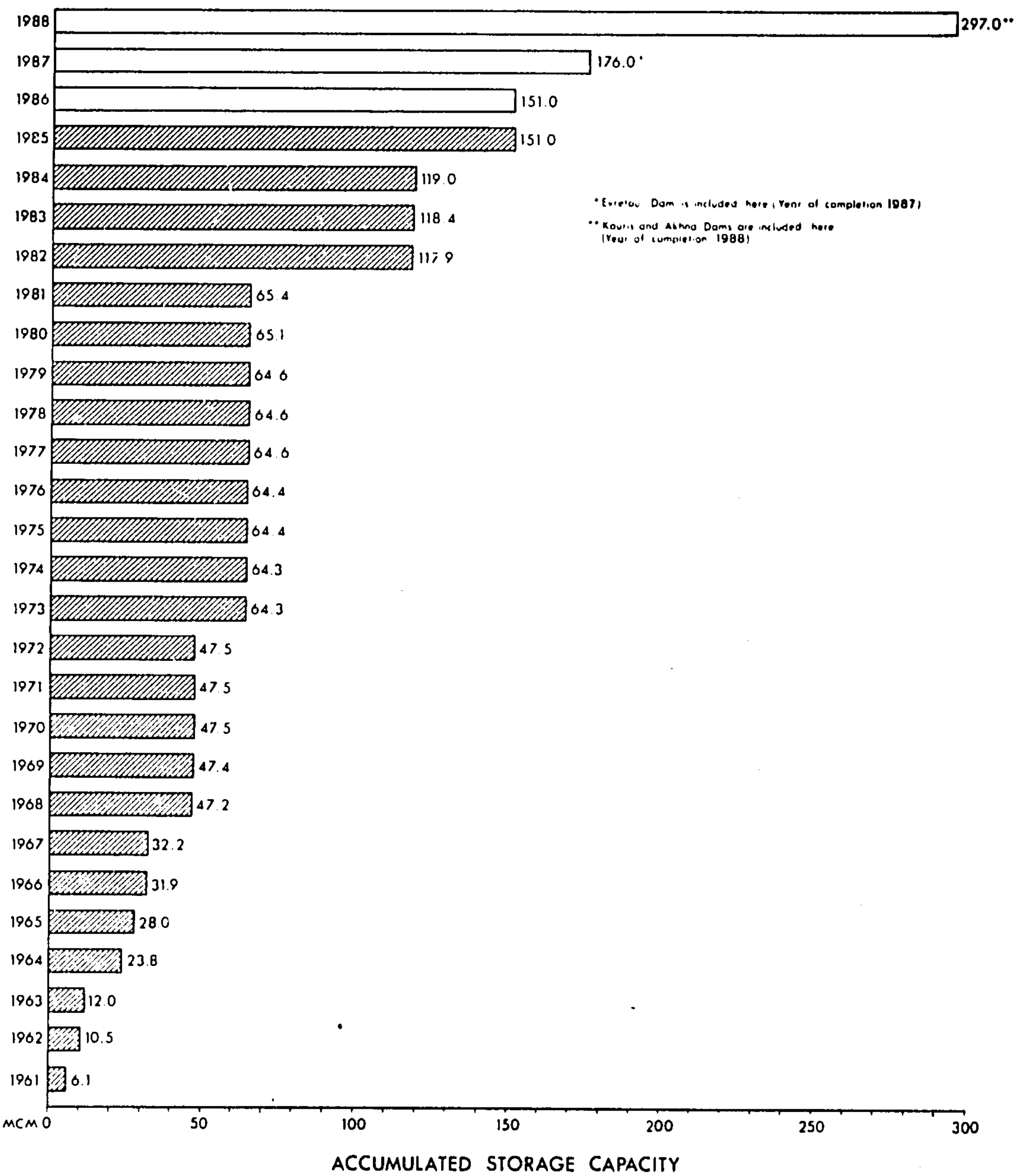

2.4.1 Irrigation Division Schemes - Small Projects (Village Projects)

As explained before, almost all small single community irrigation works are cosntructed in accordance with the Irrigation Division Law. The land owners with the consent of the Government form an Irrigation Division and request the Government to proceed with the preparation of a feasibility study of the project. The feasibility study is presented to the land owners, members of the Irrigation Division for approval or rejection. Upon approval, and provided the Government agrees, the project designs are finalized and construction works start right after the approval of the funds appropriation. The capital cost of such projects is fully financed by the Government from Government funds in the following way.

- The Government provides from the Government Development Funds Budget 2/3 of the capital cost, which is given as a Government grant, to the Irrigation Division. The proportion of Government subsidy is not always the same and may vary depending on the socioeconomic situation of the land-owners.

- The remaining 1/3 of the capital cost or whatever remains, is provided by the Government to the Irrigation Division through the Loan Commissioners as a long term, low interest loan. The loan is paid in 20-25 years at a rate of interest around 7% (at present) with a three years grace period.

Upon completion of the works the project is handed over to the Irrigation Division for management, operation and maintenance. The I.D. elects the Irrigation Committee which according to the Irrigation Division Law is entrusted with all legal and administrative powers to act on behalf of the Division on matters related to management operation and maintenance of the project.

The Irrigation Division has to pay for all operation and management cost plus 1/3 of the maintenance cost. The remaining of the maintenance cost is subsidized by the Government.

Therefore for projects constructed in accordance with the Irrigation Division Law the Government in practice pays all capital cost and has to recover within 20-25 years 1/3 of the capital cost, or any other proportion being te loan granted to the Irrigation division plus the interest resulting from the low interest rate. In principle it is the responsibility of the Irrigation Division Committee to impose and collect the charges that correspond to the annual installment for the loan repayment. The annual charge for the capital cost loan repayment is decided by the Irrigation Committee which decides on a per hectare (or per donnum) charge calculated by dividing the total annual amortization cost of the loan by the area commanded by the distribution system, thus each beneficiary paying according to the extend of his land being benefited by the project. This measure of charge for capital repayment has been found to the just, easy to apply and acceptable by the majority of the beneficiaries.

2.4.2 Government Waterworks Schemes - Major Projects

Waterworks constructed under this Law constitute the bulk of the public irrigation project in Cyprus. Out of the 151,00 MCM of surface storage in Cyprus 141.44 MCM constitute dams constructed under the Government Waterworks Law. Therefore the charge for irrigation water from these projects is very important and very critical since it affects the production costs, of a major part of the irrigated agricultural industry. This will be even more critical and most important with the completion of the new projects now under construction, such as the Southern Conveyor Project and the Khrysokhou Irrigation Project.

Table 3 shows a list of the Government Waterworks, completed and under construction, their storage capacities and their water yields as well as those of the Irrigation Division Projects, indicating the great role that the Government Waterworks have in the agricultural production sector.

The Government Irrigation Projects provide for the construction of the headworks (dams, boreholes, diversion weirs) and the distribution system up to the farms outlet. For all these works the landowners are not charged anything nor do they undertake any obligation or responsibility towards the project. After completion of the works, at their request for water supply, they undertake to buy water at a price which is fixed by the Council of Ministers and which may be revised from year to year.

2.5 WATER CHARGING FUNCTIONS

2.5.1 General

The discussion that follows is applicable only to Government Irrigation Projects where farmers are asked to pay a charge per cubic meter of water consumed. The policy on the water charge or on the recovery of investment for Irrigation Division Projects has been discussed in Section 2.4.1.

2.5.2 Purpose of water charges

Cyprus, with a semi arid climate, with a low rainfall unevenly distributed and of unreliable pattern, has an accute water problem which make irrigation projects very expensive to construct, and manage. Like every good or service offered, water has a price for which consumers are asked to pay and prices are charged for two reasons (a) financial and (b) economic. The financial one is that enough money must be raised to pay the cost (or part of the cost) of operation maintenance and management, the capital cost (or part of the capital cost) the interest on capital and the insurance cost incurred for providing the water to the farm outlet. The economic is that the quantity of water the consumers will buy and use will depend on the price, i.e. if the price is very high this will discourage the farmers from using the water or use it only for the production of very high return crops (limited use) where low prices will encourage the wastefull use of the water. In broader sense pricing also has a social function related to the multidimensional nature of social welfare where price levels influence income distribution, economic stability, and other social goals and to some extend the foreign trade balance.

358

Table 3 GOVERNMENT WATERWORKS PROJECTS AS COMPARED TO IRRIGATION DIVISION PROJECT

		Storage Capacity MCM	Yield MCM
	I. Government Waterwork		
	A. Operational Projects		
1.	Argaka Magounda (0)	0.990	0.900
2.	Ayia Marina (0)	0.300	0.300
3.	Kalopanayiotis (0)	0.363	0.250
4.	Kiti (0)	1.610	0.250
5.	Lefkara (0)	13.850	5.000
6.	Pomos (0)	0.860	0.900
7.	Xyliatos (0)	1.220	1.200
8.	Yermasoyia	13.500	9.000
9.	Polemidhia (0)	3.430	2.400
	B. Prior Projects		
10.	Paphos (P)	52.000	22.000
11.	Vasilikos-Pendaskinos (P)	32.000	15.000
12.	Khrysokhou (P)	25.000	14.000
	C. Southern Conveyor		
13	Southern Conveyor (SCP)	123.000	70.000
	D. Recharge Waterworks		
14.	Recharge Waterworks	19.321	19.321
	Total	287.444	160.721
	II. Irrigation Division Projects (26 Dams 20 ponds)	9.556	9.000
	Grand Total	297.000	169.721

1 Under construction

Letters in brackets stand as follows:
(0) For Operational Project (P) For Prior Project

2.5.3 Water charge function and the Law

The importance of the water charge for water from the Government Waterworks has been foreseen by the Cyprus Legislator and in 1968 the Government Waterworks Law was amended to provide guidance for water charges from such projects. In the Law which was passed by the House of Representatives of the Republic the following is stipulated, in summary.

359

The Council of Ministers may by Regulations, ratified by the House of Representatives, fix the fees, rates or any other money consideration which may be levied or collected from persons who use water or get benefit from Government Waterworks, these either being fixed in money terms per donum or according to volume or time of use or according to the benefit accruing or capable of accruing. In fixing the rates regard shall be made to:

i. the interest on capital expended,

ii. adequate provision for a sinking fund and insurance of the works, and

iii. cost of operation, maintenance and administration of the works and the cost of pumping the water.

The rates or fees according to the law shall not be more than 40% of the weighted average cost of the water (per cubic meter) but in some special cases considering the high costs of any works or other economic and social conditions prevailing in the project area the rate may be increased up to 65% of the weighted average cost of the water.

From the above it is seen that the Law defines the maximum water charge that the Government is allowed to impose for recovering part of the investment, and according to the Law the Government is allowed to recover in normal cases 40% of the total weighted average unit cost of water and in extraordinary cases up to 65% of the total weighted average unit cost of the water. It also gives to the Government the power to:

(a) Fix the unit of water charge this being either in money terms per cubic meter of water or in money terms per donum of land irrigated or in money terms per donum of each crop irrigated or in money terms per unit of time used. This flexibility contained in the Law is very usefull since irrigation projects are not always equipped with water meters or water metering is not always easy to carry out.

(b) Fix different water prices for different crops, depending on the benefit accruing or on the Government policy regarding the agricultural production and food requirement of the population.

(c) Fix different water prices for different times of water use of the year (spring, summer, autum and winter). Water during winter flows combined with dam overflow have usually low price compared with water supplied during summer time.

(d) Fix different water prices depending on the benefit accrued or capable of being accrued.

(e) Fix different water prices depending on the volume of consumption (escalating water prices).

(f) Fix different water prices for different project areas after consideration of the high cost of the works (capital and running

360

costs) or other economic and social conditions prevailing in the project area.

2.5.4 Water charge function and the Loan Agreement Between the Government and the World Bank in relation to the Southern Conveyor Project

The importance of the price of the irrigation water from the Government Waterworks not only those financed (partly) by the World Bank but of the irrigation water from all Government Waterworks is emphasized strongly by the inclusion in the Agreement of a separate clause setting the minimum average prices of irrigation water, in contrast to the Law which sets the maximum allowable prices. For pricing purposes the agreement divides the projects into three categories, (a) the Operational Projects, (b) the Prior Projects and the Southern Conveyor Project.

The Operational Projects are all small projects constructed before 1980 and generally the unit water cost is considerable lower than the remaining prior and the Southern Conveyor Projects. The Prior Projects are the three large projects financed by the World bank namely the Paphos Irrigation Project, the Vasilikos-Pendaskinos Project and the Khrysokhou Irrigation Project. The Southern Conveyor Project is defined as a category by itself (see Table 3 for Project Classification). For each of the three categories the Agreement stipulates as folllows:

Operational Projects: For these projects the Government shall establish water charges at levels sufficient to recover a percentage of the weighted average unit cost of the water made available under such schemes which percentage shall be:

- for fiscal year 1984 not less than 28%

- for fiscal year 1985 not less than 35%

- for each year thereafter not less than 40%

Prior Projects: Starting with the year in which water is made available (first year of operation) under each of the Prior Irrigation Projects, respectively establish charges for the water made available in the area covered by the respective Project at levels sufficient to recover a percentage of the weighted average unit cost of water made available under such projects which percentage shall be:

- for each year starting with the first year of operation until the sixth year of operation not less than 30%, 40%, 45%, 50%, 60%, and 65% respectively,

- for each year thereafter not less than 65%.

Southern Conveyor Project: Starting with the year in which water is made available under the Project (first year of operation) establish charges for project water which shall apply equally to surface and ground water, at levels sufficient to recover the weighted average of the full unit cost of groundwater and of a percentage of the unit of surface water which percentage shall be:

- for the first year of operation not less than 45%
- for the second year of operation not less than 55%
- for the third year and the years thereafter not less than 65%.

For the purpose of price setting the term "unit cost" means full operation, and maintenance costs together with capital cost to be calculated at an interest rate of 9% per annum over a period of 40 years and the term "weighted average" of such unit cost means multiplying the unit cost for each scheme of project by the corresponding volume of water produced, totalling the result and dividing such total by the total volume of water available under said schemes and projects.

2.5.5 Criteria for fixing prices:

The Law as explained above sets the guidelines for maximum water pices whereas in the Loan Agreement the minimum charges for each type of project are recommended. In general it is stated that the Government using the Law provisions and the Loan Agreement clause should proceed and impose such prices so that 40% and 65% of the total cost of the irrigation water is paid by the consumers depending on the source of supply or the Project. Since not all projects are the same, differing in cost dispersed in various locations of the island, supplying water of different quality and with high or low pressure, varying and stready discharges and irrigating low or high return crops the following criteria were considered in the past and are always considered for fixing the water prices, these being within the guidelines stated in the Law and the Loan Agreement (in other words the Government from each category of Projects collects the stated percentage of the total cost of the water with prices differing from project to project).

(a) The weighted average cost of water: This criteria is the first named in the Law and the Loan Agreement as a basis for fixing water charges. For each project the cost of water is calculated using the present worth method of analysis for the capital component cost and the running cost method for the variable cost. Therefore, the capital water cost component for a project is more or less constant whereas the variable cost component represents the actual cost incurred during the year under consideration. Table 4 shows the calculated capital cost, the annual cost, the total cost of water for each project and the weighted average unit cost of water from the three categories of projects.

(b) The Annual cost: Provided that the consumers must pay at least the running cost of a water then the annual cost must be taken into consideration separately.

(c) Ability of farmers to pay and Benefits received: The charge an individual or a farmer will pay for water depends on his economic situation and his income. Consideration must be made of the farmer's economic condition especially in the first years of project

362

implementation where the farmers have to spent money-on land levelling, land preparation, installation of the on farm distribution system, the plantation of corps etc without any income in cases of permanent plantation for which 5-7 years are required to reach a maturity level of production. Therefore, the water charge must take into account the farmers investment requirements program and this must be fixed in relation with other development and subsidy programs in irrigated agriculture in the project area. Related to the ability of the farmers to pay is the benefit received from irrigated agriculture, since very high water prices will discourage farmers from using water or abandon in total the irrigated agriculture which will have an adverse effect on the project economics and to the national economy in general. Since the cost of irrigation water in Cyprus is one of the highest in the world, in fixing the rates as outlied in the Law and the Loan Agreement the Government is carrying out studies on input-output from irrigated agriculture thus establishing the safe limits of the water price that farmers are able to pay safeguarding at the same time a reasonable income. From studies carried out it is seen that with the existing water prices there is no problem but in the near future there will be a problem which will force the Government to increase the subsidy unless the benefits received (product prices) are increased at a higher rate than now forecasted.

(d) Water Quality and Services: The water quality from the public projects in Cyprus is at present of no great importance because the water supply from the different projects is on the average of a uniform quality. However, there are differences from one project to another on the services offered, i.e. water pressure, rate of supply, mode of water supply (on demand, on roation) and the water dependability. These are taken into consideration when fixing the water charge from a project.

(e) Socioeconomic Reasons: Cyprus is an island with a large part of its area under occupation and with the usual natural and short communication roads blocked. This situation has created a serious problem to some communities in some project areas, for which an extra advantage has to be given to encourage them to stay in their land and continue their activities as in the past. The same is true for poor isolated communities.

(f) Equivalence of water charge from Government Waterworks to the water charge from Irrigation Division Projects

Although the quantity of irrigation water supplied from Irrigation Division Projects is relatively small in general in some communities it is as much as the water quantity delivered from the Government Waterworks. Under such circumstances the prices of the irrigation water from the two categories of projects must be as close as possible thus avoiding discrimination between the farmers. In view of this and for achieving relatively uniform prices for the whole island the Government is now studying the subsidy policies for the Irrigation Division Law Projects.

3637

Table 4 UNIT AND WEIGHTED AVERAGE COST OF WATER FROM GOVERNMENT WATERWORKS (1985)

No	Project Name	Unit Cost of in U.S. cent/m³				
		Capital	Variable			Total Unit Cost
			O + M	Energy	Total	
	A. Operational Projects					
1.	Agraga Magounda	15.02	2.54	-	2.54	17.56
2.	Ayia Marina	14.62	3.52	-	3.52	18.14
3.	Kalopanayiotis	55.00	6.58	-	6.58	61.58
4.	Khrysokhou Valley	3.78	3.52	4.84	8.36	12.14
5.	Kiti	38.82	2.42	-	2.42	41.24
6.	Lefkara	31.10	4.40	-	4.40	35.50
7.	Pomos	12.72	3.52	-	3.52	16.24
8.	Xyliatos	37.48	6.60	-	6.60	44.08
9.	Yermasoyia - Polemidhia	16.02	2.42	1.20	3.62	19.64
	Weighted average for Operational Projects	15.60	-	-	1.89	19.38
	B. Prior Projects					
10.	Paphos	19.36	2.00	5.16	7.16	26.52
11.	Khrysokhou	26.00	3.00	-	3.00	28.00
12.	Vassilikos - Pendaskinos	28.00	3.00	-	3.00	31.00
	Weighted Average for Prior Porjects	22.00	2.34	3.38	5.72	27.72
13	C. Southern Conveyor Project	38.00	4.00	4.00	12.00	56.00

1 Using the Present Worth method
2 Based on annual cost and volumes
3 Borehole scheme: All other suppled from a dams reservoirs

2.6 Water Charges Imposed since 1968:

Table 5 shows the water charges that were imposed during the period 1968-1985. As it is seen the water charges are more or less uniform and they take into accound the project location, the period of supply (overflow or supply from the reservoir) and the type of crop. Other criteria taken into consideration are the service offered and the socioeconomic considerations.

2.7 Effectiveness of the Method Applied for the investment recovery

Using the above guidelines and criteria the Council of Ministers

704

TABLE 5 WATER CHARGES FROM GOVERNMENT WATERWORKS (PUBLIC) U.S. CENT/M³*

Ser. No	Project	Year 1970			Year 1971			Year 1982		Year 1983		Year 1985		Year 1986	
		Over-flow	Vegetable	Other Crops	Over-flow	Vegetable	Other Crops	Over-flow	From Dam	Over-flow	From Dam	Over-flow	From Dam	Over-Flow	From Dam
1.	Agraka Magounda	Free	2.0	2.0	Free	2.0	3.0	Free	4.0	Free	5.0	Free	6.0	Free	6.0
2.	Ayia Marina	1.0	2.0	2.0	1.0	2.0	3.0	-	4.0	1.0	5.0	-	6.0	-	6.0
3.	Kalopanayiotis	Free	2.6	2.6	-	3.6	3.6	-	4.0	Free	6.0	-	7.0	-	7.0
4.	Khrysokhou Valley	N.O.	-	-	5.0	5.0	-	-	5.0	-	7.0	-	8.0	-	8.0
5.	Kiti	0.6	2.0	2.0	-	3.0	3.0	-	4.0	Free	4.0	-	5.0	-	5.0
6.	Lefkara	N.O.	N.O.	N.O.	-	2.0	2.0	-	2.0	Free	6.0	-	7.0	-	7.0
7.	Pomos	1.0	2.0	2.0	1.0	2.0	3.0	2.0	4.0	2.0	5.0	2.0	6.0	2.0	6.0
8.	Xyliatos	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	Free	6.0	-	6.0	-	6.0
9.	Yermasoyia - Polemidhia	-	1.4	3.0	-	2.0	3.0	-	5.0	-	6.0	-	7.0	-	7.0
10.	Paphos	N.O.	N.O.	N.O.	-	3.0	3.0	-	4.0	-	7.0	-	8.0	-	8.0
11.	Vasilikos - Pendaskinos	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	-	Free	-	9.0
12.	Mavrokolymbos	-	2.0	3.0	-	2.0	3.0	-	4.0	-	6.0	-	7.0	-	7.0

N.O. Not on operation

* Exchange rate 2 U.S. Dollar to 1C£1.0

approve the water charge for each project. The criteria adopted so far have proved to be very helpfull in fixing the water charges from the various Government Projects although it must be stated that the farmers are never happy whatever the price of the water. Of course the problem of water charges fixing will get more critical with the completion of the new projects now under construction and when efforts will be made to implement the Loan-Agreement provision for minimum charges. These provisions, if applied without any modification will create three categories of farmers, the cheap water farmers (from operational projects) the medium price water farmers (prior Projects) and the expensive water farmers (the S.C.P.).

2.8 Percentage of direct subsidies to irrigation water

As described above, Public Irrigation Projects are built either in accordance with the Government Waterworks Law or the Irrigation Division Law.

For Projects constructed under the Irrigation Division Law the Government provides the following subsidies.

Capital Costs: The Government subsidizes 0.67-0.75 of the total capital cost with the remaining given as a long term low interest rate loan. The loan is given with a 7% rate of interest paid in 22 annual equal installments with a three (3) years grace period.

Running Costs: The Irrigation Divisions bear all the operation and management costs and share with the Government the maintenance cost of the headworks in proportion of 1/3 to 2/3.

For the Goverment Waterworks the Government undertakes total financing of the works with a subsidy ranging, according to the Law, from 0-60% of the total cost of the water (capital and variable cost).

2.9 Government financial contribution to tertiary and on farm systems

In all cases the distribution systems (which are totally financed by the Government) extend from the headworks up to the farm outlet including the tertiary canals or pipes. For the on farm irrigation systems the responsibility lies in total with the farmers who can either finance his own on farm system or can make use of the "Improve water use Program" sponsored by the Department of Agriculture. According to this program the farmers can get a limited short term relatively low interest loan through the Cyprus Cooperative Bank plus any technical consultancy concering the on farm irrigation system. In the past, the program provided a 15% grant on the total capital cost.

2.10 Deficiencies of the Policies with regard to the recovery of the irrigation Investment

The policy on water subsidy as outlined above has worked satisfactory in the past. For the Irrigation Division Law Projects the recovery policy has been working up to recently quite satisfactory, with the old, low capital, low running cost projects. Lately with the construction of high capital and high running cost projects the sytem has come under pressure by the farmers for increasing the subsidy in capital cost or subsidize the running costs. This is mainly because the price of the irrigation water from the Government Irrigation Projects was relatively cheaper than the cost of the irrigation water to the farmers from the Irrigation Division Projects. Under such pressure the Government appointed a Committee to study the subsidy program (of the Government) in general including water projects subsidy. Another development is the Loan Agreement provisions which actually set the minimum prices and the maximum subsidies of irrigation water from Government Waterworks which hopefully will increase the prices of irrigation water from the Government Projects to match those of the Irrigation Division Projects. Another deficiency of the persent system is the procedure required to adopt a new water charge. Although the Law sets the maximum prices (for Government Waterworks) any price revision has to be approved by the Government and ratified by the House of Representatives which result to delays and postponements.

All the above problems related to the recovery of the capital and annual cost investment will be dealt in detail in the new study now undertaken by the Government in its effort to establish an Entity for the Management of the water Resources of the island.

3 PAYMENTS FOR THE ABSTRACTION OF WATER FROM RIVERS OR FROM GROUNDWATER

This subject has been under consideration in the past in an effort to optimize the utilization of the available water resources and curtail the pumpage from the aquifers but no decision has been taken by the Government. (According to the Waterworks Law all free funning water and all groundwater belongs to the Government). This issue will be a separate subject to be studied within the framework of establishing a Water Entity.

4 ACTUAL POLICIES WITH REGARD TO THE FINANCING OF IRRIGATION INVESTMENT IN PRIVATE SCHEMES

Private irrigation schemes are defined those that serve only one private. Since all free running surface water and the underground water belongs to the Government private schemes can only be built for use of private water or in cases of groundwater where a permit to pump water has been issued by the Government to a private. Such private schemes are comparatively small covering a very small area and no financing in any form is given by the Gvoernment, except in the cases of the on farm distribution systems, related to the "improved water use program" where the financing is very limited. Also in the case of Irrigation Associations where privately owned water is developed for irrigation purposes the Government offers financing and a grant but again the policy is to discourage the construction of such schemes. Generally, it can be said that the Government does not favour the construction of private irrigation schemes and its policy is that no such schemes are to be encouraged. This reflects the importance that the Government sets on the utilization of the vital for the economy water resources of the island.

370

5 ACTUAL POLICIES WITH REGARD TO O + M EXPENDITURE IN PUBLIC IRRIGATION SCHEMES

5.1 General

Operation and maintenance costs are made to up of the following components:

(a) Operation costs which include the wages and incidental fees (insurances, social insurance, perdinent, transport, etc) for the employment of the staff required to operate and manage the project.

(b) Maintenance costs which include wages and incidental fees for the employment of the maintenance staff plus the cost for the purchase of spare parts and equipment for the proper maintenance of the project. Improvements, additions and replacements to the project are not included in the maintenance costs.

(c) Energy Costs: These are the costs required to pump the water of the project if required.

The O + M costs are calculated by adding all costs associated with the operation, management, and maintenance of the project, including those related to the dam, plus the cost of the energy if any. Replacement to the project or imporvements or extensions or large scale repairs and maintenance are assumed as capital cost and are not accounted in the O + M costs.

5.2 Predominant methods of collecting charges

O + M recovery policies are different for the two types of public irrigation projects as follows:

i. Irrigation Division Projects. According to the Law the Irrigation Division works are managed by Irrigation Committees, elected by the beneficiaries. The Committees have the power to impose charges to the beneficiaries in such a way so:

- all operation, management and energy costs are paid by the beneficiaries. No Government grant or subsidy is given to the Irrigation Division.

- the maintenance costs of the headworks are shared between the Government and the Irrigation Division at a ratio 2 to 1. The grant is given on maintenance works carried out by the Water Development Department which controls the Government Funds. No money are given to the Irrigation Divisions for works carried out by themselves unless such works are approved by the Water Development Department.

All operation, management and the share of the maintenance costs are collected in total, separately from the capital cost, by the Irrigation Committee by imposing to each beneficiary a charge either per cubic meter of water consumed or per unit area of the

760

land commanded by the irrigation system. In cases where pumping energy cost is a major component of the O + M costs the charge is proportional to the volume of water consumed.

Based on the above the I.D. Committies, under the supervision of the Government (District Officer), prepare an annual budget of income and expenciture related to the O + M costs, with the Government contributing only 1/3 of the maintenance cost of the headwork. This budget is balanced and the beneficiaries are charged accordingly.

ii. Government Waterwork Projects

Operation and maintenance costs for the Government Waterworks are provided in a budget prepared either by the Waterworks Committee or the Water Development Department and approved by the Council of Ministers. The O + M costs are not collected separately but according to the Law they are added to the capital costs for the calculation of the unit water cost and are taken into account in fixing the water charges (see section 2.5.3).

5.3 Effect of Energy cost on O + M costs

Public irrigation projects in Cyprus, as a rule, provide the water to the individual farm outlet at sufficient pressure, around 3.5 bars, for on farm irrigation by high application efficiency systems. The responsibility for providing the required head to the farm outlet (a prefix head) lies with the project and if pumping is required then such pumping is undertaken by the Project.

The effect of the energy cost on the O + M costs is small or great depending on the total manometric head to which the water is pumped, the cost of fuel and the volume of water which requires pumping.

From the figures given in Table 4 it is seen that the energy costs where required is comparatively great being 40-50% of the O + M costs.

5.4 Low and High Capital cost Projects and O + M Costs

The amount of capital expenditure per hectare for an irrgation project (or the capital cost of water) depends very much on the type of headworks (expensive or cheap dam, pond or boreholes) the conveyance if any and the type of the distribution system. Due to topographical constraints dam structures in Cyprus are very expensive which result to high investment cost per hectare compared with borehole project which result to low investment cost per hectare. However, the low investment cost per hectare for the borehole projects is outweighted by the high pumping costs, (increased O + M cost) thus the total water cost being approximately the same for low and high investment projects. In general, it can be said that surface water projects with high investment cost per hectare and without pumping have a low O + M cost whereas groudnwater schemes with low investment cost per hectare have a high O + M cost due to pumping and due to high maintenacne costs. Table 6 gives the capital and O + M cost of surface and groundwater schemes, for comparison purposes.

Gravity schemes usually have a smaller O + M cost compared with the O + M cost of the pumping schemes as is seen from Tables 4 and 6.

Pumping schemes require higher operation and maintenance costs resulting from the following:

- Pumps require continuous attendance and maintenance which is not required by gravity scheme.
- The maintenance of the pumping unit is comparatively expensive both in wages and spare parts.
- Pumping costs extra money not required by gravity schemes.

Table 6 CAPITAL AND O + M COSTS FOR LOW AND HIGH INVESTMENT COST SCHEMES* IN U.S. DOLLAR/HA OR U.S. DOLLAR/

No	Scheme/Type	Annual cost in U.S. Dollar per Ha	Capital Cost in U.S.cent per m^3	O + M cost in U.S. cent/m^3	Total Unit cost U.S. cent/m^3
1.	Eftagonia Pond	952	18.1	9.1	27.2
2.	Arakapas Pond	1087	20.7	5.3	26.0
3.	Kyperounda Pond	1192	22.7	17.7	40.4
4.	Dhierona Pond	1352	25.7	4.1	29.8
5.	Polystypos B/H	845	16.1	24.9	41.0
6.	Alona B/H	721	13.7	14.70	28.4
7.	Askas B/H	665	12.6	15.0	27.6
8.	Agros B/H	540	10.2	13.9	24.1
9.	Sykopetra B/H	586	11.2	13.6	24.8

* All these schemes were constructed within the Pitsilia Intergrated Rural Development Project partly financed by IBRD.

5.5 Farmer's participation in O + M decisions

Operation and Maintenance decisions in public irrigation projects are taken by the responsible authority entursted with the operation, management and maintenance of the projects as follows:

i. Irrigation Division Projects:

The operation, management, and maintenance of the Irrigation Division Projects are according to the law entrusted to a Committee elected every three years. This Committee has all the legal and administrative power to operate, manage and maintain the project according to rules and regulations approved by the beneficiaries and the Government. However, due to the fact that the Committee's technical know-how are limited, and for economy reason, the Committees request and get technical advise regarding operation and

370

maintenance for the schemes from the Water Development Department, which finally undertakes the maintenance of the works, (mainly the headowrks) where the operation and management remains in the hands of the Committee.

ii. Government Waterworks

The operation and management of the Government Waterworks is entrusted either to the Water Development Department or to Waterwork committees, whereas the maintenance is always entrusted to the Water Development Department. As it appears all decisions concerning the maintenance of the Government Waterworks are taken by the Water Development Department. The same applies to projects operated and managed by the Water Development Department although Advisory Committees composed from Government officials and farmers representatives can give an advice accordingly.

For projects run by the Waterworks Committees all decision concerning the operation and management are taken by the Committees. These Committees are Government controlled Committes made up of Government officials (the district officer, representantives of the Water Development Department and the Department of Agriculture) and farmers representatives elected by the farmers.

6 FARMER'S ABILITY TO PAY WATER CHARGES

6.1 General

The charge a farmer will pay for the consumption of irrigation water will depend on his economic situation, his income in general and ivestment requirements and mainly on the revenue he is getting from the irrigated crops. Therefore, great consideration must be given in fixing a water charge to the ability of the farmers to pay. This ability is generally a function of the benefits received and the taxes paid.

6.2 Revenues from Irrigated Crops

If the net revenue received per cubic meter of water used is higher than the water charge per cubic meter of water then the farmer is considered to have the ability to pay the charge. This is established by studying farm models with representative farm budgets by considering the benefits and costs related to one hectare of each crops of the crops included in the project area. Therefore, the net benefits, before paying for irrigation water charge, are estimated by deducting from the gross revenue the production cost, the interest in operating capital, the investment cost and maintenance of on farm distribution system but not the cost of the irrigation water. Given the quantity of water required for the irrigation and compared with the proposed water charges to see if the charge is profitable or not. From the sudies carried out in 1985 the return to water from perennial and annual crops are as shown on Table 7.

6.3 Pricing policies for agricultural input and farm products

Generally, it can be said that the prices of the agcicultural

-7/1

inputs such as fertilizers, herbicides and others including machinery and fuel are controlled and to some extend subsidised by the Government, where the farm product prices are free to fluctuate and be established by the law of supply and demand with few exceptions one being the banana whose price is fixed by the Government (import of bananas in not allowed for the protection of the local production).

6.4 Tax Policies on land, on produce and income

Agricultural land is not in any way taxed nor is the production taxed. The farmers are subject to the same income tax like any other citizen of the republic. Any help they get is in the form of subsidies.

Table 7 RETURN TO WATER FROM PERENNIAL AND ANNUAL CROPS

Ser. No	Crop	Return to Water in U.S. cent/m³
1	Citrus (mixture)	19
2	Table Olives	122
3	Avocadoes	58
4	Bananas	20
5	Tomatoes	68
6	Potatoes	122
7	Ground Nut	20
8	Melons	204
9	Water Melons	106

6.5 Effect of Water Charges on the revenue from crops and on production cost

From studies carried out in the past (in November 1984) it has been established that the water cost amounted to around 10-20% of the total production cost where a 100% increase (from 6.52 to 13.04 U.S. cent/m³) of the charge would increase the portion between 20 and 35%, increasing the total cost of production by 12 to 20%. Further increase to the water charge would have a still higher increase in the procuction cost which if not compensated with higher prices of the agricultural products will render the farmers unable to pay for hich increased charges.

Table 8 shows the gross revenues, the production costs including water, and the benefits in U.S. Dollars/Ha of the main crops under irrigation in the Government Projects.

7 PROBLEMS RELATED WITH THE FIXING AND COLLECTION OF WATER CHARGES

7.1 Fixing of Water Charges and Problems

According to the existing Law and the policies the fixing of

TABLE 8 GROSS REVENUE, PRODUCTION COST AND NET BENEFIT IN U.S. DOLLARS/HA

Crop	Gross Revenue U.S. Dollars/Ha	Costs U.S. Dollar/Ha						Net Benefits U.S. Dollars per Hectare
		Production Costs	Interest on operating capital	Cost of Irrigation Water	Cost of Irrigation System	Maintenance and Replacement of Irrigation system	Total	
Tomatoes Open	10,800	6,255	285	570	315	45	7,470	3,300
Cucumbers Open	12,150	7,425	330	420	315	45	8,535	3,615
Potatoes Spring	7,500	3,405	150	300	315	45	4,125	3,285
Groundnuts	2,925	1,635	75	450	315	45	2,520	405
Water Melons	9,450	3,855	180	480	315	45	4,875	4,575
Melons	13,500	3,315	150	480	315	45	4,305	9,195
Onions	12,150	4,260	195	375	315	45	5,190	6,960
Citrus	7,740	2,640	120	825	-	165	3,750	3,990
Lemons	7,125	3,225	150	825	-	165	4,365	2,760
Avocados	11,250	1,725	175	975	-	165	2,940	8,310
Bananas	8,325	3,510	165	1,470	-	165	5,310	3,015
Table Olives	11,250	4,920	165	345	-	165	5,655	5,595

water charges is done for the two types of Public Irrigation Schemes as follows:

(a) Irrigation Division Law

For each Irrigation Division the elected Irrigation Committee is responsible for fixing the charges in such a way so that all O + M costs are paid and any debts due to capital expenditure for the construction or rehabilitation of the scheme are repaid in accordance with the loan agency terms and conditions. The fixing of charges by the Irrigation Committee is always done in accordance with the existing regulations of the Irrigation Division which are approved by the beneficiaries and the Government.

(b) Government Waterworks

For all Government Waterworks the water charges are fixed by the Council of Ministers (in accordance with the existing Law, the S.C.P. Loan Agreement provisions and the criteria as explained in Sections 2.5.3, 2.5.4 and 2.5.5) and are ratified by the House of Representatives. The relative studies for the water charges fixing are carried out by the Water Development Department and the Department of Agriculture and proposals are submitted to the Council of Ministers, for approval. The approved water charges are then submitted to the House of Representatives for ratification and are published in the Official Gazette of the Republic in the form of Regulations.

In the case of the Irrigation Divisions the mechanism of water charge fixing is simple and flexible and does not present any difficulties. On the other hand the mechanism and procedures for water charges fixing for the Government Waterworks is slow and tedious which result to delays and very often no decision is taken so water charges are not revised.

7.2 Collection of Water Charges and Problems

Water charges collection from the beneficiaries for the two types of Public Irrigation Schemes is done as follows:

(a) Irrigation Divisions

The charges are collected by the treasurer of the Irrigation Committee. These are collected either once every year or every two months depending on the method of charging. There are no serious problems except in case where the beneficiaries or land owners are at large in which case their beneficiaries are charged or the charges are collected by the tax collectors of the Inland Revenue Department.

(b) Government Waterworks

The collection of charges from the sale of water from the Government Waterworks is the responsibility of the Waterwork Committees if the Project is operated and managed by a committee or the Director of the Water Development Department if the project is managed by the W.D.D. In both cases the collection of the charges is done in accrodance with regulations approved by the Concil of Ministers and ratified by the House of Representatives. According to the existing Regulations the consumer is required to settle any bill within 15 days of its issue. If the bill is not paid then it is sent to the tax-collector of the Inland Revenue Department for collection.

The above procedure although it has been working for some time now, (over 18 years) it has a basic drawback for it does not force the consumers to pay in time and properly their debts. This resulted to the accumulation of debts from a number of consumers, amounting to hundreds of thousands of dollars enhanced also by the slow and lengthly procedure of charge collection by the tax-collectors. Based on the above findings the Water Development Department has proposed the revision of the water charge collection Regulations by introducing a number of measures which will encourage and force the consumers to pay their debts in time. Such measures are the following:

- Payment will be made within 30 days after issue of the bill.

- If the bill is not paid in time the water supply will be interrupted and for its restoration the consumer will have to pay the pending bill, a 10% surcharge on the bill and expenses for the interruption and restoration of the supply.

- The Director or the Waterworks Committee will have the right to bring the consumers to the court for the recovery of the charges in case the consumers refuse to pay.

- If the charges cannot be recovered by using the above measures. then they will be sent to the tax-collector for collection.

The proposed measures (Regulation Revisions) already tried in one project have proved to be very effective.

8 CONCLUSIONS AND RECOMMENDATIONS

This paper concludes that water charges are necessary for the efficient use of the available water resource and for the colleciton of the necessary funds to cover for the construction and operation and maintenance costs. The criteria and the guidelines available for fixing the charges are well established while the procecure for fixing the charge is slow, lengthly and tedious resulting to delays or no action at all. The procedures for charge collection are well defined and effective and with some improvements will become even much more effective.

A drawback of the water charge function included in the S.C.P. Loan Agreement between the IBRD and the Republic of the Cyprus is that it will finally create three categories of farmers, the cheap water farmers, the medium price water farmers and the expensive water farmers. This must be

375

avoided so that all farmers on the island being supplied with water from Public Irrigation Projects are treated equally. Other difficulties faced with the procedure of water charge fixing are expected to be dealt with in the study for the establishmement of a Water Entity which will undertake the management of all water resources of the island.

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FOOTNOTES

1 No official figures are available after this year because of the occupation of a large area of the area by the Turkish Army.

2 Irrigation projects are constly because of physical and social reasons. Physical in the sense that all river beds are steep and narrow presenting difficulties in finding suitable damsites, poor geology, heavy silting problems, wide variation of flows, and social, highly fragmented land tenure which add to the cost.

3 For the law, the weighted average cost of the water per cubic meter is calculated by diving the summarisation of all costs described in (i), (ii), and (iii) above, of all Government Projects by the total amount of water for sale.

IRRIGATION WATER CHARGES IN MEXICO

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1. INTRODUCTION

Mexico has under irrigation about 5.6 million hectares. Irrigation Districts, that are large scale irrigation systems, represent 60 per cent of the total. Irrigation Units or small scale systems account for 32 per cent and Private Irrigation Schemes make up the rest (around 8 per cent). These systems are operated respectively by the state, the direct users and private owners. Irrigated areas are located mainly in the northern and central parts of the country, where climate is mostly arid or semiarid.

Annually Mexico harvests an average area of 18 million hectares. The irrigated sector contributes about 50 percent of the total value of agricultural production. (Appendix).

Predominant crops in irrigated areas are very similar to those in the national crop pattern, where basic grains and products are the major elements (corn, wheat, beans, rice soya, sorghum, cotton, sugar can, saffron, sesame, etc.). They all have guaranteed prices that represent, most of the time, a ceiling price for the products. Around 50 per cent of total export value of agricultural products come from irrigated areas. Export goods such as tomatoes, cucumbers, green peppers, etc., are produced mainly in Irrigation Districts located in the north and northwest of Mexico.

The principal type of irrigation in Mexico is by gravity (70 per cent); deep well pumping makes up 30 per cent remaining. Other types of irrigation schemes such as sprinkler and trickle irrigation, are not significant.

It is estimated that between 1988 and 1990, 8.5 million hectares of total irrigated area will be needed in order to meet the demand and reach sufficiency in food production. Rehabilitation programs have been a part of the investment program. It is aimed to complete work on the systems and to recover past and higher productivity levels; it represents a cheaper unit investment per hectare than new works.

2. POLICIES FOR FINANCING PUBLIC SYSTEMS

Actual policies were established in 1983 in the National Plan for Development. The aim is for a better equilibrium between the costs of public services and payments made by users. The principles are embodied in the principal fiscal laws that apply to water use.

a) In the past, most of the investments in irrigation systems were financed by the public sector, except for some rehabilitation works in irrigation districts that were charged to the users. Today, as a product of the search of a better policy, a fair one, more participation of direct users is promoted. The investment side of cost recovery is ruled by the law: "Ley de Contribucion de Mejoras por Obras Publicas de Infraestructura Hidraulica" (Law of Contributions for Betterment of Public Works of Hydraulic Infrastructure). It establishes that direct users of new irrigation systems, built up by the state, should cover a contribution of 90 per cent of the recoverable value of the works, in a period of 15 years and with a down payment of 10 per cent of such value the first year. The interest rate for annual payments is determined also through fiscal regulations.

b) Direct subsidies to investment costs vary among type and scale of the systems, the location and the potential users of the services. Pumped irrigation is not subsidized in irrigation districts, while gravity systems have certain participation of state resources, although it is ruled by the law mentioned already. Irrigation Units, are scattered all through the country, regardless of the type of irrigation, are subsidized in the investment costs because one of the main objectives of these units is social and local development. Tendency today is to combine federal, state and private resources for the construction of hydraulic works for irrigation.

c) Public investments include the works needed to convey water and deliver it to the farm. On-farm work can be financed totally by the producer or they may be financed with the aid of a repayable loan or credit.

d) There are no general indirect methods to finance public irrigation investments other than resources included in the public budget. Today, more and more participation of local and state levels is expected in construction works.

e) The recovery of irrigation investments, when it is done by direct means, is regulated by law (Law of Contributions for Betterment). The law also dictates that the resources obtained by this mean, should be again assigned to construction of new irrigation infrastructure, or reinvested in betterment or rehabilitation of existing hydraulic facilities.

f) As with every new, enforced, change (1986 is the first year that the law is applicable), there is natural resistance from users. This is due to a change in conditions that prevailed for years, where direct recovery was not considered as normal. Also, federal funds for irrigation systems all assumed to benefit the mass of producers and rural families with no water rights or land, by taking care of promoting productivity at the same time. Gradually, irrigation works became more expensive as the level of difficulty increases. If prices, economic conditions, devaluation of the Mexican peso and deterioration of the already odd equilibrium between the agricultural sector and the other sectors, do no help to increase productivity of the rural sector, effectiveness of investment recovery will be low. In order to be realistic, present charges or contributions are being revised and adjuusted to different payment capacities of farmers.

3. PERMISSION TO ABSTRACT WATER AND FEES

Payments for the abstraction of water are established by another different fiscal law: "Ley Federal de Derechos" (Rights Federal Law). The payment for

218

abstraction is a new concept in Mexico but is considered as one of the four components of the Price of Water. (Figure 1) It was first put into law in 1982. Annually, the fee is revised and adjusted to the socio-economic conditions, potential users and policies regarding the primary sector. Meanwhile the law takes into account different charges for different regions, water uses and sources of supply for irrigation activates. The abstraction component of the price of water was allowed to be uniform for all regions, an equal right per cubic meter, everywhere, and it is low, almost symbolic, compared with water charges in other uses. Still it is consistent with the principle that every water user must pay, must contribute for the use of water.

a) For irrigation, there is only one uniform change per cubic meter in the country. For 1985, Congress of the Union decided to exempt irrigation users from this payment. The regulation and the amount of the charges are reconsidered each year.

b) Two Federal Secretaries are responsible for the assessment and collection of water charges: Secretaria de Hacienda y Credito Publico (Secretary of Treasury and Pubic Credit) and, Secretaria de Agricultura y Recursos Hidraulicos (Secretary of Agriculture and Water Resources). They act in a coordinated way and are continuously looking for better, fair and efficient water price schemes.

4. FINANCING PRIVATE INVESTMENT

Policies with regard to financing irrigation investment on private farms again are consistent with national priorities in which sufficiency in food production is an important objective. in Mexico a regime of mix economy prevails. Public sector support of private investments in irrigation amounts to credit through nationalized banks, low interest rates, tax exemptions and technical assistance, among others mechanisms. the policy is to support private efforts as much as possible, subject to the availability of resources. However, private irrigation schemes are made possible basically because individuals commit their own resources.

a) Irrigation systems are public infrastructure that provide farmers with services of water distribution and drainage of excess and return waters. The users own the land as private producers or, exploit it under the "Ejido" system.

   As was mentioned, private irrigation schemes account for a small part of total irrigated area and in national figures their contribution is small. At regional and local levels, private developments might be more important because it is associated with certain crops and agroindustries that process the commercial farm's output, or the output may be for purposes of cattle and dairy production.

b) Besides attempting to supply loans at low interest rates, the general policy is to support investment decisions of farmers, considering scarce resources and the net transfer of surplus from the primary sector to the rest of the economy. Private individuals, are entrepreneurs that look for resources to capitalize their exploitations and make a growing and steady profit from it.

c) There is a lack of recent analysis regarding the comparison of public versus private irrigation schemes. By principle, the private schemes

379.

are expected to be more efficient and productive, with lower operation costs and adequate maintenance of their installation. One most recall that in Mexico there are no public irrigation systems owned, operated and exploited by public personnel. The systems were (mostly) constructed by the public sector, but the land and water rights belong to users, to producers registered in the system.

5. OPERATION AND MAINTENANCE POLICY

The general policy is that irrigation users must cover the total operating maintenance costs of the irrigation systems. (Figures 1 & 2) In irrigation districts, operation and administration of the infrastructure is a responsibility of the public sector, in particular, of the Secretary of Agriculture and Water Resources. This agency collects water charges and applies the receipts to cover operation and maintenance costs. The policy and the instruments for the implementation of these water charges are regulated by law (Rights Federal Law). Small scale irrigation units are under the direct administration of their respective user's associations.

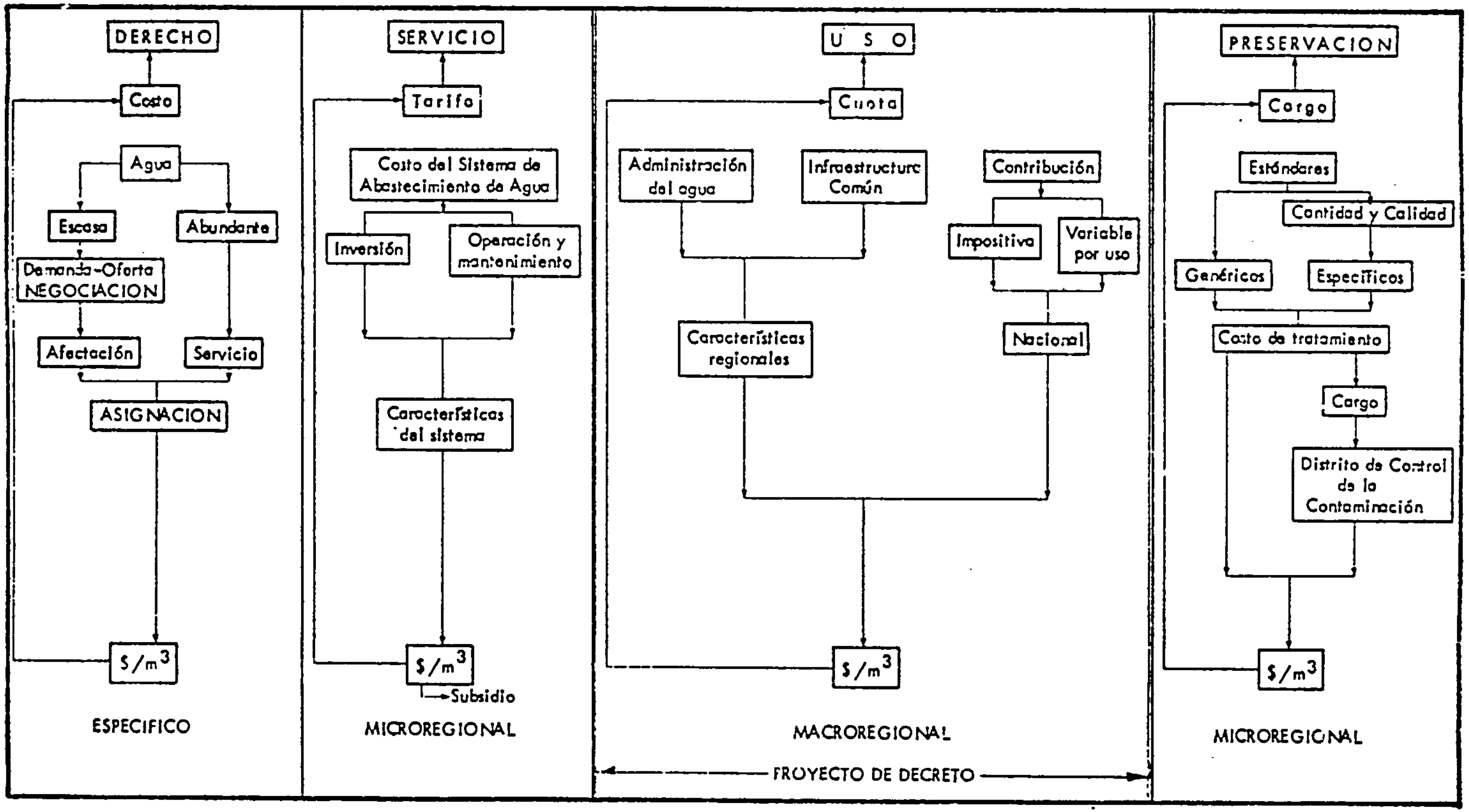
a) O&M costs are generally estimated on a yearly basis according to the accepted crop pattern programmed for the agricultural year, which in turn is a function of water availability expectations. The costs include all relevant expenditures for operation, administration, technical assistance and normal conservation or maintenance costs. The predominant method of collection of water charges is advanced payment by users when placing the order for irrigation.

   The types of water charges are mainly by volume delivered or by irrigated hectare. Amounts vary according to crops, with regard to their profitability, market of consumption and water use and, in some cases, a differentiation is made for farm size, type of producer, etc. The Government contributes some subsidies mainly to the less developed irrigation districts, those that have the smallest parcels per producer, low value crop patterns and lower technological conditions.

   The law, Ley Federal de Derechos, determines the level of financial self-sufficiency the districts must reach every year. The percentages are 60, 80, or 100 percent of O&M cost recovery depending on the size of the district and the average size of farm. Also, the same law considers some adjustments to these percentages, according to annual conditions of rainfall, controlled water availability, plagues, etc. As with most costs, irrigation expenses are rising as projects become more difficult to build and operate. Costs of dams are included in the investment costs, but their operation and maintenance are considered as part of O&M costs. In Mexico, income from energy production from multiple purpose dams is separated and directly managed by the Energy Commission, even though some of the common costs are included in the irrigation costs.

b) When economic resources are scarce to cover full O&M costs, budget for maintenance of the infrastructure is reduced and work is postponed until times with higher availability of resources. When this situation prevails over a period of years, the infrastructure suffers from deterioration and then programs and new investments for rehabilitation are needed. Actual policies are directed to stop deterioration and gradually recover and conserve structures built at

Figure 1 ELEMENTS INCLUDED IN THE WATER CHARGE



381

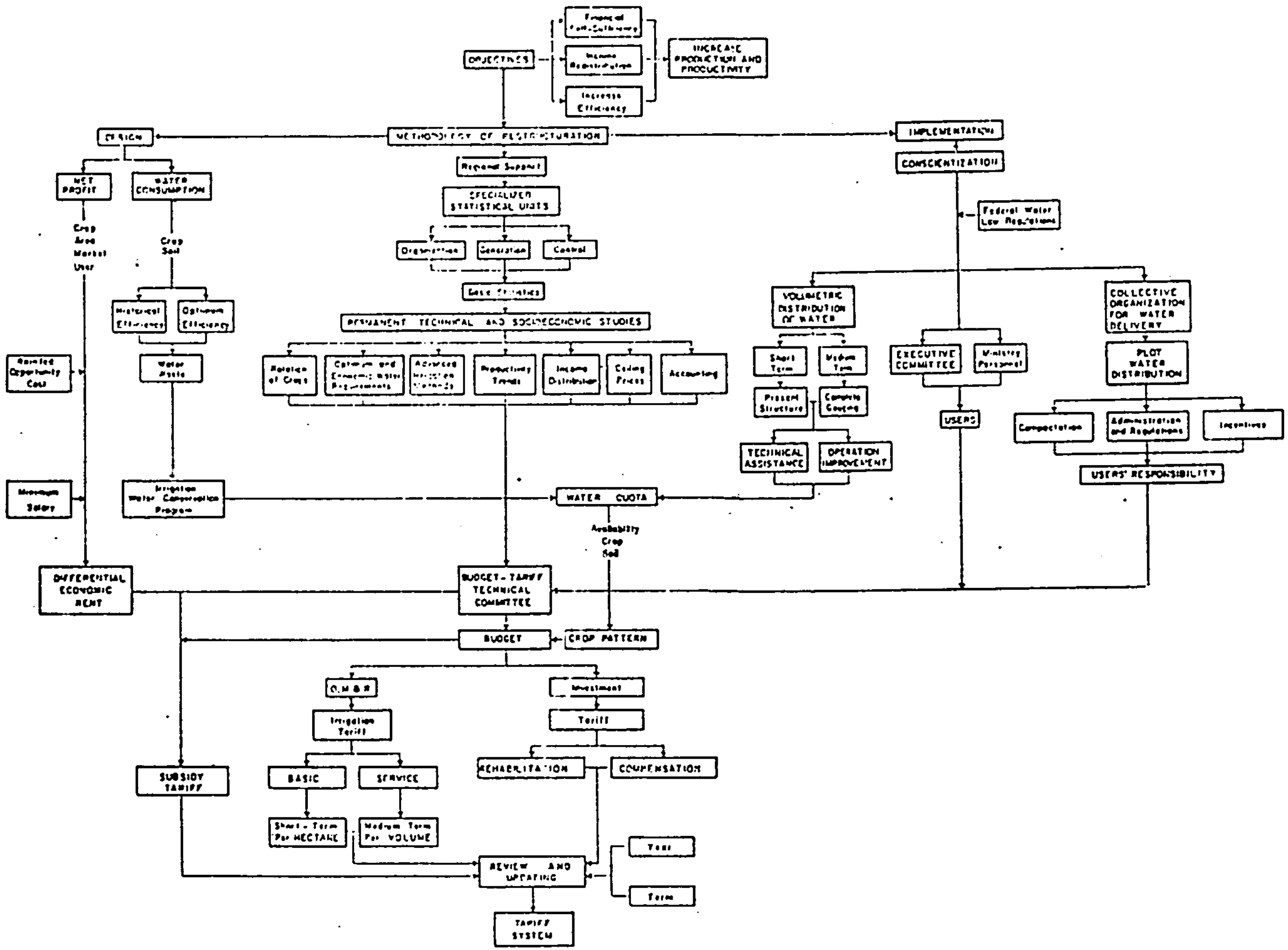


Figure 2 METHODOLOGY FOR RESTRUCTURING THE WATER TARIFF SYSTEN IN IRRIGATION DISTRICTS

382

different dates, relying on more involvement of direct users and general local participation.

c) O&M charges and investment recovery costs are calculated, fixed and collected separately and each fee is ruled by their respective law: Rights Law for O&M charges, and Law of Contributions for Betterment for Investments. National administration of irrigation districts takes care of collection of both charges. The income from O&M charges is used locally to cover recurrent cost for normal O&M. Income from recovery of investment costs should be used for new works, maintenance and repairs of existing hydraulic infrastructure. The funds are allocated to project at the central level after assigning priorities and distributing the budget among projects, programs, alternatives and regions.

d) Main components of O&M costs are: operation itself, conservation or maintenance and betterment of installations, administration, technical assistance to producers, statistics and research directed to irrigation, drainage and soil use. The first two components, operation and conservation, represent about 80 per cent of total costs, however, this percentage varies depending on the district.

e) Just few irrigation districts have deep well pumping systems; the majority are gravity ones. In districts using groundwater, the energy costs as well as the capital costs involved in drilling and equipment for the well, are covered by private uses. Energy tariffs have been steadily increasing over the past few years and represent, for users relying on deep wells, more than 70 per cent of their costs of managing water to irrigate their crops.

f) A recent reorganization of the Secretary of Agriculture and Water Resources had been carried out in accordance with national policies. More and more the activities and decision-making processes to allocate and manage resources for irrigation districts and units, are being transferred from the central to the regional level. The Secretary has Delegates in each state of the country (32) and they have the responsibility of watching over irrigation development. At the central level the following activities are performed. Setting norms, analysis and distribution of resources from the budget, plus monitoring and evaluation of projects and programs. Decisions are in accordance with national and sectorial objectives and priorities.

g) A comparison of O&M costs for high versus low investment costs schemes is difficult because many irrigation systems now operating were built where their construction were started more than 40 years ago. There development was much easier and direct than today's projects, which are constantly rising in level of difficulty and investment needs. It is expected that projects already built with good designs and correct operation procedures or rules, should have similar O&M costs per irrigated hectare. However, different characteristics of the various irrigation districts and technologies determine the level of O&M costs. Efficiency in conveyance and application also affect the unit costs, which are greater for those less efficient in water management districts, and for those having crop patterns with high water consumption per hectare, or whether there is single or multiple cropping. National administrators do not pay energy costs of deep well pumping, and therefore, from this point of view, gravity schemes for the public sector are more costly than others. Gravity systems are capital intensive in their construction with relatively low costs of O&M. Pumping systems are less capital intensive but require higher O&M costs.

h) By law and by internal regulations of irrigation districts, users or farmers do participate in O&M decisions through their representatives in the Comite Directive (Directive Committee), of the Irrigation District. Public agencies also participate, because there is an important role for the Secretary of Agriculture and Water Resources. In small scale irrigation units, because they are managed directly by their users association, farmers participate more directly in O&M decisions.

6. ABILITY TO PAY

The farmer's ability to pay water charges varies significantly according to irrigation district, location, technologies used, crops produced, efficiency in water use, and most important, prices for their products. Estimation of farmers' ability to pay poses problems. First, the statistics of cost production of crops generally are associated with prosperous or advanced farmers who are well organized, have accountants and use all inputs needed for better yields, and therefore have the higher production costs (Ed: per hectare). On the other hand, production returns most of times refer to average figures of the system or irrigation unit, instead of those of best farmers from where the costs come from. This leads to a general underestimation of the real ability to pay of farmers. In addition, rapid changes in the economic and financial conditions in Mexico, make any analysis obsolete very soon.

However, calculations for years 1976 to 1981 show that this ability is real and positive, since representative water charges average between 1 per cent to 3 per cent of production value in most cases, for most common crops. (See Table 1 for example calculations.)

a) Revenues from irrigated crops could generate a profit from 17 to 30 percent during a growing period of a crop (4 - 6 months) with respect to the costs of production. Again these calculations are for past years and today, with interest rates in the Banking System being around 90 per cent, simple annual rate, and more than 140 percent a year with continuous compounding, net profit estimates of irrigated agriculture should be revised.

b) Certain public sector industries produce inputs for agricultural production such as certified seeds, fertilizers, pesticides, etc. and are distributed at cost prices or at low cost among farmers, mainly those <u>ejidatorios</u> with scarce resources. Commercial and advanced farmers pay full costs and get their inputs out of private businesses or even import them, mainly from United States.

c) In regard to tax policies, recent administrations have decided to impose a preferential treatment to farmers producing food and primary goods. Exemptions have been agreed and implemented in taxes for land, production, and even for farmer's net income. This tends to offset to a certain point low income coming from low guarantee prices and the corresponding net transfer of economic and financial resources from the primary to industrial and commercial sectors.

2,84

Table 1 A FIRST DESIGN FOR RESTRUCTURING WATER TARIFFS FOR IRRIGATION DISTRICT No. 10 - CULIACAN Y HUMAYA, ACCORDING TO THE PROPOSED METHODOLOGY

CROP	HECTARES PLANTED	1977 AVERAGE: WATER CONSUMPTION	1977 AVERAGE: PRODUCTION COST	1977 AVERAGE: PRODUCTION VALUE	1977 AVERAGE: GROSS PROFIT PER HECTARE	1977 AVERAGE: GROSS PROFIT PER 10^3m^3	WATER TARIFFS: I-ON GOING UP TO APRIL 1977	RESTRUCTURATED: II-STARTING IN APRIL 1977: BASIC	II: COMP.	II: TOTAL	III - METHODOLOGY - FIRST PROPOSAL: BASIC	III: COMPLEMENTARY	III: BASIC	III: COMPLEMENTARY
		10^3m^3/hectare 1/	pesos/hectare		pesos 2/		3/ pesos/hectare/crop				pesos/hectare/crop		pesos/10^3m^3/crop	
Saffron	74 428	2.4	3 220	6 370	3 150	1 313	195	200		200	200	50	35	150
Soy Bean	56 503	7.1	6 510	11 000	4 490	632	210	200	150	250	200	200	35	70
Sorghum	49 045	5.8	4 915	10 150	5 235	903	200	200	100	300	200	200	35	100
Sugar Cane	30 741	11.9	11 600	18 810	7 240	614	210	200	125	325	200	400	35	60
Rice	25 000	14.4	7 600	12 730	5 130	356	210	200	150	350	200	400	35	50
Bean	18 070	2.6	5 200	7 100	1 900	731	195	200		200	100	50	35	70
Wheat	16 794	4.9	5 920	8 010	2 090	427	200	200	50	250	100	50	35	40
Tomato*	8 358	9.5	[illegible] 500	306 870	119 370	12 565	250	200	240	440	300	2 700	35	400
Chickpea	6 758	2.4	4 940	6 500	1 560	650	190	200		200	100	50	35	80
Corn	3 257	4.2	4 950	6 070	1 140	271	190	200		200	100	10	35	35
Cucumber*	3 005	7.9	155 080	240 700	85 620	10 838	250	200	165	365	300	1 700	35	400
Chilli*	1 723	9.3	69 460	111 770	42 310	4 550	250	200	200	400	300	900	35	180
Forage	1 720	7.3	4 890	7 480	2 590	355	210	200	110	310	200	50	35	40
R.Sorghum	830	6.0	5 505	8 190	2 685	448	210	200	95	295	200	10	35	45
Alfalfa	709	10.5	8 710	19 060	10 350	986	210	200	215	415	300	400	35	80
Sesame	300	3.0	4 350	6 075	1 725	575	190	200		200	100	50	35	60
Cotton	300	6.3	9 400	13 410	4 010	637	210	200	120	320	200	200	35	80
Others	7 660	6.0					200	200	95	295	200	100	35	70
WEIGHTED AVERAGE 5/	305 228	6.4					204	200	68	268	202	250	35	95

1/ 10^3m^3 = thousand cubic meters; corresponds to 10 centimeters water depth per hectare
2/ Before September 1976, one U.S. dollar = 12.50 Mexican pesos. After Sept. 1976, parity floats around 22.80
3/ Most of these tariffs were annual
4/ Tariffs that have to be covered by each crop planted. First and second crops pay independently
5/ The average is weighted with each crop's planted area

* Crops for export.

d) Water charges have been set low to not discourage production or affect significantly the net income of farmers. But, at the same time, and these are the central objectives of the Price of Water, (Tables 1 & 2) along with the amount of charges, water use efficiency and fair distribution of costs are decimal goals. For high value crops, water charges are not significant and in most cases, if not all, those charges are not subsidized. In low value crops, water charges might indeed affect substantially revenue from the activity, and this has to be taken into account when setting the amounts and deciding about subsidies.

TABLE 2. SOME CHARACTERISTICS OF THE THREE WATER TARIFF STRUCTURES

WATER TARIFFS	AVERAGE PERCENTAGE OF			1977 POTENTIAL INCOME million pesos
	Production Cost	Production Value	Gross Utility	
I	3.0	1.9	6.2	45
II	3.8	2.6	7.6	81
III	4.4	2.7	7.6	137

7. WATER CHARGE COLLECTION PROBLEMS

Problems with the collection of water charges do exist. Some of them are: frequent charges, due to high inflation rates but lacking actual statistics; allocation of available funds that just cover part of what is required to allocate fees; the enforcement of changing schemes that require human resources, actual data management and dynamic control systems, etc. These problems are widespread but the level of severity varies among irrigation districts.

Mexico supported original development as a means of colonization, promoting social peace, employment and production of primary goods. One of the problems faced now is the concept that farmers have about water as a common public resource, the Nation's property, for which there is no fee to pay. Even though water has no "legal" price, in economic terms it has a very real price that corresponds to the costs for its collection, its amount, its control and conservation. What water charges are design to cover are not the price of water but the costs of the services to deliver irrigation water to farmers and to provide adequate drainage systems. This mentality of farmers needs to be changes.

8. CONCLUSIONS AND RECOMMENDATIONS

While policies and instruments for their implementation, with regard to water charges are defined and clear, there still is a significant period of time required to reach the objectives. Hard work and effort is involved.

Irrigation costs are increasing in real terms and more rapidly than prices for agricultural commodities. In times of scarce financial resources there is a need for greater direct participation of users and farmers in coverage of associated costs of irrigation, in order to operate and maintain conveniently, the actual infrastructure and expand it to regions and farmers who do not yet benefit from it.

When setting water irrigation charges, three objective have to be promoted at the same time: Water Use Efficiency, Sufficiency of Water Costs, and Fair Distribution of Costs Among Beneficiaries. The following list suggests information about impacts upon farmers' and water change administration that is needed.

a) Technical, agronomic and economic efficiency of irrigated crops.

b) Calculation of relevant costs for setting Water Charges.

c) Collection instruments. Type, characteristics and effectiveness.

d) Water metering and its relation to water use efficiency and water pricing.

e) Differential water charges by crop, farm size, farmer, region, market of consumption, etc.

f) Financial sufficiency targets of irrigated units or developments.

g) Separation of costs and benefits with relation to water charge in multipurpose hydraulic systems.

h) Relations of agricultural prices with other sector prices, water charges and federal subsidies.

i) Water pricing in schemes for Humid Tropic Irrigation-drainage developments.

j) Pricing surface water and groundwater; regional conditions, alternative uses and over-exploited aquifers.

k) Selectivity of users and crops for water pricing and efficiency.

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7981

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383

IRRIGATION WATER CHARGES IN PERU

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I. INTRODUCTION

1.1 Agriculture Potential and Relevance of Irrigation Developments.

Peru has a territory of 128 million ha with a potential arable land of 7.6 M ha or 6% of the national territory. Actual use is 2.7 M ha. That is, an existing potential increase of 4.88 M ha (Table 1). Two regions with the best potential for additional land are the coast, with a potential of 876,000 ha, and the jungle, with 4.160 M ha, together representing 85% of the new land to be incorporated. Also, Peru only uses 1% of its potential water resources--most of them flow to the Atlantic, whereas the main irrigation development is along the Pacific coast.

A better understanding of the use of these resources may be had by studying the chart below, which shows existing resource distribution in the 3 regions of Peru:

	Coast	HighLand	Jungle
National Territory	10%	30%	60%
National Area Cultivated	25%	50%	25%
Regional Area Irrigated	100%	20%	6%
National Population	50%	40%	10%
National Value of Agriculture Production	50%	25%	25%
Regional Land Cultivated	5.6%	3.9%	0.6%
Regional Potential Increase of Land	2.1 Times	0	10.5 Times
Relation ha/Inhabitants	0.008	0.21	0.23

The numbers show that the coastal region is important in population concentration; high value of agriculture production; high level of irrigated land; very low person per hectare ratio, high productivity of land and high potential to double its area cultivated. The highlands are also important because of a concentrated level of population; substantial amount of cultivated land of low productivity; low proportions of irrigated land and low potential for increasing cultivated areas (terraces). The jungle region is the area that shows the most potential in the long run. It has a low population concentration and a great capacity to increase cultivated area (10.5 times).

In focusing our attention on the actual and potential irrigated land we must consider three aspects to evaluate the best way to increase a agriculture production in the short run:

1.1.1 Cost and Financial Possibilities

The cost of irrigation considers incorporations of new land, the improvement of the water systematization, and an evaluation of the irrigation projects (Zamora 1985) including 1,075,000 ha, concluded in the cost of US$ 900 per ha to US$ 6,000 with an average of US$ 2,500 in the coast. The same study mentions that in the high lands with 9,000 Ha of irrigation projects analyzed concludes in US$ 800 to US$ 3,500 with an average of US$ 1,300 per ha. In the jungle considering the small irrigation projects of Huallaga Central concluded in US$ 1,000 per ha.

The cost of land recuperation in the coast (PLAN REHATIC) varies between US$ 750 to US$ 2,500 with an average of US$ 1,600 per ha. In the highlands (terraces recuperation) the cost is between US$ 750 to 1,000 per ha (Masson 1985).

In addition to these cost alternatives to the critical financial needs of Peru, where the external debt problems leave small margin for public investment, we can understand why the present government is giving more priority to small and medium size irrigation schemes in the highlands instead of large irrigation projects on the coast.

1.1.2 Productivity Margins

Peruvian agriculture is characterized by a low yields. The actual margin for increases with low cost of extension service offers the possibility to double the production in the coast as well as in the highlands.

1.1.3 Water Management and Technology

The coast of Peru only uses 25% of the total water runoff. Water management and technology are in a critical situation due to low budgets in the irrigation districts and the very low cost of water charges. Water management and technology improvement in the coast and highlands provide real sources for production increase in the short run. We can conclude that, in these times of financial scarcities, the policy of irrigation development is concentrated on small and medium irrigation schemes in the highland and on improving crop technology and water management and technology on the coast.

1.2 <u>Agriculture Investment</u>

In the last 10 years, agriculture investment represented 15% of the total public investment. These investments were highly concentrated on irrigation Projects (80%) , especially on 4 projects on the coast:

-390

Names	Percent of Total Irrigation Investment 1981	1982	1983
Majes - Sihuas	41.9	10.0	13.8
Chira - Piura	23.0	34.2	19.4
Jequetepeque - Zana	9.4	9.1	16.1
Tinajones	7.8	5.1	3.0
TOTAL	82.1	58.4	52.3

These irrigation investments were also concentrated on large coast projects of long maturity periods instead of on small and medium sized projects with low cost and short maturity periods.

	% Of Total Irrigation Investment		
	1981	1982	1983
Large Coast Projects	84.7	59.0	54.0
Small & Medium	5.2	13.0	15.9

The actual tendency is not only toward small and medium size irrigation, increased from 5% (in 1981 to 16% in 1983), but also toward non-irrigation investments, such as research & development, soil conservation, rural settlements, trade, etc.

Year	Irrigation %	Non-irrigation %
1975	93.9	6.1
1976	88.5	11.5
1977	91.5	8.5
1978	85.6	14.4
1979	85.3	14.7
1980	77.5	22.5
1981	84.3	15.7
1982	68.9	31.1
1983*	65.0	35.0

Source: "PERU: EL Agro en Cifras" Universidad El Pacifico

* Estimated.

1.3 Crop Pattern Under Irrigation Agriculture

The predominant crops under irrigated lands of the Coast are: rice; white corn; yellow corn; sugar cane; fruit; vegetables; sorghum; soya; beans.

In the highlands we have: potatoes; wheat; white corn; barley.

1.4 Future Irrigation Plans

A National Irrigation Plan is under preparation, to be conducted by the National Institute to Increase The Agriculture Frontier (INAF) with the participation of the Agriculture Office of Planning (OSPA) and the Agricultural Policy Analysis Group (GAPA). The priorities are :

1. To concentrate the financial resources on small and medium size projects in the highlands where most of the rural people live, and where the projects have a high return with a short maturity time.

2. To finish the present stages in which large projects on the coast are involved, but not to continue the projects under the traditional standards.

3. To give increased importance to improving and maintaining the irrigation infrastructure and to improving water management and technology.

Under these guidelines, the expectations of the government for the future increase of land from the projects under way are:

	Total increase 1986-90	
Institution	Improved land	New land
National Institute to Increase Agricultural Frontier		
Plan Meris I	680	130
Plan Meris II	1,983	2,347
Linia Global 2	14,360	12,315
Plan Rehatic I	2,827	--
AFATER	18,502	--
Agriculture Sectorial Program National Institute of Development		
Majes		20,000
Tinajones	12,000	
Jequetepeque-Zana	30,000	13,400
Olmos	--	1,200
Sierra - Centro - Sur	18,430	
Puyango-Tumbes	2,500	6,500
Totals	114,658	62,915

392

2. ACTUAL POLICIES REGARDING THE RECOVERY OF IRRIGATION INVESTMENTS IN PUBLIC IRRIGATION SCHEMES

2.1 Definition of Public Investment in Irrigation :

An irrigation scheme is considered a public investment when it is conducted by :

1) The National Institute to Increase Agriculture Frontier, which specializes in small and medium size irrigation projects. They also conduct the preliminary studies of large projects.

2) The National Institute of Development, which specializes in the construction of Large Projects.

3) The Agriculture Sectorial Special Project, which specializes in small projects.

4) The Corporation of Development, dedicated to small projects and emergency investments.

2.2 Actual Policy Applied in the Recovery of Investment

In Peru there is no National Policy for Public Investment Recuperation as a whole, but specifically for irrigation investments the actual policy is based on the General Law of Water D.L. 17752 July 24, 1969, in which all water users have to pay per volume unit in order to finance the operations and maintenance of the irrigation district. Also, all beneficiaries of public works have to pay back to the government in conditions established for each specific case. The regulation of tariffs D.S. 683-72-AG , August 2, 1972 mentions three components: use, service and amortization. The last component is the one applied for recuperating public investment and was totally calculated by the government. These regulation was very specific in the methodology to calculate the amortizations:

1) Net cost excluded of financial expenses and interest.

2) Time of payment determined in each case depending on the return and useful life of the infraestructure.

3) Annual Payments actualized by a "factor."

If the government does not calculate the amortization by the time it was specified by the law the value will be 10% of the first component. Also in this tariff regulation there was no farmers'' participation and the total income went to the government treasury.

On July 10, 1981 a New tariff Regulation changed the components:

1) Users Group Income

2) Canon

3) Amortization.

But, in this instance there is no specification or amortization. It is only mentioned that the value is 10% of "Users Group Income" Component if there are no government calculations.

In conclusion, we see that the actual policy for public investment recuperation is the "symbolic" payment of 10% of the " Users Income " component which is also symbolic due to the reduced level with no relation with the actual needs in the irrigation district.

2.3 Effectiveness of the Method Applied

In spite of experience, Peruvian farmers are not prepared for real values of amortization. Post Agrarian Reform years, droughts, flood periods, and negetive terms of trade, made the farming business difficult, even creating the negative margins and losses. From 1975 to 1983 agriculture suffered under these circumstances and then it was difficult to apply a sound policy of public investment recuperation. In addition to this there was the government crisis: reduced budgets, low personnel salaries and the exodus of technical talent the consequence were no up-dated amortization calculations and ineffective measures to recuperate public investment. Recently, as a result of government policy oriented towards improving the terms of trade and the farming business, has been possible to initiate a new policy with real values for the amortization component.

2.4 Direct Subsidies Applied to Different Kinds of Irrigation Works and Government Financial Contribution in the Development of Tertiary Canals and on Farm Works

Both Large Coastal Irrigation Projects and for Small Projects in the Sierra, direct government subsidy was the only way for construction and rural development. The San Lorenzo Irrigation, Chira - Piura, Tinajones, Majes - Siguas, or Chili Irrigations together with all small projects of Plan Meris I and Linea Global II are all clear examples of the government as the direct investor, to date farmers are reluctant to repay. Table 1 shows the real subsidies on Chancay - Lambayeque Valley due to the difference between the nominal tariff (0.00030$M versus the real tariff(0.0032 $ m3) (Sarria & Zavaleta 1985).

Farmers accept participating in the development of tertiary canals and on farm works where a traditional quota exists to face these kinds of investments. Sierra communities are used for these projects works which have their own system for working it out.

Government financial contribution occurs in emergency cases where the Regional Development Corporation receives special funds to finance these special situations. In 1983, the northern coastal region suffered from a destructive flood. Government financial participation was significant in this instance.

2.5 Deficiencies of the Actual System and Plans for Changes

The main deficiencies of the actual system are (Sarria 1984):

1) Lack of government decision to enforce the Water Law, in any or all of

its aspects.

2) Lack of government investment recuperation policy to be applied in the amortization calculations, as stipulated by the Water Law.

3) The reduced budget in the tariff Office of the General Board of Water, Soil and Irrigation where there is no technical capability to follow the amortization policy.

4) Lack of government decisions to punish farmers who do not follow the payment conditions.

5) Lack of farmers awareness and acceptance of the need for public investment recuperation.

6) Bad experiences of the Users Group in the management of the tariff Funds and farmer training at this time, the government is trying to design new tariff legislation where a clear methodology is fixed for indicating:

- Who the direct beneficiary is
- What the net recuperated investment is
- When to initiate payments
- How long farmer must pay

3. ACTUAL POLICIES REGARDING THE FINANCING OF IRRIGATION INVESTMENT IN PRIVATE SCHEMES

3.1 Definition of Private Irrigation

Water for agriculture is owned by the State. All users must be registered in each Irrigation District and must present their crop plans each year.

The Water Law (1969) stipulates that any private initiative to work on desertic land requires a license for developing a private irrigation scheme. Private initiatives could be on any kind of irrigation works: canal, construction, pumping system developments, etc.

In 1982 the government created the " Private Integral Development Project" (PRIDI) to organize and finance through the Agrarian Ban all private initiative for developments agricultural projects on desertic lands, Supreme Decree NOI9-84-AG has regulated private irrigation schemes since April 10, 1984, for development projects a minimum of 100 ha to a maximum of 50,000 ha. In July 26, 1984 by Supreme Decree NO68-84 AG, the government lays out the economic and financial conditions to develop these projects.

3.2 Actual Financial Policies to Stimulate Irrigation Investments

Due to national financial problems in the last two years, the Agrarian Bank has not been able to create the funds specially applied to " PRIDI " projects. However, any private initiative could also apply to Agrarian Bank funds for capitalization under terms and conditions that vary with the crop and with the flows of income and expenses. The private initiative could include:

395

a) pumps, canals, machinery, rural construction, etc.

b) cropping costs.

There are "Integral Project Credit Basis" and are restricted to land owners who plan to work their land (not sell or rent). The actual carrying out depends on water availability.

1. Capitalization Credit Policy: (long term)

Beneficiaries	Individual farmer Farmer Association Cooperatives Water users' Group
Time of Payment	From 7 to 10 years Program BID 125/IC-PE considers 15 years
Grace Period	From 2 to 4 years
Interest Rate	Coast 48% of effective rate Sierra or Jungle 28% of effective rate Emergency areas 13% of effective rate
Equity relation	From 5% to 20% borrowers From 95 % to 80% Bank

2. Cropping Cost Credit Policy: (Short Term)

Time of payment	Depends on type of crop (6 to 13 month)		
Grace period	None		
Interest Rate	Coast	Food	23 % effective rate
		Nonfood	40 % effective rate
	Sierra	Food	14 % effective rate
	and Jungle	NonFood	40 % effective rate.
	Emergency Areas	Food	0 % effective rate
		NonFood	40 % effective rate

As said before, the Agrarian Bank Funds are the second best alternative until "PRIDI" Funds are made available.

3.3 Comparison With Public Irrigation Schemes

There is no way to compare actual public irrigation schemes with private irrigation schemes because of the lack of experience in the private sector. Before the agrarian reform, private initiatives existed in small scale irrigation projects but there is no information about the investment level, productivity or O & M expenses.

4. ACTUAL POLICIES REGARDING WITH O & M EXPENDITURES IN PUBLIC IRRIGATION SCHEMES

4.1 Basis for the Calculation and Main Components of O & M Expenditures. Are the O & M Cost Arising from the Dams Included?

The Tariff Regulation is clear in explaining the basis for O & M calculation. It mentions that Water tariff has three components: Users Group; Income; Water Canon; Amortization.

The "Users Group Income" component, finances the O & M expenditures and the funds collected are given to the users group, not in property since they belong to the government, but for administrative purposes.

The annual budget for O &M is prepared by the User Group together with the Technical Administrator who is the government official in charge of water management of the Irrigation District. The main components of the O & M calculations are :

1. Management and Water distribution cost;
2. Water charge administrative cost;
3. Users Group administrative cost;
4. Hydraulic Studies cost for superficial or underground water;
5. Conservation of irrigation and drainage infrastructure;
6. Reserve Funds for emergencies.

The Tariff Regulation mentions that 90% of the O & M budget is involved in these cost items. The remaining 10% is used in river basin studies. The Users Group General Assembly approve the budget and send it to the Regional Director for final tariff calculation. The water legislation is clear in pointing out that this component of water cost must not be higher than 5% of production cost of the least profitable crop.

Dams' O & M cost are supposed to be included on "Management and Water Distribution Cost" and "Conservation of Irrigation and Drainage Infrastructure" However, since large irrigation schemes are under "Autonomous Authorities " they are in charge of the maintenance of the irrigation infrastructure which is partially financed by the Water tariff and by a Special Quota.

4.2 Government Contribution to O & M Expenditures

As mentioned previously, in recent years farmers' conditions have created the need for constant government contributions for the maintenance of their irrigation infrastructure, either by National Agriculture Sector Budget directed to Irrigation Districts, or by the emergency funds as was the case of the Reconstruction Bonds applied to the Northern Floods in 1983. Government contributions have been increasing from 1981 - 1983, due to the decreasing collection charges from tariff this has also been the tendency through 1984 and 1985.

291

4.3 Comparison of O & M Expenditures with those Actually Required: Tinajones Case

One of the most important characteristics of present irrigation systems is the considerable difference between actual O & M expenditures and the real required costs. The inflation rate and the small increases in the budget were ingredients for this situation. The consequence of this deficiency is poor conditions in most of the irrigation infrastructure.

An example will be the Tinajones case where the maintenance situation is not as bad as the rest of the systems. EMTECO, a private technical conservation enterprise, is in charge of these works.

In 1985 , the Irrigation District of Chancay-Lambayeque had a tariff of 0.0002 US$/m3 but the SARRIA, et. al. study concluded that the real components of the tariff were :

Users' group Income (O & M)	517,000 US$
Canon	51,700 US$
Amortization	1,752,000 US$
Total	2,320,700 US$

Assuming deliveries of 1,079 million m3/year gives us a tariff of 0.002 US$ which explains the difference of actual budget for O & M with real expenses, where only 10% of real need is collected.

4.4 Method of Collecting O & M Charges and Relation to Cost Recovery

The Water Tariff Regulation mentions that water charges payments have to be made in the Technical Administration Office at the Irrigation District where special personnel is in charge of the collection, bank deposits and general accounting (Art. 15).

Each Irrigation District chooses the frequency of payment There are two alternatives: Cash Payments, in which farmers have to pay in advance to get their irrigation order, and Monthly Payments, in which farmers have to pay the last month's water received in order to be able to receive water the following month (Art.18). In actual practice, farmers pay on a yearly basis and upon issue of the invoice by the technical Administration Office.

There is a delay in the payments, but there are no penalties for this. The Tariff Regulation mentions that if the farmer uses water without making a tariff payment, he is obliged to pay a fine which runs from 0.37 US$ to 10 US$. (Art. 38)

Delay in payments is the reason for liquidity problems and lack of O & M expenses. Since the tariff is the result of O & M expenses and capital recovery cost, both are collected together at the same time.

But when charges are collected, the funds are deposited in different bank accounts. The funds collected for O & M from the "Users' Group Income" component of the tariff go to the Agrarian Bank to an account named " Users' Group of the Irrigation District of ...." The funds collected from capital recovery or "amortization" and "canon" go to the Bank of the Nation to an account named "Users' Service" (Art.19).

The bank account "Users' Group of the Irrigation District of ...." has to be administrated by the water users' group for specific purposes: as was mentioned before; 90 % of O & M and 10 % for river basin studies. Thus it is clear how the funds collected by a National Administration Office go back to the irrigation district where the funds were collected.

The bank account "Users' Service" is used by the Public Treasury Office in new investments.

Central level staff receive no support from tariff collection funds. They are paid by the State Agrarian Sector Budget and follow the National Budget rules and limitations. Provincial level staff are in the same situation. At the project level the Special Autonomous Authority have their own budget which has nothing to do with tariff collection funds. Only the personnel in charge of tariff collection, bank deposits and accounting are paid by tariff funds from the "Users' Group Income" account and they work for the Technical Administrator Office.

4.5 O & M Cost for Irrigation Schemes with High Investments per Hectare Compared with Those of Low Cost

Let us analyze the data comparing one example for each type of irrigation:

Table 1. HIGH INVESTMENT IN O&M: CHILI IRRIGATION DISTRICT*

a) O & M Budget for Arequipa Users Group**

Year	Amount	Ha	US$/ha
1983	92,629 US$	10,644	8.7
1984***	63,832 US$	10,644	6.0
1985***	29,824 US$	10,644	2.8

* Study made by the Agricultural Sectorial Program DGSI 1,983

** Average Exchange Rate: 1983 1,683 soles/US$
1984 3,730 soles/US$
1985 11,364 soles/US$

*** Projected

349

b) O & M Budget for La Joya Users Group

Year	Amount	Ha	US$/ha
1983	349,975 US$	12,370	28.2
1984	222,468 US$	12,370	17.9
1985	106,818 US$	12,370	8.6

c) O & M Budget for Sihuas Users Group

Year	Amount	Ha	US$/ha
1983	79,551 US$	838	94.9
1984	50,288 US$	838	60.0
1985	36,348 US$	838	43.3

Table 3. LOW INVESTMENT IN IRRIGATION: PLAN MERIS I (1983)

a) La Huaycha Project 540 ha (Medium)

Main canal	7 Km
Lateral canal	6 Km
Structures	47
Drainage	7 Km

Total O & M Expenses .... 1,183 US$

Total O & M Expenses per ha .... 2.2 US$

b) Granja Porcon Project 190 ha (Small)

Main Canal	9 Km
Lateral Canals	4 Km
Structures	34

Total O & M Expenses .... 487 US$

Total O & M Expenses, per ha ....2.5 US$

c) Carahuanga Project 970 ha (Large)

Main Canal	12 Km
Lateral	17 Km
Structures	50

Total O & M Expenses .... 5,830 US$

Total O & M Expenses per ha .... 6.0 US$

Table 4. COST OF PUMPING

Well no.	Operation Cost*		Maintenance Cost		Total O & M		
	Total $	$/m3	Total $	$/m3	Total $	$/m3	$/ha**
p-3	8,200	0.028	938	0.0028	9.138	0.030	300
p-4	8,100	0.028	969	0.0028	9,069	0.030	300
p-5	23,500	0.023	1,677	0.0021	25,177	0.022	220
p-6	13,300	0.020	1,036	0.0014	14,336	0.024	240
p-7	28,000	0.023	1,677	0,0014	44,013	0.024	240
p-8	7.900	0.022	988	0.0028	8,888	0.024	240
p-9	8,200	0.020	941	0.0021	9,141	0.024	240
p-10	8,600	0.028	938	0.0028	9,538	0.030	300
p-11	13,200	0.018	1,052	0.0021	23,790	0.028	280
p-12	8,200	0.016	957	0.0014	9,157	0.017	170
p-13	6,900	0.043	723	0.0043	7,623	0.047	470

* Exchange Rate 13,977 Dec. 1985
** Assume 10,000 m/ha average for Coast
***There is no specific study on O & M Expenditures for pump irrigation. However, the data for Moche Irrigation from the 1AFATER Project (Increase of Agricultural Frontier Through Irrigation Techniques) could be used to determine some coefficients to make comparisons possible.

401

We can draw some conclusions from the numbers shown:

1 High investment irrigation has an O & M expenditure of around 20 to 17 US$ per ha/year.

2. Low investment irrigation is around 5 US$ per ha/year.

3. Pumping irrigation systems have an expensive O & M cost of around 240 US$ per ha/year.

4. The difference between O & M of high cost with low cost is understandable because of the sophisticated system of canals reservoirs and drainage.

5. Gravity schemes are considerably cheaper than pumping because of equipment and fuel cost savings as well as the fact that they last considerably longer than mechanical systems which periodically break down and require repairs.

4.6 Farmers' Participation

Through the years, Peruvian water legislation has progressively changed from being state oriented to becoming more farmer-participation oriented. The Water Law of 1969 and Tariff Regulation of 1972 had no farmers' participation at all on O & M decision. In 1979, the Water Users' Group was created and the New 1981 tariff regulation gave farmers the administration of the "Users' Group Income" funds from tariff collection thereby giving them responsibility for O & M budgeting and expenditures, as well as for technical administration.

Presently all water legislation for evaluating farmers' performance of these responsibilities is undergoing revision.

5. CONCLUSIONS

1. There is potential for increased Agriculture production that can come from installing new cultivated or by improving already existing crop and water technologies

2. The Government of Peru is in critical financial condition due to external debt problems and balance of trade difficulties.

3. There is no national policy for public investment recuperation In the specific case of public irrigation investment, the tariff regulation stipulates an amortization tariff component to recover public investment. However there are no policy guidelines for making calculations. Past experience shows that the use of this " amortization " tariff component did not obtain the desired objectives.

4. The PRIDI Project is a public organization dedicated to the development of private irrigation schemes. The Agrarian Bank does not have the necessary funds to develop the PRIDI projects, nonetheless it

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402

offers capitalization funds for irrigation projects under conditions that are not so convenient to farmers.

5. Water management in Peru is in a state of crisis. O & M expenditures are far below those actually required. tariff collection is slow and late. The tariff rates are out of date.

6. O & M cost per hectare of low cost irrigation schemes are much lower than high cost investment irrigation and pumping systems. Gravity irrigation O & M expenses are lower than the irrigation system which need pumping. A reduction in fuel prices can change this situation.

6. RECOMMENDATIONS

1. The Government must dedicate public agriculture investments to small and medium sized irrigation schemes in the highlands. They should also improve crop and water technologies.

2. The Government must establish a short run public investment recuperation policy.

3. The tariff regulation has to be updated to include clear policies for irrigation public investment recuperation and to allow for calculating amortization tariff components.

4. The Government must give priority to private irrigation investment by supplying funds to the Agrarian Bank and thereby permitting the development of PRIDI Projects.

5. Technical studies to support and promote private , commercially viable, irrigated agriculture in the coastal region should be undertaken by PRIDI. Commercial Farming by the private sector should be supported by government.

6. The Government must initiate a dynamic policy toward the optimization of water use in agriculture.

- Water charges collection must be up-dated
- Tariff must be up-dated
- On-farm water management training should receive greater emphasis by INIPA (National Institute for Agriculture Research and Extension)

7. Last, but not least, the government must reorganize its institutions and update its water laws to be able to face the challenges of the future.

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407

Appendix Table 1 PRODUCTION COST AND REVENUES OF THE MAIN CROPS IN PIURA VALLEY (US$/ha)

COST ITEMS	COTTON	RICE	YELLOW CORN	GRAIN SORGUN
LABOR	241.8	296.7	107.8	55.0
MACHINERY	114.0	183.3	118.0	118.6
ANIMAL TRACTION	5.9	—	—	—
SEED	15.1	26.4	25.9	52.1
TRANSPORTATION	15.5	31.2	28.9	4.2
WATER	2.2	5.16	1.7	17.7
FERTILIZER	64.8	97.2	57.0	52.9
CHEMICALS	163.2	14.2	58.1	66.1
PACKING	18.8	5.5	—	—
SUB-TOTAL	641.3	659.6	397.4	366.6
ADMINISTRATIVE COST	90.5	68.0	37.5	32.9
FINANCIAL COST	199.7	183.6	76.0	53.3
SOCIAL BENEFIES	113.1	149.6	52.1	26.6
OTHERS	37.7	40.4	19.8	18.3
TOTAL FARM COST	1,082.3	1,101.2	582.8	497.7
PRODUCTION KG/Ha	11.0	5,500.0	3,500.0	4,500.0
FARM PRICE US$/Kg	146.4	0.23	0.21	0.19
VALVUE OF PRODUCTION	1,610.0	1,265.0	735.0	855.0
NET INCOME	532.7	163.8	152.2	357.3

Source : NATIONAL INSTITUTE FOR RESEARCH AND EXTENTION

1) EXCHANGE RATE 13.5 SOLES PER US$

2) COST ARE FOR MARCH 1986.- COTTON, CORN, RICE AND SORGUN ARE IMPORTANT CROPS IN COASTAL IRRIGATED LANDS

3) COTTON PRODUCTION ARE IN "CARGA" PER Ha

405

Appendix Table 2 ACTUAL WATER CHARGES APPLIED IN SOME REGIONS OF THE COUNTRY (US$/1000 m^3)

IRRIGACION DISTRICT	1980	1981	1982	1983	1984	1985
SAN LORENZO	0.83	0.56	1.72	1.96	0.88	0.67
ALTO PIURA	0.50	0.36	0.94	0.39	0.29	0.096
MOTUPE	0.50	0.35	0.28	0.23	0.26	—
LA LECHE	0.50	0.35	0.28	0.11	0.13	—
CHANCAY - LAMBAYEQUE	0.83	0.56	0.35	0.59	0.53	0.21
ZAÑA	0.50	0.35	0.71	0.29	0.13	—
JEQUETEPEQUE	0.50	0.35	0.35	0.17	0.26	0.10
CHICAMA	0.50	0.35	0.21	0.14	0.10	—
MOCHE	0.50	0.67	0.57	3.57	0.41	—
SANTA	0.83	0.56	1.00	0.41	0.26	0.10
CASMA	0.50	0.36	0.45	0.19	0.10	—
HUARMEY	0.50	0.36	0.40	0.16	0.40	0.07
BARRANCA	0.83	0.56	0.50	0.20	0.32	0.39
HUAURA	0.83	0.56	0.50	0.20	0.35	0.10
CHANCAY - HUARAL	0.83	0.56	0.64	0.26	0.46	—
CHILLON	0.83	0.67	1.10	0.45	0.46	0.14
RIMAC	0.83	0.67	0.64	0.26	0.44	0.14
LURIN	0.50	0.49	1.10	0.45	0.51	0.16
MALA	0.50	0.42	0.74	0.30	0.89	0.28
CAÑETE	0.83	0.67	0.50	0.41	0.18	0.21
CHINCHA	0.50	3.50	0.71	2.05	2.06	—
OCOÑA	0.33	0.90	0.57	0.98	0.44	0.34
CHILI	0.83	0.56	0.68	0.24	0.10	0.13
CAJAMARCA	0.33	0.45	0.28	0.25	0.10	0.37
ABANCAY	0.33	0.22	0.64	0.46	0.31	0.39
*Average exchange rates: S/. per US$	1980...300	1981...442	1982...698	1983...1,682	1984...3,730	1985...11,364

IRRIGATION WATER CHARGES IN JAMAICA

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1. INTRODUCTION

The area presently irrigated in Jamaica is approximately 40,500 hectares (100,000 acres) or 12.2 percent of the cultivated land. Approximately 85 percent of the irrigated land comprises the semiarid to sub-humid plains in the south-central area of the island, in the parishes of Clarendon and St. Catherine.

Approximately 70 percent of the irrigated land is in sugar cane; the other important uses being bananas and pasturage, each of which occupy approximately 10 percent of the irrigated lands.

The predominant method of irrigation is surface irrigation employing furrows. Drip irrigation of bananas is presently regaining favor. Sprinkling is used to a limited extent.

There are no present plans for new irrigation systems in Jamaica. However, there are active projects for major improvement and rehabilitation of the systems in the two principal irrigated areas of the island. These systems comprise approximately 85 percent of the irrigated area. For the larger area, the Clarendon Plains (21,000 hectares), the project is in the detailed design stage (July, 1986). For the other, the St. Catherine Plains (14,000 hectares) the principal investigations for project formulation are now being carried out.

2. FINANCING POLICIES

Present policies for the financing of investments in public irrigation schemes are two fold:

(i) where the sums are large and require specific loan financing; and

(ii) where the sums are smaller and may be accommodated in the national capital budget.

For investments requiring loan-financing, a Project Profile usually requiring a preliminary feasibility study, must first be forwarded by the proposing agency to the Planning Institute of Jamaica for presentation to the Pre-selection Committee of the Ministry of Finance. On approval by the Pre-selection Committee, funds are provided to the proposers for detailed feasibility study and design. The Planning Institute then begins the process of identifying and confirming a source of funds for the execution of the proposed works. With positive feasibility findings and the completion of designs, a loan agreement to fund the execution is completed and the works executed. In recent years, feasibility studies and designs have been financed by special loan programmes; and the repayment of such loans are considered a part of the execution cost.

For relatively small works, the Ministry of Finance may directly approve requests for the provision of funds in the annual capital budget.

Present levels of subsidy to irrigation works are:

(i) for capital costs: 100 percent to all types

(ii) for O & M costs:

-canal system fed mainly by river diversion - 84 percent
-canal systems fed mainly by borehole wells - 92 percent
-pressurized pipe systems fed by borehole wells - 95 percent

The Government in Jamaica finances the total construction of irrigation water distribution systems up to the individual farm lot boundaries. It also makes loans available to farmers to finance on-farm works.

The Irrigation Act makes statutory provision for the application of local taxes to finance irrigation investments. However, the provision has not been applied. There is at present no active policy for the recovery of investments in irrigation in Jamaica.

3. IRRIGATION WATER APPROPRIATION POLICIES

At present, a charge is made only for a license to abstract groundwater. Such a license is perpetual. The present charge is four hundred Jamaican dollars (J$400.00). The Underground Water Authority presently imposes the license charges.

Legislation is proposed to require annual licenses for the abstraction of ground and surface waters, and further annual charges for the use of water, depending on the nature of both the abstraction and the use. The proposed legislation will establish a Water Resources Authority in the place of the present Underground Water Authority. The new Authority will impose the license and user charges.

4. IRRIGATION COSTS

Sixty percent of the irrigated lands are served by private systems (which include the self-contained systems of Government owned estates, some thirty-nine percent by public systems and one percent by a semi-public system.

The single present policy in support of private irrigation is a subsidy paid by the Sugar Industry Authority to producers of sugar cane who pump water for irrigation. The present subsidy level is five Jamaican dollars (J$5.00) per long ton of canes produced.

Meaningful hard data on comparative investment costs are not presently available. However, public system construction must include certain cost factors not applicable to private systems, e.g: purchase of canal and pipeline rights of way; purchase of well sites; construction on public roads; and more elaborate well control houses. Unit costs for similar items are otherwise the same.

4.1 Private

Operation and maintenance costs reported for private systems averaged J$900 per acre served in the crop year 1985. For public systems, the equivalent average costs for deepwell systems was J$750 and for a gravity river system J$110 per acre served. These figures reflect the inadequate maintenance of public systems; and possibly, exaggerated energy costs for private systems.

Private and public well pumps averaged 80 percent operating reliability; with private pumps averaging 85 percent of rated yield and public 75 per cent. The public river system averaged approximately 50 percent of rated yield.

4.2 Public

O & M expenditures (for public systems) are taken to comprise:

-local scheme office costs.
-energy costs.
-system operator costs.
-system maintenance costs (cleaning, ordinary repairs etc.).
-Costs arising from (diversion) dams are included.

Costs of replacement of plant and equipment, and for Ministry head office services are not included.

In recent years, O & M expenditures have fallen short of requirements, resulting in inadequate preventative maintenance of well pumps and cleaning and repair of canals. During Financial year 1985/86 the Mid-Clarendon Irrigation Authority requested J$6,268,782 but was allocated only J$4,221,016.

Energy is the principal component of O & M expenditures where water is pumped. The costs of field operating staff or "canal attendants" and of canal cleaning are next in importance; and are the principal cost components of systems which do not include pumping.

The unit O & M cost of water in community sprinkler systems is approximately twice that in canal systems fed by borehole wells.

Available records do not allow for the concise identification and comparison of similar type systems of high and low investment costs.

As indicated in 4 c) above, O & M cost of a gravity system is approximately one-seventh that of a deepwell system.

5. OTHER RELEVANT AGRICULTURE SECTOR POLICY

Data are given in Table 2 for the principal irrigated crop, sugar cane, which also reflects the lowest revenue of standard crops.

Agricultural inputs other than fertilizers are traded at market prices. The importation of agricultural inputs does not attract duties. A current programme supported by the Canadian International Development Agency makes fertilizer available at eighty percent of world market prices.

Farm product prices are determined by the market conditions. While there are a number of commodity "boards", there is no specific policy of price support.

Land in active agricultural production receives a seventy-five per cent remission of taxes. There are no taxes on produce, or presently on incomes derived from the production of crops.

The present level of water charges in public irrigation systems operates as a major subsidy in the production of irrigated crops.

6. ADMINISTRATION AND WATER CHARGES

Central Government Ministry support to public irrigation includes two assigned administrative officers, Ministry Engineering Division representation on the boards of (4) Irrigation Authorities, ad-hoc technical assistance by the Ministry Engineering Division and the engagement of consultants for specific investigation and development tasks.

There is no support of public irrigation at the parish (provincial) level in Jamaica.

At the scheme level, four of the five public schemes are constituted as statutory Authorities governed by a Ministry appointed board of nine members. The fifth is constituted as a department of the Ministry having jurisdiction. Each scheme has a Works Manager (2) or, if small, a Works Overseer Grade I (3), other Works Overseers, accounting, clerical, operating and maintenance staff.

The four public systems organized as Irrigation Authorities include local farmer representation on the boards. The board chairman is normally a local farmer and he has executive powers.

There is presently no capital cost recovery. Where the irrigation system is operated by a "Statutory Body" called an "Authority", the charges collected by the Collector of Taxes are handed over to the Authority. Where the system is operated as a department of a Ministry, the collected charges go into the general revenue - this applies to one case which is proposed to be changed.

The levels of charges are set by the Central Government Ministry. Quarterly billings are made to contracted farmers and payment is made to the local Collector of Taxes who is provided a charge roll.

Government does not contribute to the payment of the amounts charged to farmers. Government actually subscribes eighty four to ninety five percent of the O & M costs of public systems as indicated above.

The present institutional "set up" is considered to be adequate for collection of water charges. The efficiency of collection is determined entirely by the resolution of the governing bodies in locking off supply to defaulters.

The major weakness of the system is in the updating of charges. This updating is controlled by the central government ministry having jurisdiction.

410

These ministries have been reluctant to increase the charges.

7. CONCLUSION

Farmers served by public irrigation systems are presently having a "free ride" compared to the operators of private irrigation systems. This condition is however, somewhat reduced by the lower water productivity of public systems due to their inadequate maintenance.

8. RECOMMENDATIONS

It is recommended that prescriptive systems be instituted for public irrigation bodies to:

i) Allow the acquisition of the funds they require each year for operation and maintenance, whether by budgetary grant or the collection of charges; and

ii) make mandatory the updating of charges whenever the limit of availability of budgetary support would produce a shortfall in the funds required for operation and good maintenance.

411

Table 1

Water Charges Applied in Public System

Type of System	Present Annual Charge Applied Since 1983	Previous Annual Charge and Applicability
Gravity Canals served by river diversion	J$12.00 per cubic yard per hour continuous flow (c.y.h.)	J$3.60 per c.y.h from 1957 to 1983
Gravity Canals served mainly by deepwells	J$30.00 per c.y.h	J$9.00 per c.y.h. from 1957 to 1983
Pressurized pipe systems served by deepwells or boosters from canals	J$50.00 per c.y.h	J$18.00 per c.y.h. from c. 1968 to 1983

* Present rate of exchange J$5.50 = US$1.00

Table 2

Average Revenue from Sugar Cane Cultivation with Surface Irrigation Using Deepwells

	Private	Public
Average yield is 25 tons/acre/year		
Average price is J$88 per ton		
Revenue from cane sales, per acre	J$2,200	J$2,200
Pumping subsidy at $5 per ton	125	nil
Gross revenue	J$2,325	J$2,200
Production cost other than water supply per acre	612	612
Irrigation water supply, per acre	900	60
Net revenue. per acre	813	1,528
per hectare	J$2,009	J$3,776

Source: Sugar Industry Research Institute

412

Short Report on Cost of Irrigation Water and Irrigation Water Charges in Some Arab Countries

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1. INTRODUCTION

At present the Arab Countries import more than 50% of its food requirements and the rate of increase in demand for food exceeds the rate of increase in agricultural production. On the other hand aridity is the major constraint for increaed food production, and, hence irrigtion development is considered a prime way of raising agricultural production, which is a prerequisite for attaining the goal toward food security. This is confirmed by the fact that at present only 30% of the cultivated areas in the Arab Countries is irrigated but its production amounts to some 75% of the total agricultural production.

A rapid irrigation development in the Arab Countries only started in 1950's and gained full momentum during 1960's. In all large river basins, major surface storage reservoirs have been built or are under construction (Nile, Euphrates and Tigris). In other parts of the Arab World, (Jordan, Lebanon, Saudi Arabia, Yemen Arab Republic and Countries of North Africa) smaller dams are in different stages of planning or execution. Saudi Arabia, Yemen Arab Republic and People's Democratic Republic of Yemen are planning to convert the traditional spate irrigation to perennial irrigation by better control of flood water of these seasonal wadis and the use of the groundwater reservoirs in the alluvial plains of these wadis. The large groundwater basins known so far (Egypt, Sudan, Libya, Tunisa, Algeria, Saudi Arabia and the Gulf States) are being developed.

This process of rapid agricultural development under irrigation was accompanied by the process of desertification as marked by increasing micro-aridity and declining productivity. In many Arab Countries (Egypt, Iraq, Syria, etc.) manifestations of waterlogging and salinity on irrigated lands are major problems due to poor management of irrigation water in the conveyance system as well as in the field. Also increasing salinity of underground water and falling level of water tables due to overpumping is another serious problem in nearly all Arab Countries. In Saudi Arabia and the Gulf States, for example, the artesian flow of springs and wells is decreasing, the water quality is deteriorating the water level is falling due to increased extraction and perhaps decreased recharge; thus causing salt water intrusion.

418

From the above it becomes evident that in most Arab Countries the easily accessible conventional water resources, such as river flows and shallow groundwater of good quality have been almost entirely committed. In the allocation of water between the sector, priority normally is given to the domestic sector for which quality requirements are stringent. Agriculture on the other hand, requires relatively large quantities of water, but this sector can accept low quality water. As indicated above in most Arab Countries, the easily accessible good quality water supplies for agriculture are diminishing and it is therefore inevitable that there will be a tendency, in the future to look for agriculture as a potential user of marginal quality water, including the utilization of effluent water from domestic as well as for industrial waste, this will not only alleviate the water shortage situation, but it will also solve the problem of wastewater disposal.

Hence the scarcity of water supplies, hich is badly needed to meet the increasing needs of population growth and rapid development in agriculture as well as in industry has given cause for concern in formulating of national development plans in the Arab Countries. It is gratifying to report that decision makers are being increasingly involved in divising ways to optimise the use of available supplies as well as augmenting the available water resources by non-conventional means and the development of costly and deep underground water. The non-conventional resources programme includes two programmes, one is for increasing domestic water supply through desalination of saline water (sea water and underground water) and the other is for the treatment of the sewage effluent and its use for different purposes.

In this regard it may be pointed out that in arid areas, as is the case with the Arab Countries, recycling of water may have a greater impact on future usable water supply than any of the technologies aimed for increasing water supply such as, water harvesting, weather modification (artiiiciala rain) desalting of saline water, etc. Treated sewage water can be used for irrigation, industry, rercharge groundwater and in special cases, properly treated wastewater could be used for municipal supply. With careful planning various industrial and agricultural demands may be met, by purified water, there-by freeing freshwater for municipal use. Several Arab Countries, particulary, Jordan and the Gulf States, have already initiated ambitious programmes in this field.

2. COST OF UNDERGROUND WATER IN SOME ARAB COUNTRIES

The following discussion is based on the available information on ground-water costs from FAO files and project reports and the documentation centre of FAO. The cost of groundwater from wells depends on the cost of the well and pumping equipment plus the cost of operation and maintenance. It also depends on the discharge of the well and the number of pumping hours per annum. The well cost depends primarily on the geological formation, the depth, the well design and the type of screen to be used. Well cost is sensitive to the location, both in terms of access to site and availability of drilling equipment (existence of a Government Drilling Department, for instance). Well cost increases markedly if equipment and material have to be imported from outside the country, especially by a Contractor. The cost of groundwater as related to depth of wells is summarized in Table 1, while Graph 1 shows the relationship between the depth of wells and their total cost in different countries. On the other hand Table No. 2 indicates the cost of water taking all related factors into consideration.

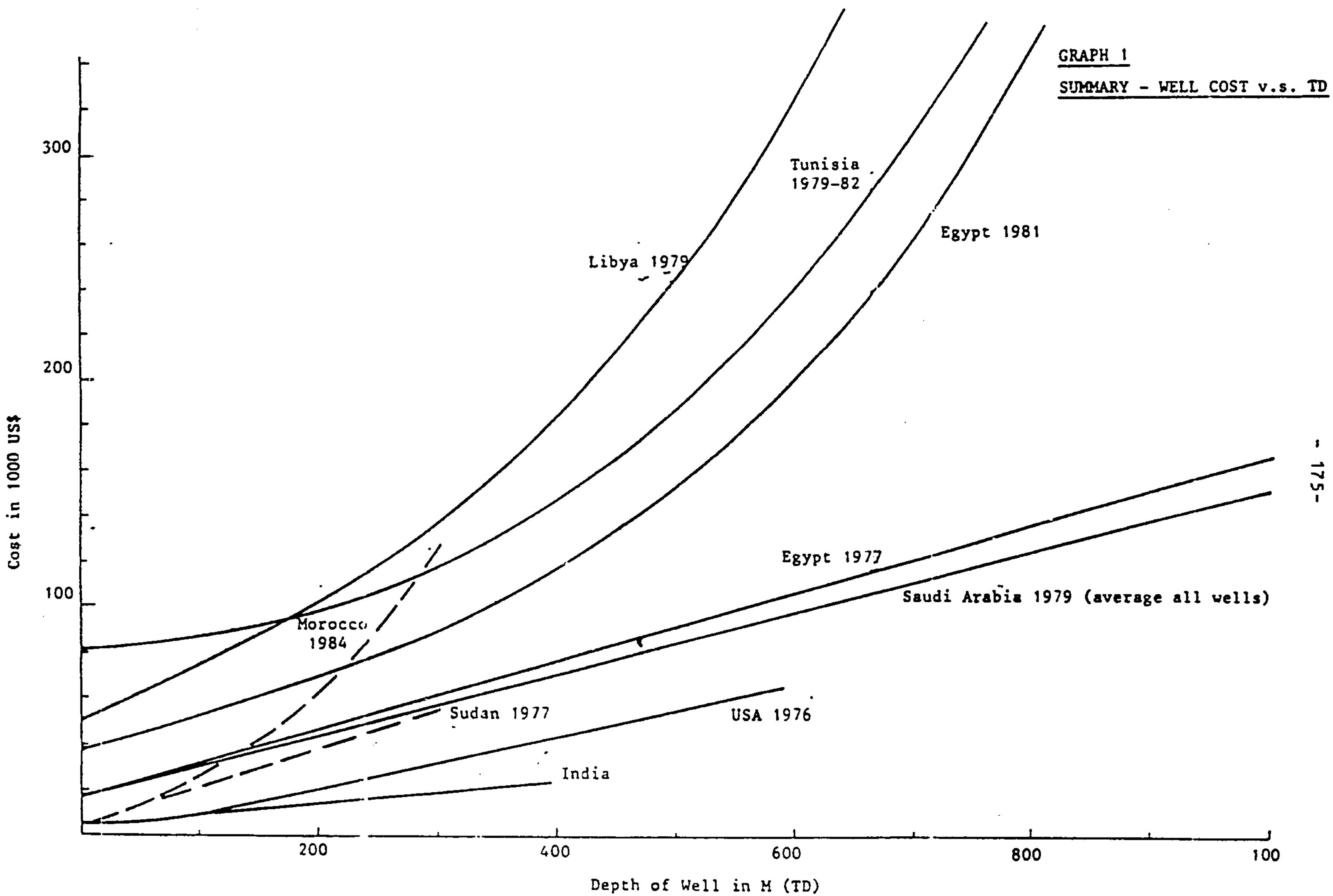
TABLE 1

SUMMARY OF GROUNDWATER COST AS RELATED TO DEPTH OF WELLS AND ADJUSTED FOR 3 600 H OF PUMPING

Country	Year	Depth of Well m	Cost in US $ Per 1000^3 m
Jordan	1984	200	92
Libya	1972	500	113
	1982	200	185
Egypt	1977	500	30
	1981	200	60
Tunisia	1982	400	205
Syria	1975	500	83
Saudi Arabia	1979	500	27
	1979	400	20
	1979	200	12

Irrigation projects based on groundwater derived from wells (especially deep wells) are expensive and normally fall in the category of high expensive irrigation projects. In addition to the high cost of water the costs of the water distribution system as well as the land development have to be added. Higher capital costs (above $ 4 000/ha) plus operation and maintenance costs ($100 to 300/ha/year) always require higher valued crops and higher cropping intensities so as to be justified on an economic basis. Table No. 3 summarises the cost of irrigation projects related to the depth of groundwater.

415



GRAPH 1
SUMMARY - WELL COST v.s. TD
Cost in 1000 US$
300
200
100
200
400
600
800
100
Depth of Well in M (TD)
Libya 1979
Tunisia 1979-82
Egypt 1981
Morocco 1984
Egypt 1977
Saudi Arabia 1979 (average all wells)
Sudan 1977
USA 1976
India

- 175-

TABLE 2: COMPONENT OF WATER COST FROM DIFFERENT DEPTHS OF WELLS - SYNTHESIS OF WELL DATA

TD (m)	Q (m^3/h)	Pump Lift L (m)	Q x TD (10^3/hxm)	Equip. cost (10^3US$)	Total Well cost (10^3US$)	Energy cost* diesel ($/h)	Energy cost* elect. ($/h)	Average annual energy cost (10^3 $) h. of pumping 2880	3600	4200	Capital & Replacement costs (10^3 $) Well**	Pump***	Total Incl. 4% mainten.	GW cost (US$/$10^3m^3$) h. of pumping 2880	3600	4200
100	50	80	5	5.5	44.5	0.64	0.69	1.93	2.41	2.81	5.67	3.75	9.79	81	68	60
200	100	150	20	12.6	61.5	4.66	5.00	13.83	17.28	19.57	7.10	8.59	16.31	105	93	85
300	150	200	45	20.4	91.7	9.33	10.00	27.65	34.56	40.32	10.36	13.90	25.23	122	111	104
400	200	300	80	28.7	132.6	18.66	20.00	55.58	69.12	81.06	15.10	19.57	36.05	159	146	139
500	250	400	125	37.4	185.0	31.12	33.30	92.16	115.2	134.4	21.44	25.83	48.78	196	182	174
600	300	500	180	46.5	250.0	46.67	50.00	138.24	172.8	201.6	37.14	31.07	70.93	242	226	216
800	400	600	320	56.1	416.0	74.60	79.90	221.8	277.2	323.4	64.80	61.60	131.50	114	91	78
1000	500	700	500	65.4	628.7	108.80	116.60	322.6	403.2	470.4	95.00	103.30	206.20	143	115	98

* Energy cost calculated on the basis of: overall pump eff. = 0.7; overall pump eff. x motor eff. = 0.6, diesel oil cost: $0.26/Lt.; electricity: $0.08/kwh

** Capital cost I = 5; N = 20. Replacement cost I = 10; N = 20

*** Capital cost I = 5; N = 20: Replacement cost I = 10; N = 7.

TD = total depth
Q = well discharge
GW = groundwater

TABLE 3

UNDERGROUND PROJECTS - UNIT COST PER HECTARE (IN US DOLLARS)

Items	Shallow wells Tunisia[a]	Deep Tubewells 100 m-deep Bangladesh	100 m-deep Turkey	330 m-deep Egypt (New Valley)	400 m deep Tunisia
Well	1 900	500	390	2 100[b]	1 600
Pump set	700	220	1 050[c]	700	400
Water distribution system	400	-	640	4 500	5 000
On farm development	-	-	320		
Total	3 000	720	2 400	7 300	7 000

a Masonry well 17 m deep and 4.5 m diameter
b Stainless steel screen
c Including power line

The cost of water from wells of more than 200 meters deep is expected to be at least 10 US cents per cubic meter and can go up to 25 US cents per cubic meter, depending on the depth and location of wells as well as on the country concerned. In the early 1970s and before the steep rise in the cost of energy it was projected that by 1990 the cost of desalted water from the sea will drop to 5 US cents per cubic meter from desalination plants with a capacity of more than 4 million m^3/day. However, due to the rise of oil prices after 1974, this projection is no longer valid. At present the cost of desalted water from brackish water of 3 000 to 10 000 ppm using the reverse osmosis process (which is the most suitable) is just above \$1.0/m^3. While the desalted water from the sea using multi-stage-flash (the most suitable) costs about \$1.5/m^3. Hence groundwater from deep wells and which is suitable for domestic supply is still competitive with the desalted water from either brackish or seawater.

When using expensive water for irrigation, as is the case with groundwater from deep wells, maximizing the efficient use of this water is imperative, hence the advent of improved irrigation systems such as drip irrigation and more recently the minisprinklers and bubbler systems opend up another potential factor of two in the efficiency of water use by crops. This is not to mention the role of protected horticulture and the use of controlled environment in maximizing the production per unit of water as well as per unit of land. For continued intensive use, these methods should have very high priority and optimum use of other inputs, which can justify relatively high expensive water.

It must be pointed out that irrigated agriculture of 15 years from now, when it will be optimized for expensive water, such as groundwater from deep wells and desalted water from sea or brackish water, will be a much different enterprise than that of today. The control of plant enzymes is developing rapidly and the techniques of breeding in specific characteristics are increasing in strength and precision. Even without special breeding programmes, one can look forward to seeing farms where only 200 litres of fresh water per day can grow one person's food needs at a cost of 5 cents US/day for the water, if the cost of water is as high as 25 cents per cubic meter. This should be kept in mind when talking about the cost of groundwater from deep wells and its potential use for irrigation purposes.

Lastly, it must be recognized that while water supply is a social and economic necessity to the community as a whole, the amount consumed varies widely with different activities. Thus the practice is to support part of the cost of water by general taxes and part by revenues from users. Farming (the highest consumer of water) in particular has always been favoured in receiving water at low cost because of the important super structure of business and commerce which derives from the agricultural structure, but which consumes little water itself.

3. WATER CHARGES AND COSTS

In principal, the total cost of irrigation water is the summation of Capital Investment and the operation and maintenance costs of the irrigation system. In the case of multipurpose structures, such as large dams only a part of the cost of such structures should be allocated to irrigation, while allocating another part to other uses, as the case may be, such as power generation, navigation and flood control. In the countries under review, i.e., Egypt, Jordan and Morocco, irrigation water is either provided free or heavily subsidized.

3.1. Egypt

Economic feasibility studies of land reclamation programs in Egypt indicate that the minimal cost for irrigation water is 0.005 LE/m^3 (0.4 U.S. cent/m^3). This covers the operation, maintenance and modernization of the irrigation system in Egypt. It does not cover investment cost of irrigation structures neither the cost of pumping water. For newly reclaimed areas, there are additional investments in construction and maintenance of new main canals. Furthermore, the additional supply of water needed for major reclamation activities

.419

requies investments in the upper Nile basin or through treatment of water for re-use in irrigation. This increases the cost substantially above the minimal cost. In fact, it is estimated that the cost will be in the range of 0.01 to 0.02 LE/m³ (0.8 to 1.6 U.S. Cent/m³) in the 1990's. Moreover, the water that may be supplied through the Jonglei canal in Sudan was estimated to cost 0.065 LE/m³ (5 U.S. Cent/m³), with actual cost expected to be much higher. The cost of irrigation water from underground source, such as the New Valley is estimated to be about U.S. Cent 3 to 6 per cubic meter.

In Egypt farmers pay no charge for irrigation water, but they are responsible for the maintenance of the last common irrigation canal (Mesqas) and their field ditches. Hence the financial cost of irrigation water to farmer is much less than the economic cost. In other words, there is a substantial amount of subsidy provided to farmers concerning irrigation water. This, should be considered in the light of studies by the Water Research Institute indicating the marginal value product (MVP) of water used in cotton cultivation in Abyuho and El-Minya at 0.06 LE/M³ (4.62 Cent/m³). For maize cultivation the marginal value product of irrigation water was 0.039 LE/m³ (3.00 Cents/m³). Water charges, however, should be considered within the overall system of taxes, subsidies and net transfers into the agricultural sector. A joint study by the Ministry of Agriculture and the U.S.A. Agency for International Development indicated the following:

In 1975 the Egyptian consumer received a net subsidy from the agricultural sector of LE 600 million (US $ 460 million). This was effected through lower prices received by farmers. It is estimated that Government paid prices ranging from 50% to 20% below those prevailing on the free market. Agriculture also subsidised the rest of the economy through capturing the difference between world and farmgate prices, minus subsidies provided to farmers on inputs such as water energy, fertilizers, seeds and pesticides. This implicit tax revenue amounted to LE 600 million in 1975. The rest of the economy provided LE 400 million to consumers in the form of lower prices for food and fiber. Thus the agricultural sector is a net subsidizer to the rest of the economy although it is not charged for irrigation water.

3.2 Jordan

In the East Ghore Canal (Jordan Valley Irrigation Project) farmers were charged 1 fils (1000 fils equal 1 Jordanian Dinar, (JD)); 1 JD= $2.85 US) per cubic meter of water for the first 1500 mm of irrigation depth and 2 fils per cubic meter for the amount that exceeded 1500 mm. The irrigation water was supplied on demand and was measured by a constant head orifice. The irrigation network is a lined gravity system and each farm unit (3 to 5 ha size) was provided with this water measuring device. The above policy was based on the assumption that under the project soil, climatic and cropping pattern and intensity, and with a reasonable water management the depth of 1500 mm should be sufficient. Any amount exceeding this was supposed to be mainly due to poor water management and farmers should pay double for this unnecessary waste.

420

In the year 1973, a revision of water charges in the Jordan Valley was made and a new set of water charges were approved by the Government. Water charges were set at JD 0.003/m^3 (0.90 cent/m^3) and were immediately imposed. They were to be increased annually according to an approved schedule. Such a decision was made in view of the following considerations:

- Farmers are the main beneficiaries of irrigation water and they have to pay for at least the operation and maintenance cost of the irrigation system.

- Farmers ability to pay is limited in the early stages of farming, but increases as they become more experienced. This is the idea behind setting water charges at low levels in the early stages and higher levels subsequently.

However, water charges were frozen at the 1973 level. The current water charge is 3 fils per cubic meter. This is not a trivial charge; it is a moderate charge relative to typical agricultural water charge. For example, it is equivalent to 30 JD per hectare/meter, $86 US per hectare/meter, $10.5 US per acre/foot, or $0.03 US per 1000 US gallons.

Unfortunately, this current water charge falls short of covering the O&M cost of the Jordan Valley irrigation systems; the 3 fils do not even cover the cost of billing the farmers. The actual O&M cost is 7 to 10 times higher, i.e., 21 to 30 fils per cubic meter. The Jordan Valley Authority (JVA) intends to increase water charges over a period of time until they covered the O&M costs, but this is politically difficult and, while a charge of perhaps 25 fils per cubic meter may not be a problem for producers of high value fresh market vegetable and fruit crops, it may be an almost overwhelming burden to producers of lower value processed vegetables and ordinary field crops.

An important reason why O&M charges are high per unit of water delivered is because the system only accounts for the delivery of about 500 mm of water over the approximately 240,000 dunums (du) (24,000 ha) served. Competition for water is high at critical times during the year and the system has to be operated continuously throughout the year. Furthermore, in order to assure a reasonable degree of equity throughout the system, the JVA provides delivery services to the headgates of each farm unit. In addition, the project serves a long, narrow and complicated irrigated area.

Water is very valuable in the Jordan Valley. In comparison with wells, the capital plus operating cost of pumped water from private tubewells in the region is estimated to be more than 30 fils per cubic meter. For the most part, private tubewells are only used to irrigate high value crops. Furthermore, farmers with their own wells have complete control of their water supply so tend to pay a premium for this security. At any rate, this gives evidence that farmers are willing (and can) pay more for their water.

The Operation and Maintenance Department in the Jordan Valley has kept the water distribution systems sufficiently maintained to deliver water for more than 20 year without major problems or interruptions of service. Furthermore, the system boasts of having an 87 percent conveyance efficiency at normal flow, disregarding spillage losses and unbilled deliveries. During low flows the conveyance efficiency averages from 70 to 80 percent. From the available records it was estimated that in normal years only about two-thirds of the salable water is billed.

The equity of distribution is quite good because the JVA has placed a high priority on assuring that each farm unit receives its fair share of water. Upon a system of farmer-initiated requets, during critical (low) flow periods in the main crop season, each farm unit probably receives approximately 70 percent or more of its fair share of the delivered water (part of the variation is due to variations along the length of main canal).

Achieving this has been costly since the JVA services and maintains the distribution system up to the turnout of each farm and provides water distributors (ditchriders) to control and monitor the quantity of water deliverd to each farm unit. Hence there may be room for savings in distribution and maintenance cost of the small laterals by turning some of this responsibility over to the farmers. Further savings could be achieved by more efficient deployment of and better transport for the JVA ditchriders.

In the upland the cost of irrigation water pumped from wells ranges from JD 0.015 to 0.030/m^3 (4.3 to 8.6 cent/m^3) depending on the characteristics of the geological formation and depth of groundwater (see table 4).

From the figures in table 4 it could be noted that it is a deliberate Government policy to subsidize heavily irrigation water in the Jordan Valley. This subsidy however is much less in case of irrigation settlement project in the upland. In case of Qaa' Ed Disi, this project has no settled farmers, and water is being used by the Ministry of Agriculture for commercial irrigation projects and by the Authority of Aqaba for municipal water supply. In this case the water is being sold at prices, a bit higher than the actual cost, thus leaving a small margin of profit.

Table 4

Cost of Irrigation Water in Jordan and Prices charged to the Farmers (1 $ = JD 0.350)

Project	Depth of GW M	Actual Cost US Cent/m³	Price of Water to the Farmers US Cent/m³	% of Charged Price to Actual Cost
1.Jordan Valley	Surface	8.57	0.86	10.0
2.El Jafir	15-20	4.29	1.14	26.6
3.Katranah & Wadi El-Abyadh	30-50	4.86	1.71	35.2
4.El-Arja	30-50	5.14	2.00	38.9
5.Qaa' Ed Disi	150	8.57	11.43	133.4

3.3. Morocco

In Morocco irrigation water charges range from Dm 0.22-0.27/m³ with an average of DM 0.25/m³. Out of this, the cost of energy ranges from DM 0.05-0.20/m³ while the operation and maintenance ranges from DM 0.80-0.10/m³. (DM = $ US 0.113)

Some case studies indicated that actual water charges are about 38% of the production and dlivery cost of each cubic meter. because of the relatively cheap and subsidized irrigation water, farmers benefiting from irrigation projects tend to play it safe and apply more than recommended amounts of water. It is estimated that in the lower Moulouya Irrigation Project, actual water use was 48% higher than the recommended use.

The Government of Morocco intervenes in the price of some inputs and agricultural outputs. Subsidies are provided to maintain low retail prices for flour, bread, sugar, edible oil and milk, as well as for agricultural inputs such as fertilizers, seeds, machinery, livestock and credit. The beneficiaries of land reform projects pay 40% of the total cost of land and irrigation development over a 20 year period. The interest rate charged is 4% compared to the current interest rate of 14% charged by commercial banks.

423

In this connection it may be mentioned that in Iraq, that the annual water charges were set in 1983 as one Iraqi Dinar (ID=2.7 US$) for every donum (donum=2500m²) of reclaimed land which is irrigated by irrigation network owned by the Government and half a dinar for every donum of reclaimed land or orchard that is irrigated by non-government means.

4. CONCLUSIONS

4.1 In principles, the total cost of irrigation water is the summation of capital investment and the operation and maintenance costs of the irrigation system. In the case of multipurpose structures, such as large dams, only a part of the cost of such structures should be allocated to irrigation, while allocating another part to other uses, as the case may be such as power generation, navigation and flood control.

4.2 It is recognised that while water supply is a social and economic necessity to the community as a whole, the amount consumed varies widely with different activities. Thus the practice is to support part of the cost of water by general taxes and part by revenues from users. Farming (the highest consumer of water) in particular has always been favoured in receiving water at low cost because of the important super structure of business and commerce which derives from the agricultural strucutre, but which consumes little water itself. Hence in the countries under review irrigation water is either provided free or heavily subsidised.

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421

ANNEX 1

Expert Consultation on Irrigation Water Charges
22-26 September 1986
FAO, Rome

LIST OF PARTICIPANTS

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ANNEX 2

AGENDA

The Joint FAO/AID Expert Consultation on Irrigation Water Charges
22-26 September 1986
FAO, Rome

Monday, 22 September 1986

Chairperson Morning Session: Mr. P. Dieleman

09:00-10:00 Registration

10:00-10:30 Opening of Workshop

Welcome Address by Mr. G.M. Higgins, Director Land and Water Development Division (FAO)

Welcome Address by Ms. J. Atherton, Senior Advisor for Rural Institutions (AID).

10:30-11:30 Background Paper: Irrigation Development and Water Charges, by Mr. H.M. Horning. Invited speaker (former Director, Land and Water Development Division, FAO)

11:30-12:30 Background Paper: Approaches to Financing Irrigation, by Mr. I. Carruthers, Professor of Agrarian Development, Wye College (University of London, UK)

Chairperson Afternoon Session: Mr. N.S. Peabody III

14:00-14:45 Background Paper: Effect of Water Charges on Irrigation System Efficiency, by Mr. A. LeBaron, Professor Resources Economics and Mr. J. Keller, Professor Irrigation Engineering (Utah State University, Logan, USA)

14:45-15:30 Background Paper: Operation and Maintenance Costs, by Mr. J.A. Sagardoy, Senior Technical Officer, Land and Water Development Division (FAO)

15:45-16:30 Background Paper: Cost Recovery in Irrigation Projects: Perceptions from World Bank Operations Evaluation, by Mr. P. Duane, Senior Evaluation Officer, Operations Evaluation Department (World Bank)

16:30-17:15 Background Paper: Institutional Mechanisms for the Application of Water Charges, by Ms. J. Atherton (AID)

421

Tuesday, 23 September 1986

Chairperson Morning Session: Mr. N. Tsiourtis

08:45-09:30 Background Paper: Resource Mobilization in Farmer-Managed Irrigation Systems: Needs and Lessons, by Mr. W. Coward, Professor, Department of Rural Sociology (Cornell University, Ithaca, N.Y., USA) and E. Martin (International Irrigation Management Institute)

09:30-10:15 Background Paper: Water Charges: A Tool for Improving Irrigation Performance, by Mr. L.E. Small, Associated Professor of Agricultural Economics, Rutgers University, USA (International Irrigation Management Institute, Sri Lanka)

10:30-11:15 Background Paper: Irrigation System Recurrent Cost Recovery: A Pragmatic Approach, by Mr. Mark Svendsen, Research Fellow (International Food Policy Research Institute, Washington, USA)

11:15-12:00 Background Paper: Cost Recovery for the Lezíria Grande Project: a case study of a rehabilitation project in Portugal, by Mr. C. de Jong and Mr. L.H. Sprey (International Institute for Land Reclamation and Improvement, Wageningen, Netherlands)

Chairperson Afternoon Session: Ms J. Atherton

13:30-14:15 Background Paper: The Dominance of the Internal Rate of Return as a Planning Criterion and the Treatment of O&M Costs in Feasibility Studies, by Ms. Mary Tiffen (Overseas Development Institute, London, UK)

14:15-15:00 Country Paper, Philippines, by Ms. María Concepción J. Cruz, Assistant Professor and Chairperson, Graduate Program on Environmental Studies (University of the Philippines at Los Baños, Laguna)

15:15-16:00 Country Paper, Pakistan, by Mr. M.A. Chaudhry, Project Economist PRC/USAID (Pakistan Irrigation Systems Management Project)

16:00-16:45 Country Paper, Brazil, by Mr. Eliseu Alves, President of CODEVASF (Development Corporation of the San Francisco Valley)

Wednesday, 24 September 1986

Chairperson Morning Session: Ms. María Concepción Cruz

08:45-09:30 Country Paper, China, by Mr. Xu Guohua, Associate Professor (Department of Irrigation and Drainage, Beijing University of Aricultural Engineering)

428

09:30-10:00	Country Papers, Jordan and other Middle East countries, by Mr. A. Arar, Senior Regional Officer, Regional Office for Near East (FAO) and Mr. J. Keller, Professor (Utah State University)
10:15-10:50	Country Paper, Nigeria, by Mr. J.A. Akinola, Assistant Chief Water Engineer (Federal Department Water Resources, Lagos)
10:50-11:20	Country Paper, Tunisia, by Mr. Habib Essid, Director General of the Irrigation District Gafsa-Jerid, Tozeur
11:20-12:00	Country Paper, Cyprus, by Mr. N. Tsiourtis, Senior Water Engineer, Water Development Department, Nicosia.

Chairperson Afternoon Session: Mr. E. Alves de Andrade

13:30-14:15	Country Paper, Zimbabwe, by Mr. G.D. Mudimu, Department of Agricultural Economics, University of Zimbabwe
14:15-15:00	Country Paper, Mexico, by Mr. A. Olaiz Pérez, Technical Secretary, Mexican Institute of Water Technology, Cuernavaca
15:15-16:00	Country Paper, Peru, by Mr. C.A. Sarría, Project Analyst, Group of Agricultural Policies Analysis, Ministry of Agriculture, Lima
16:00-16:45	Country Paper, Jamaica, by Mr. T. Hardware, Managing Director of Underground Water Authority, Kingston

Thursday, 25 September 1986

08:45-09:00	Brief meeting of all participants to develop a common understanding of the working sessions
09:00-11:00	Break into five groups to prepare the Main Conclusions and Recommendations (First Task)

Chairperson: Mr. J. Keller

11:00-12:30	Plenary session to compare and discuss the Main Conclusions and Recommendations
14:00-16:00	Groups will wind up discussions on Main Conclusions and discuss their assigned topics (Second Task)
16:00-17:30	Leaders and Rapporteurs convene to synthesize the Main Conclusions and Recommendations as presented by the Groups

424

Friday, 26 September 1986

09:00-10:30	Groups will continue discussions and prepare a preliminary statement for each set of guidelines for the special topics assigned
	Chairperson: Mr. J. Keller
11:00-12:30	Plenary Session to discuss the set of guidelines for the topics assigned
14:00-15:00	Continue Plenary Session
15:00-17:00	Groups separate and prepare their final statement
17:00-17:30	Closing Remarks

ANNEX 3

WORKING GROUPS

The Working Groups were organized in order to prepare the policy and technical guidelines with regard to the topics indicated below:

GROUP 1 **Financing Irrigation - (Macro Considerations)**
Group Leader: G.D. Mudimu
Rapporteur: I. Carruthers
Group members: J. Olivares, J. Atherton, J.A. Akinola, W.S. Post

GROUP 2 **Cost Reduction Measures**
Group Leader: T. Hardware
Rapporteur: Jack Keller
Group members: P. Duane, E. Telahoun, D. Kraatz, Xu Guohua

GROUP 3 **Revenue Enhancement**
Group Leader: C.A. Sarría
Rapporteur: W. Coward
Group members: L.H. Sprey, N. Tsiourtis, H.M. Horning, S. Burchi

GROUP 4 **Setting Irrigation Water Charges (levels & structure)**
Group Leader: A. Olaiz Pérez
Rapporteur: L. Small
Group Members: María C. Cruz, C. de Jong, M. Saiz

GROUP 5 **Organizational Structures & Administrative Development**
Group Leader: M.A. Chaudhry
Rapporteur: N.S. Peabody III
Group Members: M. Svendsen, M. Tiffen, A. Arar, Habib Essid

The specific tasks assigned to each group were as follows:

First Task Each group is to formulate 4-6 specific statements of the group's Main Conclusions and Recommendations regarding the appropriate forms of irrigation water charge policies (both of national governments and of international donor agencies) with respect to the goals of (a) social equity, (b) economic efficiency, and (c) satisfactory system management.

1631

Second Task Each group is assigned a set of specific issues (below) to be discussed with a view to formulating a set of guidelines and recommendations on matters related to irrigation water charge policies. (These would be "technical" guidelines in the sense that they deal with various details involving economic, social and institutional aspects as well as engineering and agronomic aspects).

WORKING GROUP NO. 1

Question A What are the implications for host countries of the contrast between USAID/World Bank (and other donor) approaches to irrigation cost recovery?
Is financing rehabilitation works different from total scheme development?

Question B Given that a large irrigation project cannot pass conventional economic viability tests, and that the scheme goes forward on various "non-productive" arguments involving equity, etc., how do long-run benefits materialize (when, where and in what form) and how are they measured?

Question C Are there technical criteria that establish the amount of subsidy which a given economy can afford to put into irrigation? How is this answer connected to national and world-wide rates of inflation?

Question D Why can poor farmers in one part of the world pay all costs of irrigation development (less interest/concessionary/interest on original investment) plus continuing recurring costs, whereas poor farmers in another part of the world cannot pay, even though comparison of groups is made by reference to basic food crops? What are the explanations? Are these explanations informed guesses or rationalizations?

Question E
i. How will farmers respond to "indexing"?
ii. Should O&M costs always be recovered?
iii. Can revenues from other sources be increased?

Question F Transfer investment and O&M responsibilities entirely to farmers? The public utility argument.

WORKING GROUP No. 2

Question A What broad measures can be effective in increasing O&M revenues without raising fees and those which increase collection rates reduce the costs of collection, index fee rates, etc.?

4/12

Question B Under what conditions can these measures be effectively implemented?

Question C Should irrigation agencies be encouraged to develop secondary sources of income to supplement irrigation fee collections? What types of secondary income sources are most appropriate?

WORKING GROUP No. 3

Question A What broad measures can be effective in reducing the costs of operating and maintaining irrigation systems?

Question B What are the likely impacts of these measures on system performance and sustainability?

Question C Under what conditions can these measures be effectively implemented?

Question D What are the rational arguments for favouring low recurring costs at the expense of high investment cost? (machinery vs. labour, etc.)

Question E Why any maintainance?

Special Questions

i. To what extent might delivering farmers, or groups of farmers, their share of supply, more or less on demand, increase their profits? and willingness to pay charges?

ii. What are the technical options for such flexibility (implied in i. above) in deliveries within direct diversions, storage and mixed systems?

WORKING GROUP No. 4

Question A What broad principles should govern the setting of irrigation fees?

Question B What are the merits of flat rate fee systems vis-à-vis more complex fee structures, i.e. differentiation by system, region, crop, season, etc.?

WORKING GROUP No. 5

Question A What changes in the role and organizational structure of irrigation authorities (and other agencies such as revenue departments) are necessary to establish and

4737

maintain an accountable relationship between farmers and the agency?

Question B What is the role (need for) water measurement in water pricing and cost recovery questions?

Question C What roles for farmers beyond the tertiary canal (transferring O&M responsibilities to farmers)?

i. Do governments still alter or transfer indiscriminately farmer managed irrigation systems into state managed irrigation systems? Yes. No. Why? (What is the rationale?)

ii. Delineation of O&M responsibilities farmers can take on, by water source and system

iii. "Social" and "technical" criteria that will govern the transfer possibilities in the situations implied in the answer to question B

Question D Assuming that the best way to improve water use (physical as well as economic) productivity is to make water scarce, what are the operational, economic and "cost recovery" implications of doing so?

V34-