PN-AAT-893
42581

NEPAL'S SMALL AND MEDIUM SCALE IRRIGATION SECTOR

Report of the Special US Review Team

Mark Svendsen, USAID

Dan Macura, USBR

Jim Rawlings, USBR

United States Agency for International Development

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SUMMARY

In June of 1984, a three-person water resources team visited Nepal at the invitation of the Minister of Water Resources Mr. Pashupati S. Rana to review the small and medium scale irrigation sector. The team was composed of engineers from the United States Agency for International Development and the United States Bureau of Reclamation. The purpose of the visit was to assess opportunities for increasing rates of irrigated agricultural production and needs for assistance in improving irrigation system design, construction, operation, and maintenance. Conclusions reached by the team include the following.

The strategy for irrigated agricultural development laid out in the guidance for Nepal's Seventh Five-Year Plan is valid. That guidance stresses increasing agricultural output from underutilized existing irrigation capacity while proceeding to establish a solid information base for planning future large-scale water resources development.

Control and management of irrigation water is currently the most neglected aspect of water resources development and utilization in Nepal and has great potential for enhancing irrigated agricultural output. In addition, there are important opportunities to improve maintenance operations and to undertake selective improvements that, coupled with improved operating procedures, would greatly improve system operating efficiencies.

Measures aimed at water supply augmentation should focus on the capture of lesser tributary streams and on developing shallow groundwater resources for use in conjunction with existing surface supplies. Feasibility investigations should include a study of a wide range of conjunctive use management options as well as energy, maintenance, and economic issues.

Any water resource management program undertaken in Nepal must take into account the fact that some 80% of the irrigation facilities in the country are farmer developed and operated. This very strong tradition of community involvement in irrigation system design, construction, operation and maintenance would be envied by other Asian countries currently trying to foster such farmer involvement to reduce recurrent cost burdens on the government and improve system operational efficiencies. Improvement programs must avoid undercutting this tradition of local involvement while seeking to build on and supplement it.

To maximize gains in overall agricultural production, top priority should be given to improving operation and maintenance in irrigation systems which are government-operated. This means working both with Irrigation Department managers and with groups of farmers who manage water at the tertiary levels of government systems.

To effectively carry out a program of O&M improvement, a separate specialization or division within DIHM should be established. Personnel assigned to this division would receive specialized training and would work to develop O&M procedures tailored to particular irrigation systems.

Government assistance to farmer-managed systems, particularly the smaller hill systems, should be targeted on selective improvements and repairs that require financial or technical resources beyond the reach of the community itself. Rendering such assistance requires different procedures than those used in new system construction or the rehabilitation of government-operated systems. The approach developed to accomplish this must avoid creating dependency and the expectation of continuing government assistance.

Technical assistance provided to support and facilitate these programs must have as as a coequal objective, developing and strengthening the various Nepalese institutions responsible for assessing problems, developing and implementing solutions and monitoring and evaluating results in the irrigation sector. The mode of assistance should emphasize working in collaboration with counterpart institutions, continuity, and involvement over an extended period.

One major problem hampering a precise diagnosis of the problems constraining efficient irrigation system operation and maintenance is an absence of data describing current operating system operation and performance. Additional data are essential if effective solutions to these problems are to be developed and tested. Several steps could be taken immediately to improve the data base available for these purposes. One of these is a series of rapid appraisal studies of existing government-operated irrigation systems. Another is an institutional analysis of the irrigation sector that would include all ministries, departments, agencies, institutes, private sector firms and PVOs that play or could usefully play roles in the change process.

I. INTRODUCTION

Background

A team of three U.S. irrigation and water management specialists visited Nepal in June of 1984 at the invitation of the Minister of Water Resources, Mr. Pashupati S. Rana. The purpose of the visit was to conduct a reconnaissance review of the small and medium scale irrigation sector, and to assess opportunities for increasing rates of agricultural production and needs for assistance in improving irrigation system design, construction, operation, and maintenance. The review team was comprised of a Water Management Engineer (Mark Svendsen), a Water Resources Engineer (Dan Macura), and an Operations and Maintenance Engineer (Jim Rawlings). Titles and affiliations are shown in Appendix A. The detailed scope of work for the team is also included in Appendix A.

The problems faced by Nepal in improving the living standards of its people are substantial and well documented. They include serious physical obstacles to communication and transportation, a relatively narrow physical resource base, an underdeveloped (but rapidly expanding) human resource base, a near absence of fossil fuels, and serious environmental degradation of hill area ecosystems due to population pressure and overuse. Indeed, few countries began their development as late and at such a natural disadvantage. A development profile of Nepal, extracted from a recent World Bank document, is presented in Appendix B.

The invitation to the special US team by the Government of Nepal reflects the great importance that Nepal accords to irrigated agriculture in meeting the basic nutritional needs of its population. It also recognizes that the water resources of Nepal comprise one of the country's most important natural assets.

Nepal has made notable progress in the past 25 years in developing its irrigation water resources. Prior to the inception of the first 5-Year plan (prior to 1956), there were only about 17,000 hectares of government-developed irrigation command in the country. The bulk of this area (about 13,000 hectares) was included in the command of the Chandra Canal which was completed in 1928. Following the conclusion of the Second Plan period in 1965, command area had tripled to around 52,000 hectares. By 1980, completed command of government-developed systems had risen to nearly 240,000 hectares, a 14-fold increase. The only jarring note to this impressive expansion is the fact that less than half of this area currently receives irrigation water (MWR, 1980; Rising Nepal 1984)[1] and that national yield averages of the primary foodgrain crops grown in these systems have remained stagnant in spite of this development.

After a preliminary review of available literature in the United States, the team visited Nepal from June 3 through 15. Four days were spent in the field visiting irrigation systems in the Western Hills and the Central Terai. The remainder of the period was devoted to meetings with a wide variety of officials and specialists in various ministries, departments, and organizations in Kathmandu, in reviewing literature not available in the U.S., and in drafting a preliminary report detailing the team's findings. The team was accompanied in all phases of its work by Mr. Jack Pinney, General Engineering Officer of the USAID mission to Nepal. A complete itinerary is shown in Appendix C.

Because of the preliminary nature of the team's mission and the short time available to it, this report is brief. The following section comprises a summary of the conclusions reached by the team during its review. Section III contains an overview of the nature and extent of irrigation development in Nepal, a brief discussion of the findings of several recent irrigation sector reviews, and a discussion of policy priorities set by His Majesty's Government of Nepal (HMG/N). Section IV is an exploration of selected elements of the current water resources program as observed during the team's visit. Section V presents a strategy for improving the performance of small and medium scale irrigation systems in Nepal.

Definition of System Scale

Because the notion of irrigation system scale figures so importantly in the terms of reference for this review, a brief discussion of "small", "medium" and "large" irrigation systems in a Nepalese context is in order. There does not currently appear to be any one set of criteria in use in Nepal for such a categorization. One standard definition offered to us was based on development costs. This classification system, however, totally ignores farmer-developed and operated irrigation systems, which comprise some 80% of the irrigated hectarage in the country.

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1 The MWR report makes this assertion with regard to the provision of supplemental water to even a single crop in a year. The Rising Nepal story of 13 August quotes the Director General of the Department of Irrigation Hydrology and Meteorology (DIHM) as saying that only fifty percent of the command area was getting a regular supply of water throughout the year.

Another possible definition is based on commanded areas. However, no consistent set of limits appears to exist for such a classification. In addition, different limits would probably have to be applied in the Hills and in the Terai.

One point on which all seem to agree is that very small systems, those under 50 hectares, should be considered separately, since they are almost always farmer-owned and operated. Formally, DIHM does not work with such systems, responsibility being assigned to the Department of Agriculture and the Ministry of Panchayat and Local Development.

The Irrigation Sector Review published by the Ministry of Water Resources (MWR) in 1981 likewise ignores traditional size-based groupings, distinguishing systems only on the basis of whether they are "government" or "non-government" systems. Both types actually span a considerable size range, since government systems range from 50 hectares and up, and "non-government" or "communal" systems in practice range from a few hectares up to many thousand of hectares.

Following these precedents, this review categorizes systems in terms of their managing entity. In addition to grouping systems which are farmer managed, a distinction is made between those systems and projects governed by a multi-dimensional Development Board or Project Authority, and those operated and maintained directly by the Department of Irrigation Hydrology and Meteorology (DIHM). The latter two categories tend to correspond very roughly to traditional notions of "large" and "medium" systems, though exceptions are numerous. To summarize, the three categories comprise:

1. Farm-managed systems operated principally by water-users and the institutions they create and control.

2. Agency-operated systems under the direct supervision and control of the DIHM, though they may have farmer-controlled sub-systems at their base.

3. Authority-operated systems having an integrated management structure concerned not only with the capture and conveyance of water but also with its equitable distribution throughout the system and with system productivity in agricultural and economic terms.

The third of these categories has been the subject of several Water and Energy Commission Secretariat (WECS) studies and reports. Many but not all of the conclusions and recommendations found in these reports apply also to the case of agency-operated systems.

II. SUMMARY OF FINDINGS

1. The preliminary Seventh Plan (1985-1990) strategy for increasing agricultural production by consolidating gains in existing irrigation schemes, while at the same time establishing a solid base of information for planning future large-scale water resources development, is reasonable and sound.

Nepal should follow both of these paths in pursuing its national development objectives. But major water resource development projects, undertaken now, will not address immediate and pressing needs. Furthermore, serious questions about the effectiveness of some types of completed projects under current operating conditions have arisen. These questions need to be addressed, with particular attention paid to irrigation system agricultural and economic outputs, before major emphasis is placed on new large-scale development.

2. At the present time the most important water resources to develop further are existing installed irrigation capacity, and (in conjunction) groundwater and rainfall. All three sources should be considered for use together in enhancing economic output from existing surface water commands.

a. Surface water supplies in major rivers are abundant, but suspended sediment imposes severe design and economic limitations on their development. Secondary streams, while experiencing wider seasonal variation in flows, are easier to develop and are less subject to sediment problems. Existing development from these sources is reaching only about one-half of its design commanded area, implying an inefficient use of currently diverted supplies and/or a failure to divert adequate water for delivery to all lands.

b. Groundwater supplies are available over widespread regions but aquifer characteristics limit development of large-volume point sources.

c. Rainfall in Nepal varies from region to region but generally ranges from 2000 to 3000mm annually. Though most of the rainfall is concentrated in the June to September monsoon period, rainfed cropping intensities in many regions of Nepal are greater than 100%. This implies that rainfall is sufficiently well distributed in these regions to permit the taking of more than one rainfed crop per year.

The foregoing suggests a strategy of employing available surface irrigation water more effectively, supplemented with on-demand groundwater pumping from small wells and rainfall, to reduce risks and raise yields associated with rainfed double cropping patterns over the largest possible areas.

3. Control and management of water in agency and authority-operated systems, at both main system and tertiary levels, is currently the most neglected aspect of water resource development and utilization in Nepal and has great potential for enhancing irrigated agricultural output.

Because of the importance of precipitation to agriculture in Nepal, irrigation water control and management in many ways is more difficult than in more arid areas. The challenge is to reach as wide an area as possible with controlled and responsive water supplies to compensate for gaps in rainfall patterns while making maximal use of "free" rainfall. This is particularly critical where relatively expensive pumped water is being used.

Presently, it appears that very limited control is exerted over water in agency and authority-operated systems. Formal DIHM control in some large systems extends only to the block or branch channel level (approximately 1000 hectares), leaving management below that level largely to the discretion of the irrigators. At the same time, there does not appear to be an organizational structure in place to assume this responsibility. Likewise there appears to be little collection and use of meteorological and hydrologic data at the system level to determine farm water requirements and to monitor and control main and secondary canal system flows in response to those requirements. This is a major gap in control that needs to be filled if current HMG/N strategic plans are to be carried out. At the same time it is a major opportunity for improving the reliability and areal coverage of irrigation supplies to existing commanded areas thereby raising agricultural production.

4. An effective maintenance program for agency-operated systems requires increased funding levels and a reexamination of current procedures.

Completed maintenance and repair actions observed in the field were generally well done. However, there appears to be a problem with the timely undertaking of these activities and with the availability of funds to carry out adequate levels of maintenance. There is also a need to examine the costs and benefits associated with higher levels of maintenance designed to reduce conveyance losses and with selected system improvements such as the installation of additional water control and measurement structures and improved communications facilities for Operations and Maintenance (O&M) personnel. It is likely that returns to such improvements, coupled with improved system operational procedures, would be substantial.

Tendering and contracting procedures should be reexamined to seek modes insuring selection of the best-qualified bidders. One approach would be to pre-qualify bidders based on past performance and capability. There is also a need to upgrade the construction and quality control skills of local private sector contractors. Expanding the ability of the DIHM to undertake routine repairs itself on a force account basis should also be considered.

5. Different approaches to planning and design are necessary in the case of new irrigation development and that of rehabilitation or improvement of existing systems.

One of Nepal's most valuable irrigation sector assets is its strong tradition of user management of irrigation systems. Some 80% of the irrigated hectarage in the country is farmer-managed. A major challenge is to find ways of providing financial and technical assistance to such systems without damaging or destroying that tradition. To do this, the agency providing assistance must be responsive to, and in some way accountable to, the irrigators' organization, rather than simply taking over, improving, and then "handing back" the system.

In the case of existing agency-operated systems, careful study of current modes of operation and current system management problems must be done before proceeding with design or redesign. Careful rethinking of the DIHM role in different design, redesign, and assistance situations is required to develop these different, tailored approaches.

6. Long term success in improving irrigated agricultural production depends heavily on upgrading the capabilities of DIHM to plan, design and operate and maintain irrigation systems.

The attention of the DIHM is currently focussed on project identification, design and construction and, to a lesser extent, on repair and maintenance. On larger projects, however, detailed design, construction, and construction supervision are often delegated to expatriate A&E firms and to local and foreign construction companies. The Department's planning and design capability needs to be strengthened to reduce costs, decrease reliance on foreign consultants over time, provide independent internal evaluations of the adequacy and appropriateness of proposals and plans developed under contract, and insure that external resources are properly directed and consistent with HMG/N development strategy.

Additionally, a specialization in irrigation system operation and maintenance should be created. Policy and procedural guidelines should be developed for these activities, incentives encouraging strong performance created, and training programs developed to familiarize personnel with sound O&M procedures and methods. These specializations should be set up at the regional and system level with direct support from the central office in Kathmandu.

III. SECTOR BACKGROUND AND PRIORITIES

Subsistence agriculture feeds large segments of the Nepalese population in rugged and isolated valleys across the country. In addition, agriculture is the backbone of the national economy, making up two-thirds of the annual GDP. Eighty-seven percent of this agricultural production consists of foodgrain. Rice and wheat are important crops in the terai, while maize is the dominant crop in the middle hills. Cash crops are still relatively unimportant in terms of area and are produced mainly in the Terai (FAO, 1983). In all, 90% of the population is dependent on agriculture for its livelihood.

Moreover, this population is expanding at a prodigious rate. Population growth over the past decade has averaged 2.6% per year, giving a doubling time of just 26 years. Furthermore, the rate of increase is accelerating--from 2.3% in 1971 to 2.6% in 1981.

At the same time agricultural production increased by only around 1% over the same decade, due mainly to an increase in area under cereals. This increase has come almost entirely through deforestation, which links the issue of agricultural productivity firmly to a second major problem facing Nepal--the frighteningly rapid degradation of its natural resource base. Wheat yields per hectare have increased marginally, while those for paddy have remained largely unchanged. In the case of maize, yields have actually declined over the past ten-year period (FAO, 1983).[2]

Recent setbacks (due partially to drought conditions) have been severe. Ministry of Finance figures show a 28% decline in rice production during 1982/83 (EIU, 1984). From its traditional position as a small rice exporter, Nepal has become a net rice importer.

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[2] One of the major difficulties encountered in trying to assess impacts of the irrigation development efforts of the past 25 years and the reasons for stagnant productivity is the absence of statistical information on production, broken down by irrigated and non-irrigated areas. According to researchers at the Agricultural Projects Services Centre (APROSC), this is not routinely done, and while attempts are being made there to do this, results so far are sketchy and incomplete.

Irrigation[3]

Nepal covers 54,400 square miles (14.2 million hectares), an area half the size of the state of Colorado in the United States. Of this area, about 2.3 million hectares (16%) is cultivated. The bulk of this cultivated land (70%) is located in the terai--the low humid extension of the Gangetic plain extending along the southern border with India (see Figure 1). Almost all of the remainder lies in the hill region, which occupies a mid-elevation belt between the Terai and the Himalayas to the north. Statistics describing basic land and population resources of Nepal are shown in Table 1.

The population of Nepal, estimated to be about 14.5 million in 1981, is distributed quite differently (see Figure 2). More than half of Nepal's population lives in the hills, and because of much smaller land holdings there (approximately 0.4 hectares per family), pressure on arable land in the hills is about 4 times that in the terai. Furthermore, arable land in the hills is fully exploited and, in fact, has been pushed beyond the point at which it can be viably maintained in the long term (MWR, 1981).

The terai, on the other hand, with 40% of the country's people and 70% of its presently cultivated land has seen its cultivated area double since 1950. In addition, it is estimated that another 450,000 hectares of arable land (about one-quarter of the current figure) is yet to be developed there (see Figure 3). Where increased food production is the major concern, the major regional potential clearly resides in the terai.[4] On the other hand, it is clear that the land frontier is rapidly closing and that future gains in production will have to come through increased productivity.

Approximately 22% of the country's cultivated land is currently irrigated.[5] Two-thirds of this irrigated area lies in the terai, while the remaining third is in the hills (see Figure 4). In both cases, however, the irrigated area constitutes only 20% to 25% of the current cultivated area in the respective region.

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3 This section draws heavily on MWR (1981).

4 This picture is complicated by the fact that the national food economy is not well integrated, and food security must be addressed on a regional as well as a national basis.

5 Following the useage in MWR (1981) irrigated area here is taken to mean the area that can receive a regular controlled supply of water in addition to direct precipitation for at least one crop.

Table 1.

LAND AND POPULATION RESOURCES OF NEPAL

Landforms		Mountain	Hill	Terai	Nepal
Area	(Ha)	2120000	8630000	3400000	14150000
Distribution	(percent)	15.0%	61.0%	24.0%	100.0%
Arable Land					
Mid 1981 area	(Ha)	32000	650000	1600000	2282000
Distribution	(percent)	1.4%	28.5%	70.1%	100.0%
Prop. of land	(percent)	1.5%	7.5%	47.1%	16.1%
Prospective area	(Ha)	32000	650000	2050000	2732000
Distribution	(percent)	1.2%	23.8%	75.0%	100.0%
Prop. of land	(percent)	1.5%	7.5%	60.3%	19.3%
Population					
Mid 1981 head	(head)	500000	8100000	5900000	14500000
Distribution	(percent)	3.4%	55.9%	40.7%	100.0%
Overall density	hd/km2	23.6	93.9	173.5	102.5
Arable density	hd/km2	1562.5	1246.2	368.8	635.4
Irrigated area					
Government	(Ha)	0	10000	91000	101000
Non-government	(Ha)	0	150000	250000	400000
Total	(Ha)	0	160000	341000	501000
Distribution	(percent)	0	31.9%	68.1%	100.0%
Prop. of arable	(percent)	0.0%	24.6%	21.3%	22.0%
Non-Irrigated Arable Area	(Ha)	32000	490000	1259000	1781000
Distribution	(percent)	1.8%	27.5%	70.7%	100.0%

Source: Ministry of Water Resources (1981).

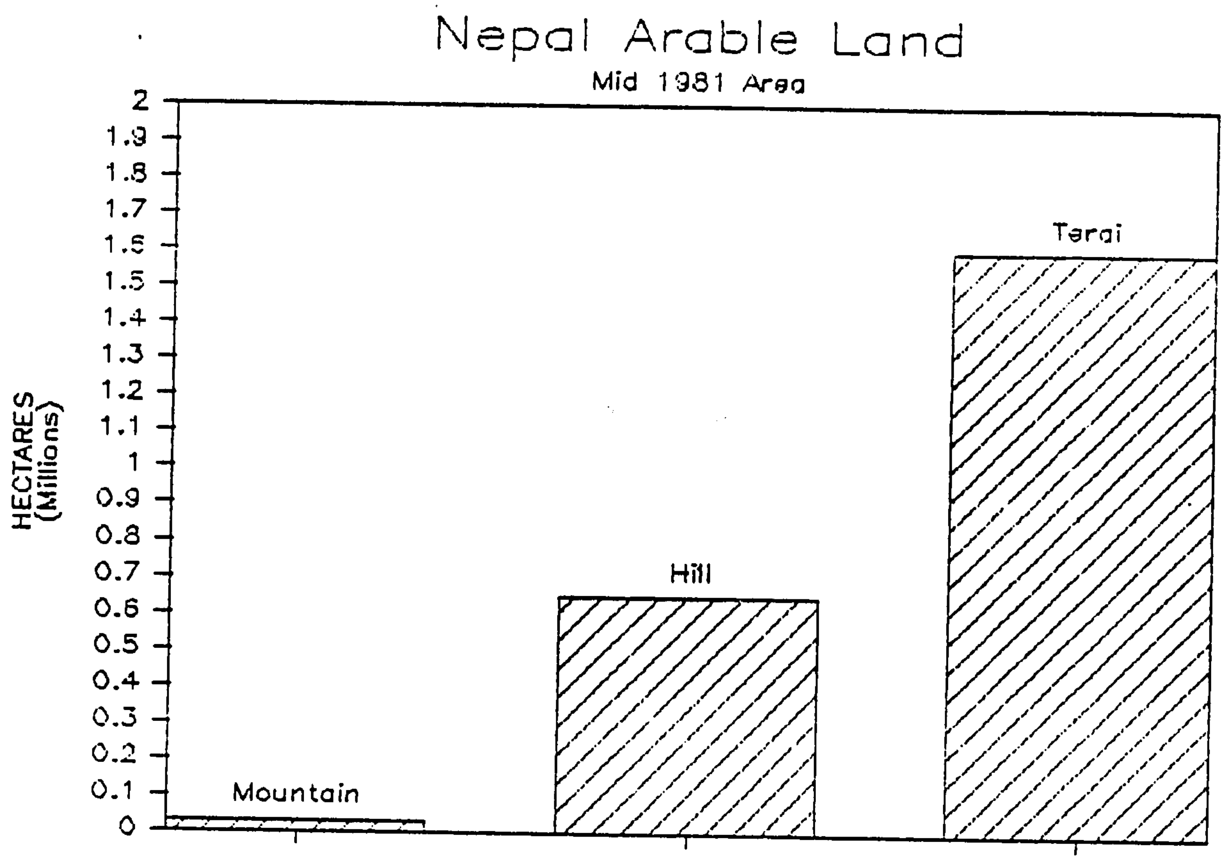


Figure 1.

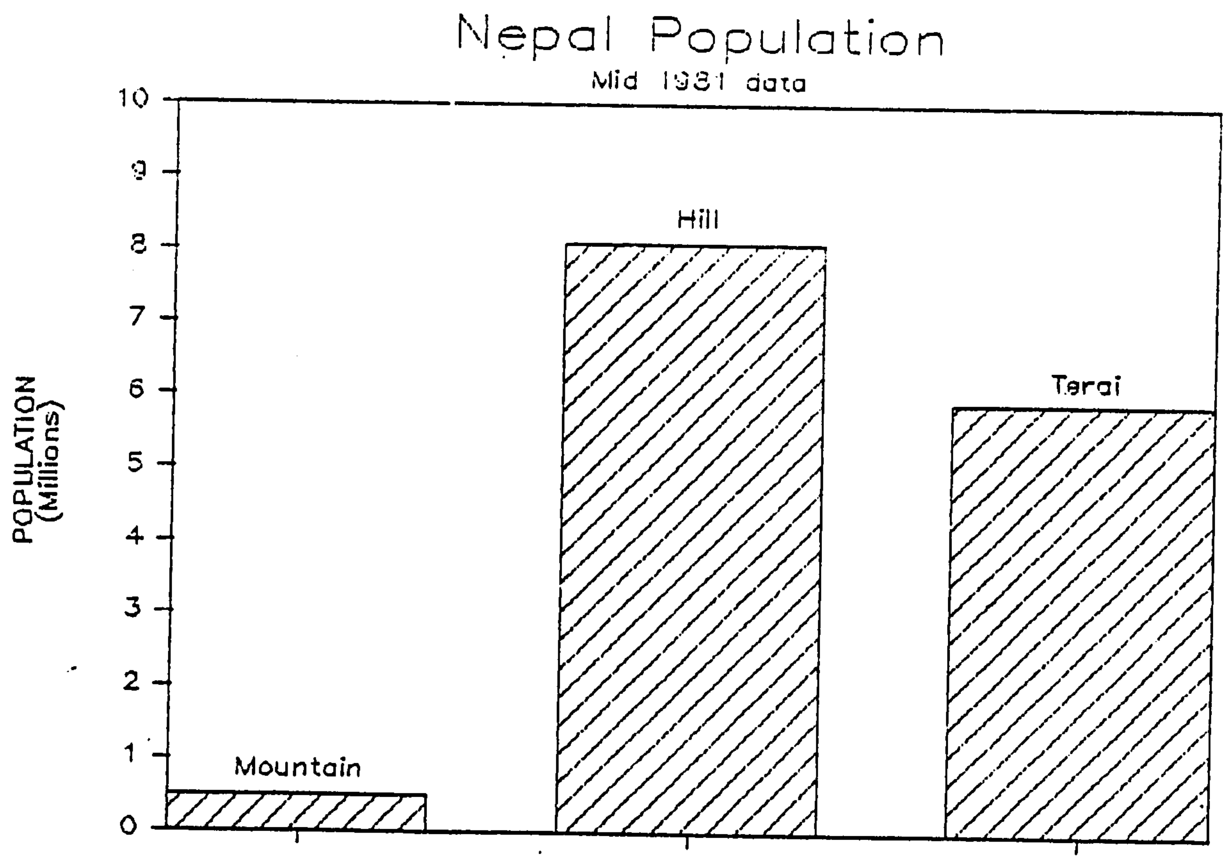
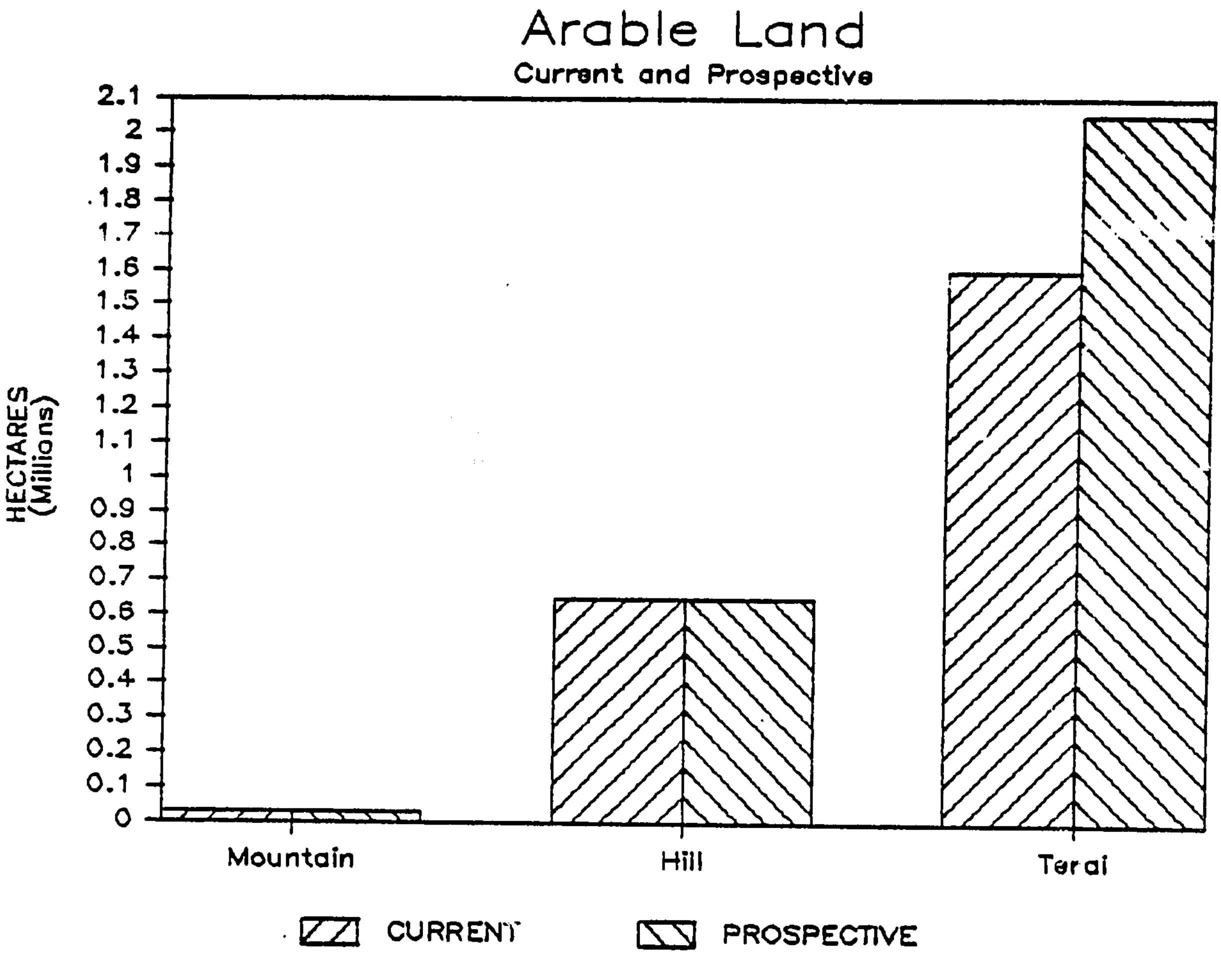


Figure 2.



Arable Land
Current and Prospective
HECTARES (Millions)
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Mountain
Hill
Terai
CURRENT
PROSPECTIVE

Figure 3.

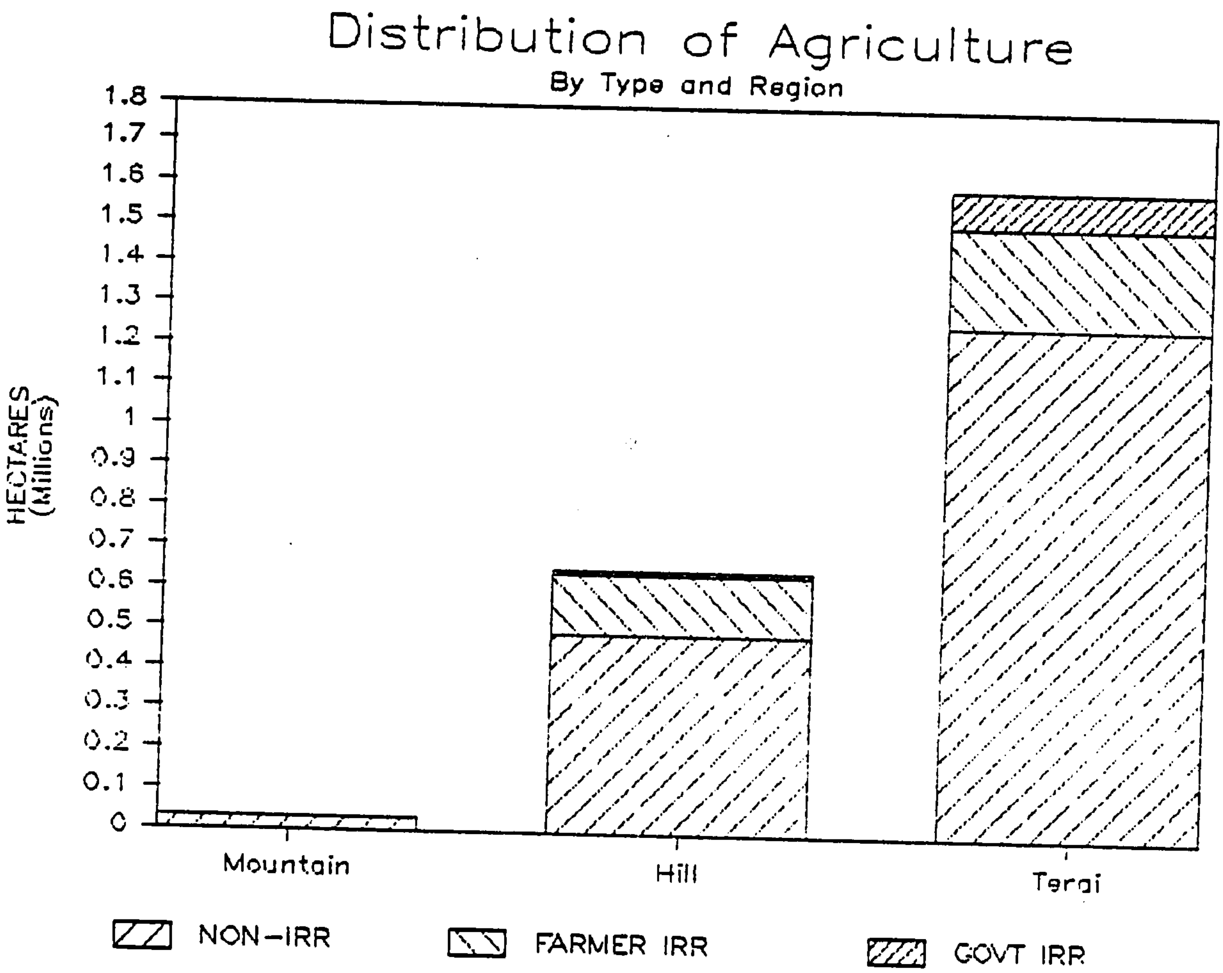

Distribution of Agriculture
By Type and Region
HECTARES (Millions)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Mountain
Hill
Terai
NON-IRR
FARMER IRR
GOVT IRR

Figure 4 .

In a situation that is unique in Asia, fully 80% of the irrigated land in Nepal, or 4 hectares out of every 5, lie in systems that are farmer designed, constructed, and managed (see Figure 5). In the hills, as one might expect, more than 90% of irrigation falls into this category, much of it in existence for hundreds of years. On the other hand, there is only about 10,000 ha of government developed irrigation in the hills, about half of which is in the Kathmandu valley. Most of this development, about 80%, occurred during the third plan minor irrigation project program or preceded it.

Similar situations prevail in hill areas of other Asian countries, such as the Philippines and Indonesia. There is a particularly close parallel with the Indian State of Himachal Pradesh, a region that is also dominated by the foothills of the Himalaya north of the Sivaliks.[6]

Even in the terai, however, fully 70% of the land currently irrigated is found in farmer-managed systems. While a number of the these systems are small, many are quite large--some covering as much as 10,000 hectares. Feeder canals for these systems may carry 10 cumecs (350 cfs) of water. To operate and maintain systems this large, complex organizational forms are required and have been developed by the irrigators/farmers themselves. The structure and operation of one such large system is described in Pradhan (1984).

The great bulk of government irrigation development that has occurred to date has taken place in the terai, and this will continue to be the primary venue for such development. It is important to note, however, that a large share of the proposed command of imminent government irrigation development projects in the terai is already extensively irrigated by farmer managed systems (MWR, 1980). This simple fact has enormous implications for the types of improvements that should be undertaken, for the "without project" side of the economic analysis, and for the mode in which development is carried out.

[6] USAID has recently signed an agreement with the Government of Himachal Pradesh to assist the Irrigation Department in extending irrigation coverage there while retaining essential features of traditional farmer control and participation in decision making.

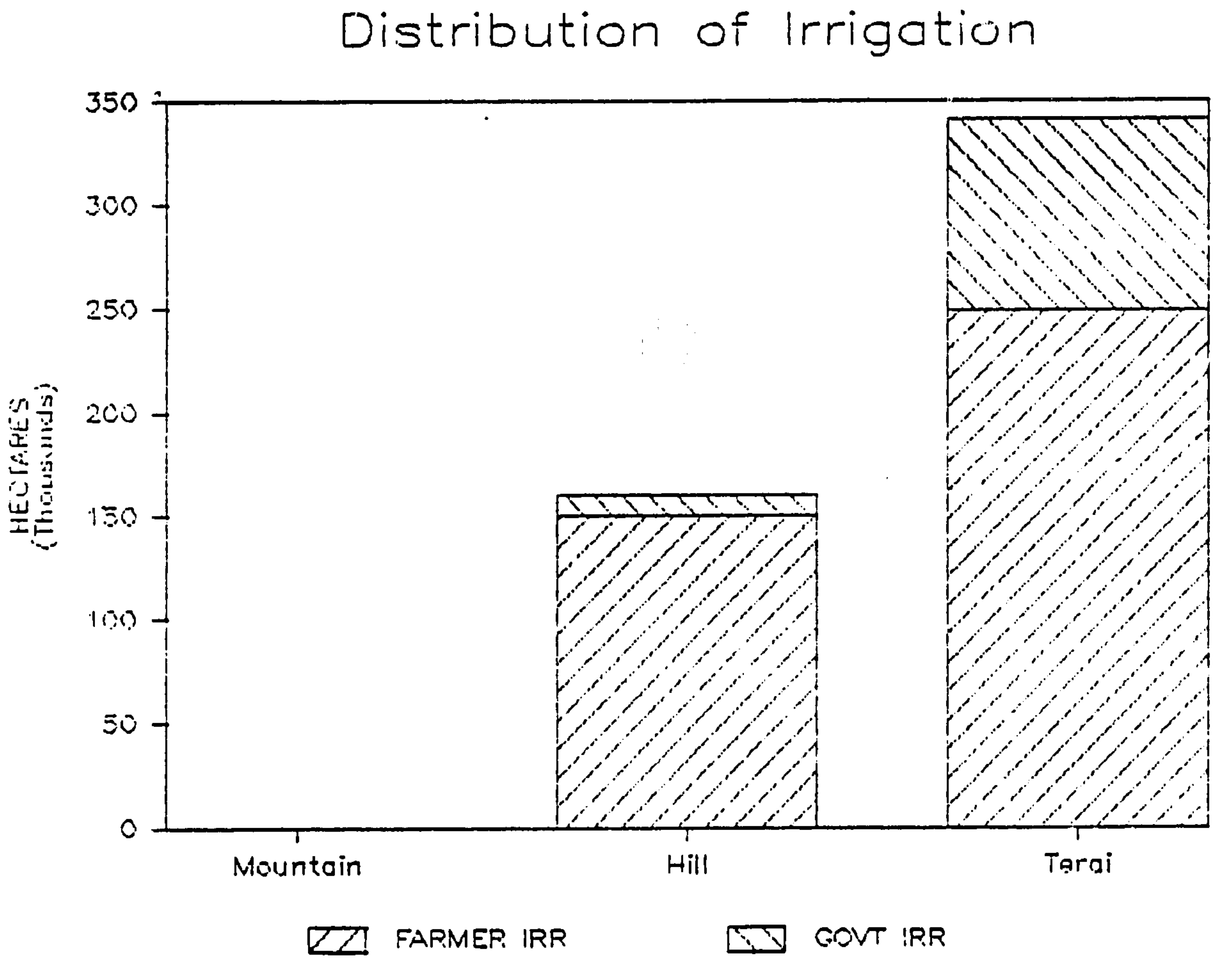

Distribution of Irrigation
350
300
250
200
150
100
50
0
HECTARES
(Thousands)
Mountain
Hill
Terai
FARMER IRR
GOVT IRR

Figure 5.

Recent Sector Assessments

ADB

Recent assessments agree that irrigation development is essential for achieving agricultural growth. As the Agricultural Development Bank's (ADB) Agricultural Development Strategy Study (1983) puts it, "Irrigation development would be the main basis for crop intensification, if a high rate of growth in the agriculture sector is to be achieved in the medium and longer term." The ADB report points out that while there are a variety of options to substantially increase agricultural production without major investments in infrastructure, "yields and cropping intensities achievable by any cultivation approach are limited in the absence of adequate water control."

The ADB report lists three major preconditions that must be satisfied in order for accelerated irrigation development to take place. These are:

1. Strengthened irrigation institutions particularly in the areas of planning and management.

2. Increased scope of operations in new irrigated areas to reduce the gap between nominally commanded and actually irrigated areas.

3. Better use of existing irrigation systems through rehabilitation and intensified operation and maintenance.

Points two and three are obviously closely related as one of the principal goals of improved O&M would be to reduce this gap.

To accomplish this the report proposes, in priority ordering, completion of ongoing projects, command area development to close the "area gap" in existing systems, groundwater development, new surface run-of-the-river schemes, and, finally, multipurpose storage schemes.

MWR

The Ministry of Water Resources' (MWR) Irrigation Sector Review (1981) presents a similar listing of needs and proposed interventions. Needs are:

1. Strengthened planning procedures including needs identification, specification of objectives, and relating development targets to development resource allocations.

2. Integration of agricultural and irrigation sector development recognizing that irrigation water is a critical agricultural input.

3. Enhanced project planning, design, and supervisory capability on the part of the implementing agency.

4. Streamlined institutional financing and implementation procedures.

5. Recognition that successful irrigation development depends on a post-implementation ability to operate and maintain that development.

Common Themes

In examining these two lists, several common themes stand out. One that emerges at the top of both is the need to improve irrigation sector planning capacity. One aspect of this task is to strengthen the capacity to undertake broad sectoral planning that will relate irrigation development actions to broader agricultural goals. The MWR survey points out that "a fundamental problem with irrigation sector development is that it has not been specifically directed at producing any beneficial impact" (MWR, 1981). This type of planning necessarily extends to entities beyond DIHM including, most specifically, the Department of Agriculture. The WECS set up under the MWR in 1981 is addressing this area with assistance from CIDA.

The second category of planning requiring attention is that involving project preparation, comparison, and choice. The MWR sector review here points to the absence of a planning framework within which systematic and rigorous planning can be undertaken as well as the organizational capacity within DIHM to apply it. This kind of planning capability is oriented toward more effective development of new irrigation capacity rather than improving the productivity of existing capacity.

Another category highlighted is that of integrating agricultural and irrigation-related concerns in the management of existing schemes. This requires the recognition that irrigation water is a critically important input in agricultural production, and not an end or a valuable output in and of itself. To be useful, it must be combined with inputs of high yielding seeds, adequate fertilization, pest and disease control, labor, markets, and management. Furthermore, it must be recognized that regular and reliable supplies of water are often the critical lead factor necessary to reduce the investment risks associated with modern commercial-input agriculture to levels acceptable to farm decision makers.

This problem is being addressed through several Command Area Development projects supported by the ADB. It is not yet clear how successful these projects will be in improving agricultural productivity in targeted schemes or in effecting the broader changes in thinking and procedure that will be necessary to transform the sector as a whole. They will most probably comprise necessary but not sufficient steps toward achieving this end.

The third major area of weakness is that of government attention to the problem of operating and maintaining completed irrigation systems. This links very strongly to the second area above. Integrating agricultural and irrigation requires that both agricultural and irrigation inputs be controllable and that mechanisms exist for effecting this control to the point where farmers themselves take over management responsibilities.

Currently for irrigation water inputs, this is not generally the case. The MWR report points to the failure of DIHM to recognize and address its expanded responsibility in managing the increasing extent of irrigated hectarage in the country once constructed. Likewise there is an unrecognized need to increase the intensity of management specifically on high-cost systems designed for intensive year-round irrigation. Compounding this problem are the inadequate levels of regular expenditure budgets used for system O&M.

A pair of proposals have been developed by WECS to address some of these needs (WECS, 1983a; WECS, 1983b). The two proposals are aimed at strengthening the design and planning capacities of the DIHM respectively. Together they call for the creation of separate specializations within DIHM for project design and execution on the one hand and for investigation, feasibility studies and monitoring on the other. Our analysis suggests that a natural and complementary third component in this setup is a specialization in system operation and maintenance.

The Seventh Plan

Current government thinking on development priorities in the agricultural sector is indicated in the guidance for preparation of the Seventh Plan recently issued by the National Planning Commission (NPC, 1984). It is worth examining this document with some care as it gives a very clear sense of direction to agricultural development strategy.

"Overall priority", under the Seventh Plan, is accorded to the development of the agricultural sector. This sector is rightly seen as the engine that drives the development process, both through its direct effects and through its impacts on effective consumer demand and linkages with industry and export trade.

HMG/N has set as a target for the Seventh Plan (1985-1990), an annual agricultural production growth rate of 3.5%. At the same time steps are to be taken to reduce the rate of population growth. If this level of agricultural growth is achieved, it is still expected to increase per capita income by a relatively modest 1.8%.

Within the agricultural sector, 11 sub-goals are identified. Of these, top priority is given to the raising of food production. To do this, three primary measures are suggested.

1. A "campaign" to increase food production in the mountainous region to the level of self-sufficiency within 10 years.

2. "Special programs...to step up food crop production and productivity" in food-deficit hill districts and to increase people's purchasing power through development of other income-generating activities.

3. (a) The development of "small and medium-sized" irrigation systems in the mountains and the Terai, (b) the more efficient use of water in existing hill area irrigation systems, and (c) in the Terai, "comprehensive improvements...in the water-use pattern of the irrigation projects already commissioned" and, additionally, the implementation of "new feasible projects."

Listed separately as point number 8 within the Agricultural Sector is the goal "to extend irrigation facilities." To do this, both long and short-term plans are suggested. The short-term plan emphasizes relatively simple quick-yielding measures to extend irrigation coverage. These include improving the coverage of existing agency-operated systems through improved management, the mobilization of local skills and technology in mountain and hill regions to exploit small-scale water resources wherever feasible, small tubewell irrigation development, and proper maintenance and repair of existing systems to maintain gains in efficiency.

The long-term plan is very short and emphasizes "preserving the big and medium-sized surface and groundwater irrigation projects" and carrying out "feasibility studies of such projects...in large numbers." Implementation of such projects is not stressed.

The clear picture that emerges from the Seventh Plan guidance document is of an irrigation strategy based on the consolidation and more effective utilization of installed irrigation capacity with a focus on <u>output</u> from irrigated agricultural systems. Existing capacity is to be supplemented by relatively small quick-yielding efforts to capture and utilize new sources of irrigation water. These efforts should mobilize the skills and expertise of the user-population whenever possible, particularly in hill and mountain regions. Feasibility studies of possible new large and medium projects, are to be made, but moves to implement these projects during the Seventh Plan are not emphasized.

IV. WATER RESOURCES DEVELOPMENT

General

In the total development of any river basin system, control of the headwaters must be achieved. This normally requires the construction of a large dam and reservoir with sufficient capacity for total regulation. This permits operation with a firm water supply, carry-over capacity through periods of deficient precipitation, and capacity to remove the devastating peaks of flood water runoff.

Unfortunately, this headwater development is costly and often most be deferred until development and needs of the downstream area can support the upstream costs. During this period, project lands must be brought into production through less costly approaches.

In Nepal, the level of expenditure necessary to gain basin control is currently prohibitive and will continue to be so for many decades. Development along the primary rivers is further complicated by their having some of the highest gradients and sediment transport in the world.

An intermediate stage of development must, therefore, be encouraged through the utilization of waters from lesser, tributary streams. Diversion structures will be less costly and, on the smallest of these, can often be temporary, replaced annually with local labor and materials. This type of development, however, brings with it water supply limitation which restrict full-scale development. Seasonal variations of stream flow and precipitation must either be accepted or compensated for through local storage or the development of groundwater resources.

Fortunately, the abundance of water in Nepal will exceed the annual demands placed upon it for many decades to come. With proper management and the eventual construction of storage facilities, a surplus will always be present to compensate for seasonal variations and regional needs. Although surface flows will exhibit seasonal deficiencies and excesses, the incorporation of groundwater supplies can compensate for the periods of shortage.

Existing Agriculture

The bulk of the agricultural production in Nepal depends entirely on natural rainfall. Projects diverting natural streamflow on a run-of-the river-basis have, in general, been successful but too often plagued by flow variability. Without supplement water, farmers must operate at the mercy of the local weather conditions. Production records, as available, show a high degree of variation. Farmers must wait for the pre-monsoonal rains to prepare the fields, plant in anticipation of rain, and harvest during a highly variable dry season. Agricultural crops, however, have well-defined water requirements from planting to maturity. Seasonal variations can often delay planting, reduce yields and force the harvest of a molded or a moisture ridden and difficult-to-store crop.

Although climatic conditions are highly favorable, development beyond a single crop agricultural base is risky without supplemental water. Favorable seasons can often yield second crops in particular regions, but input investments can never be assured. For the farmer with limited resources, the risk of crop failure is great and benefits are presently marginal. With supplemental water for irrigation, even agriculture primarily reliant on rainfall can be sufficiently predictable to insure timely harvests yielding premium crop value.

Enhancement of Existing Systems

It is the team's view that the economic productivity of existing agency-operated irrigation systems could be greatly enhanced through the application of improved water management, operation, and maintenance practices.

The first and foremost responsibility of the agency managing an irrigation project is to make water available at the farm turn-out at the proper time and in the amount needed by the farmer for optimum production. If a project is properly designed and constructed, the key to this most critical responsibility is an effective program of operation and maintenance.

Facilities observed by the team that have been constructed by the government during or after the late 1950's appear to be, in general, adequately designed. Most structures observed were in good condition and reasonably well maintained. The major problems appear to be lack of good water management practices, inability of both farmers and DIHM O&M organizations to control farmer water-taking along the canal systems and to enforce strict water scheduling. Timely water delivery will give the farmer confidence that water will be available when it is needed and this, in turn, will allow him to increase production. Some specific suggestions for improving project O&M are found in Appendix D.

When a supply system is purposefully over-sized to accommodate future block development, poor water management practices are actually promoted unless subsequent stage development takes place within a reasonably short time period. This is due primarily to the fact that users under the first block abuse the excess supply canal capacity temporarily available. Therefore, expedient development of the entire command area of existing supply systems is important. Full development of all the potential land in the project area holds O&M costs for each hectare to a minimum.

Subsurface drainage was reported to be a problem on some of the projects we observed. As full irrigation development in the command areas of terai systems is realized, subsurface drainage problems will probably continue and must be dealt with through more careful water management to reduced deep percolation losses and by installation of properly designed and constructed drainage systems. In Annex F of WECS (1982), soil drainage conditions in the Narayani Irrigation Project are discussed. The report states that of the Stage I gross command area of 22,000 hectares, a rise in groundwater table is being observed over at last half of the project area resulting in water-logging of soils.

The team inquired about water diversion and delivery records. Some record keeping exists in tubewell systems recording when and how long a tubewell was operated and which farmers and crops received the water. In surface water systems, records are much less comprehensive. Adequate water measuring devices were not found at strategic locations in the systems. Accurate water measurements at river diversions, main supply canals, tertiary canals, tertiary laterals, farm turnouts and operational wasteways are essential for good water scheduling. Accounting for tailwater reuse would also be necessary to accurately determine project and on-farm water use efficiencies. To be useful, however, water measurement data must be one element of a management system that collects and analyzes data makes decisions, implements decisions and monitors the results.

Experience from the United States

A primary factor in resolving these major problem areas is to have the water users involved in the entire process of project planning through construction and with O&M management thereafter. Experience in the United States has shown irrigation projects to be most successful when the O&M organization responsible for water delivery was controlled and operated by the water users. This experience also says that it is best to have the water user organization control and manage as much of the system as possible.

On large and complex systems, it may be necessary for the irrigation agency to manage the main system while user organizations manage lower portions of the project. However, it has been our experience that as time passes and the user organization gains expertise, it is best to transfer O&M responsibilities for increasingly larger portions of the project to them.

Close coordination between the operating agency and the user organization is essential. The user organization can request technical assistance from the operating agency at any time and this assistance is given promptly. The Board of Directors (elected by the users) of the user organization holds monthly and special meetings to conduct the business of the project. A water user can attend any meeting to discuss his problems with the Board of Directors. The Board also holds an annual meeting of all the users to discuss O&M problems and report such items as water supply, O&M costs (past and future), water measurement records, crop census, new and improved crops and farming practices, and water rights.

Water user organizations in the United States are non-profit, sub-divisions of the state in which they are located. This gives them taxing authority to collect O&M assessments through the local county tax system. All O&M assessments are collected in advance (usually in 2 semi-annual installments) for the next operating season. Annual assessments for the coming year are recommended at the annual water user meeting by the Board and approved by a majority vote of those users present. The Board hires a manager and O&M crew to accomplish actual project O&M work. Outside contractor assistance is hired when needed. However, most of the work is done by project forces.

It is important to note that the irrigation district (ID) board is involved with the development process from project conception. At conception the ID boundaries are layed out and a board of directors elected (usually 3, 5, or 7 members, depending on project size). The board is then in place to make certain the project is planned, designed, and constructed to meet their specific needs. They are also there to assist with timely government authorization and funding of the project.

We observed that there may be a problem of timely maintenance and repair along the canal system. Project management in the United States has a highly mobile maintenance crew trained and properly equipped to make emergency repairs so that water deliveries are not interrupted for lengthy periods of time. Close surveillance of the system to detect deficiencies during the operating season and non-operating season is essential. For example, immediately after unwatering the system, each kilometer of canal and tertiary and every structure is inspected. A repair plan is prepared and prioritized for each deficiency found. Highest priority repairs are made first, prior to the next irrigation season. Some lower priority work may be scheduled for a later time, when funds and labor are available.

Time did not permit a detailed review of existing cost records of personnel, equipment use, materials and supplies, and administrative and general expenses, major replacement, and special items. Such records are found to be extremely useful in the

U.S. in preparing planning Operation, Maintenance and Replacement (OM&R) estimates and for determining OM&R budgets for existing projects.

Groundwater Development

Potential

In the Terai and most of the interior basins, groundwater resources are extensive, though generally unmeasured. These resources can be developed for potable supplies or supplemental irrigation. The costs associated with this development will be extremely variable and dependent upon the identified needs and available energy sources for pumping.

Throughout the Terai, fine grained sediments to clay sizes predominate the lithologic profiles. Subsurface materials tend to become finer grained from the West to the East and from the foothills southward.

A cursory review of subsurface data obtained by previous investigators indicates an obvious lack of high yield aquifers throughout the Terai. Alluvial materials are typically very fine grained to depths of several hundred meters. In the absence of supporting data, it is believed that coarser materials would exist in close proximity to the deeply incised river channels as they discharge onto the Terai plain. As the sediments become finer grained, saturated thicknesses correspondingly increase in compensation.

Groundwater production, therefore, must compensate by developing greater thicknesses of saturated, fine grained, low yielding sediments. In general, existing wells have been drilled below economic depths. Low yielding seidments are overdrafted causing excessive drawdowns and higher cost operations. With proper well design, pump selection, and more numerous smaller units, groundwater operations could produce reliable irrigation supplies, virtually maintenance free, for extended periods.

Options for Groundwater Development

Groundwater development as a supplement to surface water irrigation can take several alternative courses. Large numbers of small diameter shallow wells can be drilled throughout the project, each discharging into a secondary or tertiary system. Alternately, a lesser number of larger capacity wells available to the entire project can be developed along the main canal. Either alternative has benefits and drawbacks, with variations from project to project.

Numerous shallow small-diameter wells throughout a project area would be individually less costly. Operation and day-to-day maintenance could be assigned to the benefitting farmers. Maximum water control and utilization could be achieved by making water available directly at the point of use. Conveyance losses would be minimized.

The alternative of a centralized well system would permit the pre-selection of the best subsurface conditions for well installations. Individual well costs would be higher with greater yields per well. Additional conduits might be required to transport the product water to the canal system. Time delays would be greater and system losses higher. This centralized source must provide water to even the most remote user on the project, requiring excessive pumping for even the most minimal demand. This type of system would require control, operation, and maintenance by someone other than the water-user. The operation and maintenance, however, would be more centralized and could be performed by a smaller staff of more qualified technicians.

Groundwater Data Base

The detailed groundwater data presently available for the Terai plain is generally confined to small, widely separated project areas, identified by previous investigators. In understanding the geologic history of the Terai and the sources of sedimentary deposition, this existing data was found to be adequate for reconnaissance and feasibility level evaluations. For cost estimating purposes and project planning, a standard well design can be assumed with a reasonable degree of accuracy. Once projects are identified, the groundwater or subsurface data must be site specific, as can only be derived from pilot hole, investigations.

Artesian Conditions

In some areas of the Terai, artesian conditions have been identified. This has resulted in free-flowing wells with generally low yields of a few liters per second. Any pumping in these areas will quickly result in the reduction or elimination of the artesian pressures.

Water Quality

Although water quality data is generally sparse and the existing analyses lack detail, it is generally believed that the quality is excellent for irrigation uses from both surface and groundwater sources. Surface water, though subject to localized contamination, is useable but typically heavily laden with sediment. With a glacial origin and high gradient streams, sediment transport ranging from coarse materials to rock flour in colloidal suspension create a wide range of end-use problems. Groundwater by contrast, provides a sanitary, sediment free water supply when properly developed.

Annual fainfall appears to be sufficient throughout the country to prevent salt buildup under current irrigation practices. However, some subsurface drainage may be needed in the future under low-gradient Terai conditions should water tables rise appreciably. This should be monitored. As centralized sanitation and industrial wastes become more common, care should be taken to insure that the available water supples are protected.

Well Design

For project planning purposes, the preferred well design should assume an economic depth no greater than 150 meters. Yields should be based on 30 liters/second. On larger capacity centralized wells, depths as great as 300 meters may prove to be reasonable with yields in the range of 80 liters per second. Wells should be designed and developed to minimize drawdowns, operations costs, and maintenance. Since high yield aquifers are generally non-existent, each well should develop a greater saturated thickness. Ideally, this would suggest gravel packed wells, employing high yield, Johnson type, wire wrapped screens. Surface treatment should require concrete pads and casings cemented to a depth of at least 5 meters. Well diameter and pump selection would vary between wells designated as farm wells, operated and maintained by the water user, or higher capacity project wells, operated and maintained by project personnel.

The present tubewell design, as viewed in the field, has required the construction of a pump house and baffled discharge box with a "V" notch measuring weir. These facilities are not believed to be essential and are adding considerable cost. To further reduce costs, pump houses could be eliminated by requiring all-weather pumps and outdoor waterproof panels. Equipment security and operation comfort would be factors that would have to be considered in making such a judgement.

Sample well screens presently employed in the tubewell design, were not available in the field. Production data from individual sites, however, suggests that improved yields are obtained where commercially manufactured Johnson slotted screens have been installed. Some experimentation with slotted fiber-glass screens has also been undertaken. Their continued use would not be recommended due to the lack of precision in slot diameter and the low percentage of voids per foot of screen. Aquifer conditions throughout the Terai are non-toxic so the use of non-metals cannot be justified on that basis.

Energy Sources

Energy sources available to projects in Nepal are generally deficient in both supply and reliability. The electric power grids, though they are rapidly improving, must be expanded along with the associated infrastructure. With the development of water resources, electric power will be required for pump operation, communications and associated project facilities. Initially, these needs can be fulfilled through the use of portable diesel or gasoline operated generators or direct engine-driven pumps. This approach, however, demands a broad-based support facility to insure fuel supplies, and proper operation and maintenance by trained personnel. As the infrastructure expands and permanent facilities become available, the portable equipment can be moved to the more remote localities.

Windmills

Wind resources, if available for a sufficient number of months during the year, could provide a low cost energy source for the operation of shallow farm wells. Groundwater levels, throughout the Terai, are near the surface and would facilitate windmill development. High yield aquifers are typically non-existent but the vast thicknesses of saturated sediments would yield small quantities of water 24 hours per day, indefinitely. Product water, collected in small basins, would provide potable supplies to meet domestic needs, as well as those of irrigation.

V. A STRATEGY FOR STRENGTHENING IRRIGATED PRODUCTION SYSTEMS

Introduction

A country with Nepal's water, energy, agricultural and human resources need not remain in a food deficit position. To move the nation out of that category and make agriculture a driving force in national development requires a fundamental shift in focus--from a concern with capturing water to serve as a production input, to a focus on optimizing agricultural outputs from irrigated agricultural systems.

Far from being simply an exercise in better crop husbandry, this way of looking at irrigation development places major responsibilities on the DIHM, WECS and other irrigation-related government agencies to: (a) make water available to farmers in the amounts and at the times required to achieve agreed upon production levels; (b) monitor the effects of their efforts; and (c) be accountable for their successes and failures. This way of looking at irrigation development will necessarily lead to an examination of the availablity of complementary inputs, such as fertilizer and improved seed varieties, and consideration of the responsibilities that farmers can and will take in managing water and maintaining certain system facilities. It also implies a rethinking of the DIHM's role in water resources development and, most likely, the adding of new dimensions to that role.

A strategy to accomplish this aim must do two things to be effective. It must develop improved and workable methods of making timely and reliable water deliveries to farmers in agency-operated irrigation systems. And it must develop and strengthen the institutional capacity to implement, monitor, and modify these methods. In doing this, a rational strategy must recognize the importance and worth of the legacy of centuries of indigenous farmer organization oriented toward accomplishing these tasks. This legacy of indigenous farmer organization represents another of Nepal's great underexploited resources.

These two tasks are closely related. The most effective means of building institutional capacity in Nepal is through collaborative efforts to develop improved methods of system operation and maintenance to increase agricultural productivity. To engage outside consultants to develop system operations and maintenance manuals (based on Western experience) and put on a training course or two for DIHM personnel will accomplish neither aim. Experience has shown that to be practicable and effective, operational procedures must be developed and tested on-site, and then modified as experience is gained.

In addition, a host of other factors will influence the form that O&M procedures assume and then help determine their effectiveness. Among these are officer staffing density, the qualifications of the O&M staff, the incentives that influence their commitment and behavior, farmers' perceptions of DIHM capability and responsiveness, the accountability that O&M staff feel toward farmers, farmers' ability to articulate their joint needs, and farmers' ability to manage water below the point where DIHM control ceases. These factors virtually demand that management strategies be developed in-place and that development involve both DIHM field personnel and farmers in addition to O&M specialists.

Implementing such a strategy is a long-range undertaking. As such, it is highly consistant with the traditional approach of the Nepal USAID mission of working in well-defined sectors for a period sufficiently long to develop new approaches, consolidate gains and extend them. A project developed to implement this strategy must be able to stand alone as a viable and useful activity, but must also be capable of serving as the foundation for follow-on work having an ever-diminishing technical assistance component.

Organizational Involvement

Improving the production of irrigated agricultural systems is not the function of any one organization. Even the government as a whole is not solely responsible, since private entrepeneurs and farmers are involved also. This suggests that a project designed to work solely with one organization, be it a government organization or a farmers' association, will be unlikely to succeed.

Even in the irrigation sector, a variety of institutions are involved in managing and supporting actions. In a given situation, these might include the DIHM Kathmandu office, the DIHM regional office, the Department of Agriculture, the local Panchayat, the Local Development Department, a farmers' organization, and private contractors who do system repair work. When programs are mounted to change the status quo in some way, other institutions become involved to develop a program of intervention and then implement, monitor, and evaluate it. Often one aim of such programs is actually the creation of new institutions, as in the setting up of farmer irrigator associations, for example.

It seems clear that this institutional complexity must be considered in developing a change strategy for irrigated agriculture. On the other hand, we need not be overwhelmed by that complexity. Existing roles and relationships can be analyzed and tasks in the change process identified. Organizations able to carry out these tasks can then be matched to needs. This approach is preferable to that of selecting a single organization, and then trying to create within it all of the capacities necessary to institute the desired change.

In fact, experience in the Philippines, Sri Lanka, and India suggests that certain roles, such as progress monitoring and mobilizing farmers, are best performed from outside the main line agency, at least initially. In the approach outlined by Korten (1980), one must first learn to be effective, then efficient, and finally to extend the effort more widely. Learning to be effective is often best accomplished by drawing skills and expertise from those existing organizations best able to provide it rather than creating it from scratch.

Priority Areas for Action

The foregoing analysis suggests four different categories of tasks falling within the perview of the DIHM and supporting agencies. These are (a) design/construction and (b) operation/maintenance of agency-operated systems on the one hand and the same pair of categories relative to farmer-managed systems on the other. These tasks differ substantially in their goals and in the methods and skills necessary to carry them out effectively.

Of these four categories, the operation and maintenance of farmer-managed sytems is, from the government's point of view, the least important. By definition, farmers have primary responsibility for managing these systems. In addition, the limited evidence available indicates that they do a reasonably good job of this. The government does have an important role, however, in assisting communities to upgrade and improve their systems with technical skills and financial resources and materials that are beyond local capacities. Such assistance can have direct payoffs in terms of agricultural output by expanding cultivated area and restoring failed systems to operation. However, because the work is in an assistance mode and because of the critical need to avoid creating on-going dependency on government agencies, an approach different from that employed in constructing agency-operated systems is required.

On the other hand, improved O&M of agency-operated systems appears to offer enormous potential for increasing agricultural output, as indicated earlier. The government's responsibility is direct, relatively large areas are affected, current operating efficiencies are low, and additional land that could be irrigated is available.

Improving design and construction practices and standards for agency-operated systems is also an area where improvement is needed. However, the payoffs here would be longer in coming and relate more to reducing dependence on expatriate consultants and better project planning and selection than to increasing production levels directly.

In summary, the priority areas suggested for emphasis are: first, the improved operation and maintenance of existing agency-operated systems, and, second, the development of a separate mode of providing rehabilitation and improvement assistance to farmer-managed systems. Also important, but with a lower short-term payoff, is the improvement of the DIHM capacity to design, plan and monitor new system construction.

Program Components

Specialization

To strengthen DIHM capacity in the priority areas recommended above, it will be necessary first to identify or create "nodes", e.g. working groups or divisions, within DIHM to specialize in planning and design, and operations and maintenance. The planning and design section should be further divided into separate specialities for assistance to farmer-managed systems (if DIHM is to play an important role here as in the "cluster" project concept), and design and construction in agency-operated systems.

Within these separate divisions or working groups, specialized procedures can be developed and assigned personnel can develop the skills to implement them. Training in basic principals necessary to perform these tasks should begin as soon as possible with more specialized training to follow. Ideally such training should be conducted in-country in conjunction with the Engineering Institute or another educational institution, though some may necessarily be carried out in the United States or in a third country such as India or Sri Lanka.

Additional Studies

One of the fundamental difficulties encountered in trying to pinpoint the cause of disappointing levels of agricultural production on irrigated lands and of low system efficiencies is the dearth of statistical data and case study information on Nepalese irrigation systems. In the course of this study, for example, basic production data on cereals disaggregated by irrigated versus non-irrigated areas proved to be unobtainable. The WECS Irrigation Sector Review (MWR, 1981, p.32) complains that "there is an abundance of irrigation data but it is so poorly defined and plagued with such inconsistencies that without considerable research and analysis it is of very limited use for evaluation or planning purposes."

Integrated multidisciplinary case studies of functioning irrigation systems are essential to permit an understanding of the characteristics and relationships currently prevailing. This in turn will allow the identification of critical problems and constraints, and their interrelationships, affecting attempts to improve system management. It is vital that studies assess performance in hydrologic, agronomic, and social/institutional dimensions. Mounting such studies in a collaborative mode involving experienced expatriate researchers and local agencies and institutions such as WECS, the Engineering Institute, APROSC, or a new water management institute such as the one proposed by WECS (1984), is also a powerful means of developing the capacity to conduct such studies internally.

In addition, it would be important to reassess ongoing data collection efforts aimed at agricultural production and irrigation system performance in the various national monitoring programs. Ways could then be explored of making these data collection and analysis systems more responsive to system diagnosis and improvement needs.

Management Improvement

Irrigation system management has a multitude of dimensions. Water must be managed--but so must crops, personnel, budgets, equipment, and relationships with farmers. The bottom line, though, is that the supply of water must be brought into balance with demand in a way that is predictable, for both farmers and officials, and sustainable. In order to accomplish this, focus has traditionally been on system operations and system maintenance usually considered together as "O and M."

While it is vital to treat these two together as they have many interrelationships, they do have separate identies. Operations means the manipulation of system control structures in a calculated way so as to achieve a balancing of supply and demand. "Calculated way" here implies knowledge of the supply available and the effective demand existing at a given time. Balance can then be achieved either by adjusting delivery rates, or by reducing demand through such means as hectarage restrictions, restrictions on types of crops planted, or water loss reduction programs.

Not all of the possible mechanisms for achieving this balance are available to irrigation system managers. Adjusting the cropping pattern, for example, is powerfully dependent on agricultural prices and marketing channels and is often relatively immune to independent manipulation by irrigation system managers.

Other mechanisms are under the control of irrigation authorities to a much greater degree, and may be approachable from several different directions. Loss reduction, for example, can be tackled through canal lining on one hand, or through a program of measurement, monitoring and control on the other. The first approach would effectively address major canal seepage and leakage losses, while the other would reduce over-irrigation in upper reaches and wastage to drains. Much obviously depends on the relative importance of the different types of losses and inefficiencies within the system. This general topic is one of major importance that should be addressed in a study program as discussed in the previous section.

In general, an effective operational system involves a means of assessing effective demand for irrigation water at the farm level and aggregating this demand, first to the point at which DIHM control begins and then upward to the diversion point; a mechanism for communicating information in a timely fashion to a decision-making body; a means for communicating decisions to those who operate control structures and those who grow crops; and a means of assessing and improving performance.

Maintenance is the task of preserving the physical capacity of the irrigation system to deliver water predictably to farmers' fields. Maintenance can be thought of as consisting of three different categories--routine, special, and deferred. Routine maintenance is normally done annually or more frequently and includes all work necessary to counter regular short-period disturbances to physical works such as grass and weed growth, siltation, rust, mechanical wear, bank sloughing, inspection road deterioration and so forth. Special maintanance includes repairs occasioned by major disasters such as floods, earthquakes or typhoons which are longer-period and generally less predictable. Deferred maintenance involves major modification of canals and structures and is similar, in most respects, to major system rehabilitation.

An ordinary maintenance program has three conceptual stages--planning routine maintenance, implementing both routine and special maintenance, and monitoring system conditions and work quality. Although planning and monitoring generally must be done by department staff, the implementation can be carried out either by the DIHM's own staff, or through private contractors. In Nepal, heavy reliance has been placed on the latter for both special and some types of routine maintenance.

In considering the current general approach to system O&M, this division of tasks should be reassessed in terms of cost effectiveness, quality of work done, timeliness, and responsiveness to irrigators' needs. It appears likely that maintenance could be improved along these dimensions by increasing the DIHM capacity to carry out more of the routine and special maintenance on a force account basis.

Certain tasks will no doubt continue to be most effectively performed by private contractors. Contracting modes, however, should be reevaluated and some form of prequalification based on past performance considered. In addition, training for private contractors in work scheduling, quality control, and the like could prove rewarding.

One other area that should be explored is the ability and willingness of farmers to take on certain maintenance functions themselves. Although this is often prescribed on paper, it is far less common to find it implemented effectively in the field. Any devolution of selected maintenance responsibilities must be a part of a larger pattern of cooperation and interaction between irrigation authorities and farmers to work effectively. Preexisting traditions of community management of irrigation need to be investigated and ways to preserve and extend this participation identified.

Administrative and financial systems are critically important in supporting those systems which actually operate and maintain irrigation systems. For example, a personnel system must offer incentives and specialized training to officers assigned to O&M activities and reward effective performance in carrying out O&M tasks. Currently in many Asian countries, internal reward structures are biased toward design and construction tasks, drawing attention and the most capable staff away from critical O&M functions. Supporting and implementing systems must be examined together in developing strategies for irrigation O&M improvement.

Financing irrigation system recurrent costs is an administrative area that deserves special note. Such financing can come directly from user fees or from the central treasury, or from some combination of the two. The source of O&M funding can have important implications for the level of the funding, its stability over time, and the accountability that O&M staff feel toward the water users.

There is a general tendency in most Asian countries for per hectare expenditures for irrigation system O&M to decline as irrigated hectarage rises. Employing irrigation service fees directly to finance at least a portion of system O&M costs is one way of countering that tendency. Additionally, such a linkage can have a beneficial effect on the responsiveness that irrigation personnel feel toward the farmers and on the quality of the relationship between farmers and agency O&M personnel, as experience in the Philippines has shown.

Physical Improvement

No mention has been made, so far, of physical system rehabilitation. This has been in part intentional, to avoid casting the suggested program as a civil works rehabilitation effort with a management component added in. Chambers (1984) argues that rehabilitation of main system physical works has often been a distraction that has diverted attention from management improvement tasks that have much quicker payoff potential but which may employ techniques that are less familiar to engineering staffs. Undertaking managerial improvements first, leaving large-scale physical rehabilitation (or deferred maintenance) for a later stage, may be a more effective strategy. Focusing on management systems first can also help to pinpoint precisely which physical elements in the system are the most limiting constraints from an operational point of view.

Nevertheless, rehabilitation and management improvement can be highly complementary. However, in order to achieve adequate water control in an irrigation system, the physical capability to control water (and sediment) must be present. It is important to understand, though, that control capacity is a necessary but not a sufficient condition for good irrigation water management.

Physical system improvements, such as canal desilting, addition of cross-regulators, repair and replacement of gates, selective channel realignment, or the development of tubewells as supplemental water sources will be necessary in many circumstances to achieve adequate control capability. But it is important to regard these improvements selectively and to use them to fill gaps in supply and control rather than as the central activity in a program of management improvement.

Pilot Efforts

The core of a program of work such as this must be a set of carefully monitored pilot efforts which develop, test and institute desireable changes in system management practices. Bureaucratic specialization, training, special studies, physical rehabilitation, and management plans by themselves do not necessarily lead to demonstrable increases in agricultural production. Component activities must be brought together in a cycle of field-based pilot efforts, sometimes called action research, consisting of baseline data collection, trial interventions, monitoring, feedback, modification, and assessment.

This type of approach serves two important functions. First it leads to a set of procedures that are adapted to their socio-technical environment. Because of the complexity of the management problem, it is almost certain that some experimentation will be required to develop appropriate procedures for system O&M. The pilot effort provides a situation in which such experimentation is encouraged and certain failures and setbacks are expected rather than punished. These pilot efforts are expected to be Nepalese efforts where the lead is taken by local individuals and institutions. The role of the donor is to provide financial and technical assistance to facilitate that process.

The second major result of this approach is that the individuals and institutions involved learn new skills and, more importantly, they <u>learn to learn</u> from their own experience. This is a very different process from the more usual one of engaging a set of consultants, local or expatriate, to develop an O&M manual for agency-operated irrigation systems and then train agency personnel to apply them. It recognizes that systems are dynamic, that they continue to evolve and change, and that O&M procedures must change too. Only if the approach and the process of developing and testing O&M procedures is understood, can a cycle of dependency be avoided.

Pilot efforts of the type suggested here would need to be applied separately in the case of agency-operated system O&M and that of design and construction assistance to farmer-managed systems.

Training

Substantial amounts of training would be required to implement the strengthening and improvement program outlined above. Skills needed would include system planning and design, working with farmers and communities, construction and installation of measuring structures and devices, water measurement, hydro-meteorological data collection, data processing and analysis, irrigation scheduling, systems anaysis, instrument maintenance and repair, and equipment scheduling and repair.

In addition, training for local private sector contractors might be an important element in an overall program of institutional capacity building since this has been identified as an area of weakness in the past. All training needs which are likely to recur should be addressed in conjunction with local or regional institutions.

<u>Next Steps</u>

The basic outcome of this review has been to validate the HMG's Seventh Plan strategy for enhancing utilization of existing small and medium scale irrigation potential and to suggest ways in which this could be accomplished in a context of external donor assistance. It is hoped that the ideas presented here will serve as a basis for further discussion, building on that begun during the Seminar on Water Management Issues in Kathmandu in August of 1983.

That seminar, sponsored by the Ministry of Agriculture, the Agricultural Projects Services Centre, and the Agricultural Development Council, brought together representatives from the National Planning Commission, the Water and Energy Commission, the Department of Irrigation, and the Department of Agriculture, irrigation scholars from Nepal and the United States, and representatives of other Nepalese and international agencies to discuss water management issues critical to Nepal's future agricultural development. While in many respects consistent with the suggestions for follow-up activities contained in the seminar report (see Appendix E), this report extends the analysis to suggest more specific program elements necessary to effect desired changes.

Another step will be taken in early 1985 when a water management Diagnostic Analysis workshop sponsored by the Departments of Irrigation and Agriculture and assisted and supported by AID's Water Management Synthesis II project will be held. This workshop will field a joint multidisciplinary team of water management specialists from both countries to document the functioning of two operating irrigation systems in the Terai. This information will then be compiled into a pair of case studies serving as the basis for a problem solving seminar for senior government officials. It is hoped that this workshop will add to our understanding of how both farmer-managed and agency-operated systems in Nepal function, where their most severe problems lie, and what shape potential solutions might take in each case. In addition, it should increase appreciation of water management as a multidisciplinary problem area and acquaint participants with some of the techniques that can be used to diagnose and solve multidimensional problems.

At the present time USAID is also undertaking, through a Nepalese consultant, a study of the financing of irrigation system recurrent costs in Nepal as a part of a region-wide study of this issue. This study is designed to examine the ways in which selected countries in Asia set and collect fees to fund irrigation system O&M, and to search for conditions which characterize the most successful efforts to do this.

It is anticipated that the report of this special review team will be made available to relevant HMG offices and that USAID mission staff will be available to discuss findings and suggestions and the reactions to them. Should interest in an approach such as this prove strong, the next major step would be a visit by a three to five person multidisciplinary team which would analyze system performance and case study data and conduct additional interviews and field visits to develop specific outlines of a donor-assisted project focused on irrigation system O&M.

In the interim, two supplementary activities would provide very useful background data for future project development. The first of these is a set of rapid appraisals carried out on a stratified sample of small and medium-sized irrigation systems. These should include examples of both conjunctive use of ground and surface water and agency-operated systems where farmers are known to participate actively in system operation and maintenance. Studies should examine, among other things, hydrologic questions of water application and water use efficiencies, procedures employed by both farmers and government officers in managing the systems, and the nature of the interactions between farmers and government officers.

The second type of activity that suggests itself is an analysis of the institutions and organizations that affect in some way the management of existing small and medium irrigation systems. Included, for example, would be DIHM, the Department of Agriculture, local panchayats, APROSC, the Institute of Engineering, irrigators' associations, and possibly the engineering institute at Rorkee. A more exhaustsive list of potential organizations is given in the FAO agricultural Sector Review (FAO, 1981, p.18). An understanding of characteristics of these organizations, the relationships existing among them, and their potential contributions to improving irrigation system O&M would be a necessary precursor to the design of a program that attempts to development a strong institutional capacity across the irrigation sector.

Either or both of these preliminary activities might receive technical and financial support under AID's WMS-II project if requested.

An additional interim activity that could be undertaken is in response to a difficult sedimentation problem brought to the team's attention at Chitwan. The US Bureau of Reclaimation has the capacity to carry out hydraulic model studies to develop a solution to this problem. The recently approved second amendment to the ADB's Citwan irrigation project does contain provision for such assistance and the possibility of the USBR providing services in the context of this amendment should be explored. The Bureau also has the capacity to provide certain types of training and technical assistance in support of a future longer-term program of work.

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APPENDIX A

SCOPE OF WORK

Nepal Small and Medium Scale
Irrigation Sector Review

The purpose of this mission is to review the small and medium scale irrigation sector in Nepal to assess opportunities for accelerating rates of agricultural production increases through assistance in improving irrigation system design, construction, operation, and maintenance. The team will attempt to identify intervention points within the small and medium scale sector having high potential for generating such increases and the types of training and technical assistance that would be necessary to exploit these opportunities. In addition, the team will define areas where basic information relating to irrigation system design and performance and are critically deficient and suggest types of studies and data collection programs that could remedy these deficiencies.

Because of the short time period involved, the team should review available literature before departing for Nepal. This review will include the recently completed ADB Agricultural Sector review, materials on Terai ground water potential available from the USGS, the USAID Country Development Strategy Statement for Nepal, and other background material on Nepal and Nepalese agriculture and water resources as may be appropriate.

During the overseas portion of the mission, the team will meet with representatives of the various departments of His Majesty's Government of Nepal (HMG), the USAID mission, A/D/C, the World Bank, the Asian Development Bank (ADB) and other agencies active in the irrigation and water management sector in Nepal to determine their plans, programs and priorities. Because of the extensive experience the ADB has had with small and medium scale irrigation in Nepal, the team will stop in Manila en route to Kathmandu to consult with ADB officials. The team will also visit several small and medium scale irrigation sytems in the Terai and/or hill regions and consult with farmers and district officials regarding design and operation and maintenance (O&M) practices employed in these systems.

The team will consist of three people: a water management engineer, a groundwater specialist, and an O&M engineer familiar with small irrigation channels and structures. Seven to 10 years of experience in his/her professional area is required of each team member. The team leader is expected to have had extensive Asian experience and such experience is highly desireable for the other team members.

Specific responsibilities of individual team members include the following:

Water Management Engineer and Team Leader. Survey the extent and distribution of the different types of installed and planned irrigation capacity in Nepal. Assess current water management practices in government-run and community-operated small and medium scale irrigation systems. Work with the O&M engineer to assess current design and O&M practices in both government-run and community-operated systems. Identify possible interventions to improve crop yields and cropping intensities through improved O&M and water management practices. Coordinate the work of the team and the preparation of the Brief reporting the findings of the review mission. Work closely with HMG and USAID personnel to identify program priorities and institutional and human resource constraints to suggested training and technical assistance opportunities.

Groundwater Specialist. Assess the extent and adequacy of existing groundwater records and data. Determine, from existing data, groundwater availability in various regions of the Terai and the opportunities for, problems with, and constraints to its exploitation for small-scale irrigated agriculture. In particular, examine the constraints imposed by existing power sources for pumping and existing public and private sector well drilling and pump sales and repair capabilities. Review should include traditional private sector well drilling technology as well as more modern private and public sector technology. Suggest opportunities for assistance in ground water development in the Terai and indicate training, technical assistance and additional information needs.

O&M Specialist. Assess current design and O&M practices in both government-run and community-operated irrigation systems. Assess extent and adequacy of data and records describing operation and maintenance practices now employed. Determine budget and personnel levels currently available for irrigation system O&M. Determine current water duty values used in designing different types of systems and assess system water use efficiencies. Identify possible interventions to improve irrigation system efficiencies through improved operational procedures and through better maintenance and discuss problems with and constraints to these approaches. Review should consider both role of irrigation department personnel and that of farmers in achieving these ends. Determine potential of selective rehabilitation interventions, such as improved headwork and intake structures, to increase supplies of water available in existing systems and expand the area irrigated.

TEAM COMPOSITION

Mark Svendsen	Water Management Engineer and Team Leader. Senior Water Management Specialist, Office of Technical Resources, Bureau for Asia, USAID/Washington.
Daniel Macura	Groundwater Geologist and Water Resource Engineer. Chief, Technical Assistance, Division of Foreign Activities, U.S. Bureau of Reclamation.
James A. Rawlings	Operations and Maintenance Engineer. Regional Supervisor, Division of Water and Land, U.S. Bureau of Reclamation, Upper Missouri Region, Billings, Montana 59103.

A P P E N D I X   B

NEPAL - SOCIAL INDICATORS DATA SHEET

	NEPAL			REFERENCE GROUPS (WEIGHTED AVERAGES) /a (MOST RECENT ESTIMATE) /b	
	1960 /b	1970 /b	MOST RECENT ESTIMATE /b	LOW INCOME ASIA & PACIFIC	MIDDLE INCOME ASIA & PACIFIC
AREA (THOUSAND SQ. KM)					
TOTAL	140.8	140.8	140.8	.	.
AGRICULTURAL	35.3	36.8	41.2	.	.
GNP PER CAPITA (US$)	60.0	80.0	150.0	276.7	1028.6
ENERGY CONSUMPTION PER CAPITA					
(KILOGRAMS OF COAL EQUIVALENT)	3.0	15.0	13.0	398.4	792.8
POPULATION AND VITAL STATISTICS					
POPULATION, MID-YEAR (THOUSANDS)	9447.0	11355.0	15029.0	.	.
URBAN POPULATION (% OF TOTAL)	3.1	4.9	6.4	21.5	32.9
POPULATION PROJECTIONS					
POPULATION IN YEAR 2000 (MILL)			24.2	.	.
STATIONARY POPULATION (MILL)			73.3	.	.
YEAR STATIONARY POP. REACHED			2155	.	.
POPULATION DENSITY					
PER SQ. KM.	67.1	80.6	104.0	161.7	260.7
PER SQ. KM. AGRI. LAND	267.4	308.6	355.7	363.1	1696.5
POPULATION AGE STRUCTURE (%)					
0-14 YRS	39.1	42.0	42.4	36.6	39.4
15-64 YRS	57.4	55.0	54.6	59.2	57.2
65 AND ABOVE	3.5	.	3.0	4.2	3.3
POPULATION GROWTH RATE (%)					
TOTAL	1.3	1.8	2.5/c	1.9	2.3
URBAN	4.4	5.3	5.0	4.0	3.9
CRUDE BIRTH RATE (PER THOUS)	43.6	45.5	43.6	29.3	31.3
CRUDE DEATH RATE (PER THOUS)	26.5	23.7	19.8	10.9	9.6
GROSS REPRODUCTION RATE	2.7	3.0	3.1	2.0	2.0
FAMILY PLANNING					
ACCEPTORS, ANNUAL (THOUS)	..	37.4	146.0/d	.	..
USERS (% OF MARRIED WOMEN)	..	0.7/f	4.3/e,f	48.1	46.6
FOOD AND NUTRITION					
INDEX OF FOOD PROD. PER CAPITA (1969-71=100)	106.0	101.0	82.0	111.4	125.2
PER CAPITA SUPPLY OF					
CALORIES (% OF REQUIREMENTS)	94.0	94.0	86.0	98.1	114.2
PROTEINS (GRAMS PER DAY)	51.0	51.0	45.0	56.7	57.9
OF WHICH ANIMAL AND PULSE	9.0	9.0	8.0/e	13.9	14.1
CHILD (AGES 1-4) DEATH RATE	32.6	27.8	22.5	12.2	7.6
HEALTH					
LIFE EXPECT. AT BIRTH (YEARS)	37.6	40.5	44.5	59.6	60.2
INFANT MORT. RATE (PER THOUS)	194.5	172.5	147.7	96.6	68.1
ACCESS TO SAFE WATER (%POP)					
TOTAL	..	2.0	8.0/g	32.9	37.1
URBAN	47.7	53.0	81.0/g	70.8	54.8
RURAL	..	..	5.0/g	22.2	26.4
ACCESS TO EXCRETA DISPOSAL (% OF POPULATION)					
TOTAL	..	1.0	1.0/h	18.1	41.4
URBAN	..	14.0	14.0/h	72.7	47.5
RURAL	..	..	..	4.7	33.4
POPULATION PER PHYSICIAN	73800.0	51380.0/i	30060.0/e	3506.0	7771.9
POP. PER NURSING PERSON	..	70530.0/i	33420.0/e	4797.9	2462.6
POP. PER HOSPITAL BED					
TOTAL	8290.0	6940.0	6390.0	1100.6	1047.2
URBAN	290.0	390.0	450.0	298.4	651.1
RURAL	..	..	..	5941.6	2591.9
ADMISSIONS PER HOSPITAL BED	..	..	..	..	27.0
HOUSING					
AVERAGE SIZE OF HOUSEHOLD					
TOTAL	..	5.5	..	..	..
URBAN	5.4	..	..	..	..
RURAL	..	..	..	..	..
AVERAGE NO. OF PERSONS/ROOM					
TOTAL	..	..	..	..	..
URBAN	2.0	..	..	..	..
RURAL	..	..	..	..	..
ACCESS TO ELECT. (% OF DWELLINGS)					
TOTAL	..	..	..	..	..
URBAN	30.2	..	..	..	..
RURAL	..	..	..	.	..

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NEPAL

NEPAL - SOCIAL INDICATORS DATA SHEET

	NEPAL 1960 /b	NEPAL 1970 /b	NEPAL MOST RECENT ESTIMATE /b	REFERENCE GROUPS (WEIGHTED AVERAGES) /a (MOST RECENT ESTIMATE) /b LOW INCOME ASIA & PACIFIC	MIDDLE INCOME ASIA & PACIFIC
EDUCATION					
ADJUSTED ENROLLMENT RATIOS					
PRIMARY: TOTAL	10.0	26.0	91.0	96.1	101.2
MALE	19.0	43.0	126.0	107.8	106.0
FEMALE	1.0	8.0	53.0	82.9	97.5
SECONDARY: TOTAL	6.0	10.0	21.0	30.2	44.9
MALE	11.0	16.0	33.0	37.3	50.0
FEMALE	2.0	3.0	9.0	22.2	44.6
VOCATIONAL (% OF SECONDARY)	0.2	3.8	6.8/e	2.3	18.5
PUPIL-TEACHER RATIO					
PRIMARY	33.0	22.0	38.0	34.4	32.7
SECONDARY	32.0	..	31.0	18.4	23.4
ADULT LITERACY RATE (%)	8.8	14.3	19.0	53.5	72.9
CONSUMPTION					
PASSENGER CARS/THOUSAND POP	0.1	0.4	..	1.6	9.7
RADIO RECEIVERS/THOUSAND POP	3.0/j	4.8	20.5	96.8	113.7
TV RECEIVERS/THOUSAND POP	..	..	..	9.9	50.1
NEWSPAPER ("DAILY GENERAL INTEREST") CIRCULATION PER THOUSAND POPULATION	0.7	2.4	7.3/g	16.4	54.0
CINEMA ANNUAL ATTENDANCE/CAPITA	..	..	..	3.6	3.4
LABOR FORCE					
TOTAL LABOR FORCE (THOUS)	4875.0	5537.0	7140.0	.	.
FEMALE (PERCENT)	40.5	39.2	39.0	33.3	33.6
AGRICULTURE (PERCENT)	95.0	94.0	93.0	69.0	50.9
INDUSTRY (PERCENT)	2.0	2.0	2.0	15.8	19.2
PARTICIPATION RATE (PERCENT)					
TOTAL	51.6	48.8	47.5	42.5	38.6
MALE	61.5	58.3	57.6	54.4	50.7
FEMALE	41.8	38.6	37.3	29.8	26.6
ECONOMIC DEPENDENCY RATIO	0.8	0.9	1.0	1.0	1.1
INCOME DISTRIBUTION					
PERCENT OF PRIVATE INCOME RECEIVED BY					
HIGHEST 5% OF HOUSEHOLDS	..	..	35.3/g	16.5	22.2
HIGHEST 20% OF HOUSEHOLDS	..	..	59.2/g	43.5	48.0
LOWEST 20% OF HOUSEHOLDS	..	..	4.6/g	6.9	6.4
LOWEST 40% OF HOUSEHOLDS	..	..	12.6/g	17.5	15.5
POVERTY TARGET GROUPS					
ESTIMATED ABSOLUTE POVERTY INCOME LEVEL (US$ PER CAPITA)					
URBAN	..	..	95.0	133.9	194.5
RURAL	..	..	45.0	111.6	155.0
ESTIMATED RELATIVE POVERTY INCOME LEVEL (US$ PER CAPITA)					
URBAN	..	..	..	..	178.0
RURAL	..	..	41.0	..	164.8
ESTIMATED POP. BELOW ABSOLUTE POVERTY INCOME LEVEL (%)					
URBAN	..	..	55.0/e	43.8	24.4
RURAL	..	..	51.0/e	51.7	41.1

.. NOT AVAILABLE
. NOT APPLICABLE

NOTES

/a The group averages for each indicator are population-weighted arithmetic means. Coverage of countries among the indicators depends on availability of data and is not uniform.

/b Unless otherwise noted, "Data for 1960" refer to any year between 1959 and 1961; "Data for 1970" between 1969 and 1971; and data for "Most Recent Estimate" between 1979 and 1981.

/c Estimated annual growth rate for 1972-79 is 2.6%; /d 1978; /e 1977; /f Government program only; /g 1976; /h 1975; /i Personnel in government services only; /j 1963.

May 1983

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DEFINITIONS OF SOCIAL INDICATORS

Notes: Although the data are drawn from sources generally judged the most authoritative and reliable, it should also be noted that they may not be internationally comparable because of the lack of standardized definitions and concepts used by different countries in collecting the data. The data are, nonetheless, useful to describe orders of magnitude, indicate trends, and characterize certain major differences between countries.

The reference groups are (1) the same country group of the subject country and (2) a country group with somewhat higher average income than the country group of the subject country (except for "High Income" Oil Exporters" group where "Middle Income North Africa and Middle East" is chosen because of stronger socio-cultural affinities). In the reference group data the averages are population weighted arithmetic means for each indicator and shown only when majority of the countries in a group has data for that indicator. Since the coverage of countries among the indicators depends on the availability of data and is not uniform, caution must be exercised in relating averages of one indicator to another. These averages are only useful in comparing the value of one indicator at a time among the country and reference groups.

AREA (thousand sq.km.)

Total - Total surface area comprising land area and inland waters; 1960, 1970 and 1980 data.

Agricultural - Estimate of agricultural area used temporarily or permanently for crops, pastures, market and kitchen gardens or to lie fallow; 1960, 1970 and 1980 data.

GNP PER CAPITA (US$) - GNP per capita estimates at current market prices, calculated by same conversion method as World Bank Atlas (1979-81 basis); 1960, 1970, and 1981 data.

ENERGY CONSUMPTION PER CAPITA - Annual apparent consumption of commercial primary energy (coal and lignite, petroleum, natural gas and hydro-, nuclear and geothermal electricity) in kilograms of coal equivalent per capita; 1960, 1970, and 1980 data.

POPULATION AND VITAL STATISTICS

Total Population, Mid-Year (thousands) - As of July 1; 1960, 1970, and 1981 data.

Urban Population (percent of total) - Ratio of urban to total population; different definitions of urban areas may affect comparability of data among countries; 1960, 1970, and 1981 data.

Population Projections

Population in year 2000 - Current population projections are based on 1980 total population by age and sex and their mortality and fertility rates. Projection parameters for mortality rates comprise of three levels assuming life expectancy at birth increasing with country's per capita income level, and female life expectancy stabilizing at 77.5 years. The parameters for fertility rate also have three levels assuming decline in fertility according to income level and past family planning performance. Each country is then assigned one of these nine combinations of mortality and fertility trends for projection purposes.

Stationary population - In a stationary population there is no growth since the birth rate is equal to the death rate, and also the age structure remains constant. This is achieved only after fertility rates decline to the replacement level of unit net reproduction rate, when each generation of women replaces itself exactly. The stationary population size was estimated on the basis of the projected characteristics of the population in the year 2000, and the rate of decline of fertility rate to replacement level.

Year stationary population is reached - The year when stationary population size will be reached.

Population Density

Per sq. km. - Mid-year population per square kilometer (100 hectares) of total area; 1960, 1970, and 1980 data.

Per sq. km. agricultural land - Computed as above for agricultural land only; 1960, 1970 and 1980 data.

Population Age Structure (percent) - Children (0-14 years), working-age (15-64 years), and retired (65 years and over) as percentages of mid-year population; 1960, 1970, and 1981 data.

Population Growth Rate (percent) - total - Annual growth rates of total mid-year population for 1950-60, 1960-70, and 1970-81.

Population Growth Rate (percent) - urban - Annual growth rates of urban populations for 1950-60, 1960-70, and 1970-81.

Crude Birth Rate (per thousand) - Annual live births per thousand of mid-year population; 1960, 1970, and 1981 data.

Crude Death Rate (per thousand) - Annual deaths per thousand of mid-year population; 1960, 1970, and 1981 data.

Gross Reproduction Rate - Average number of daughters a woman will bear in her normal reproductive period if she experiences present age-specific fertility rates; usually five-year averages ending in 1960, 1970, and 1981.

Family Planning - Acceptors, Annual (thousands) - Annual number of acceptors of birth-control devices under auspices of national family planning program.

Family Planning - Users (percent of married women) - Percentage of married women of child-bearing age (15-44 years) who use birth-control devices to all married women in same age group.

FOOD AND NUTRITION

Index of Food Production per Capita (1969-71=100) - Index of per capita annual production of all food commodities. Production excludes seed and feed and is on calendar year basis. Commodities cover primary goods (e.g. sugarcane instead of sugar) which are edible and contain nutrients (e.g. coffee and tea are excluded). Aggregate production of each country is based on national average producer price weights; 1961-65, 1970, and 1981 data.

Per capita supply of calories (percent of requirements) - Computed from energy equivalent of net food supplies available in country per capita per day. Available supplies comprise domestic production, imports less exports, and changes in stock. Net supplies exclude animal feed, seeds, quantities used in food processing, and losses in distribution. Requirements were estimated by FAO based on physiological needs for normal activity and health considering environmental temperature, body weights, age and sex distribution of population, and allowing 10 percent for waste at household level; 1961-65, 1970 and 1980 data.

Per capita supply of protein (grams per day) - Protein content of per capita net supply of food per day. Net supply of food is defined as above. Requirements for all countries established by USDA provide for minimum allowances of 60 grams of total protein per day and 20 grams of animal and pulse protein, of which 10 grams should be animal protein. These standards are lower than those of 75 grams of total protein and 23 grams of animal protein as an average for the world, proposed by FAO in the Third World Food Survey; 1961-65, 1970 and 1980 data.

Per capita protein supply from animal and pulse - Protein supply of food derived from animals and pulses in grams per day; 1961-65, 1970 and 1977 data.

Child (ages 1-4) Death Rate (per thousand) - Annual deaths per thousand in age group 1-4 years, to children in this age group; for most developing countries data derived from life tables; 1960, 1970 and 1981 data.

HEALTH

Life Expectancy at Birth (years) - Average number of years of life remaining at birth; 1960, 1970 and 1981 data.

Infant Mortality Rate (per thousand) - Annual deaths of infants under one year of age per thousand live births; 1960, 1970 and 1981 data.

Access to Safe Water (percent of population) - total, urban, and rural - Number of people (total, urban, and rural) with reasonable access to safe water supply (includes treated surface waters or untreated but uncontaminated water such as that from protected boreholes, springs, and sanitary wells) as percentages of their respective populations. In an urban area a public fountain or standpost located not more than 200 meters from a house may be considered as being within reasonable access of that house. In rural areas reasonable access would imply that the housewife or members of the household do not have to spend a disproportionate part of the day in fetching the family's water needs.

Access to Excreta Disposal (percent of population) - total, urban, and rural - Number of people (total, urban, and rural) served by excreta disposal as percentages of their respective populations. Excreta disposal may include the collection and disposal, with or without treatment, of human excreta and waste-water by water-borne systems or the use of pit privies and similar installations.

Population per Physician - Population divided by number of practicing physicians qualified from a medical school at university level.

Population per Nursing Person - Population divided by number of practicing male and female graduate nurses, assistant nurses, practical nurses and nursing auxiliaries.

Population per Hospital Bed - total, urban, and rural - Population (total, urban, and rural) divided by their respective number of hospital beds available in public and private general and specialized hospital and rehabilitation centers. Hospitals are establishments permanently staffed by at least one physician. Establishments providing principally custodial care are not included. Rural hospitals, however, include health and medical centers not permanently staffed by a physician (but by a medical assistant, nurse, midwife, etc.) which offer in-patient accommodation and provide a limited range of medical facilities. For statistical purposes urban hospitals include WHOs principal/general hospitals, and rural hospitals, local or rural hospitals and medical and maternity centers. Specialized hospitals are included only under total.

Admissions per Hospital Bed - Total number of admissions to or discharges from hospitals divided by the number of beds.

HOUSING

Average Size of Household (persons per household) - total, urban, and rural - A household consists of a group of individuals who share living quarters and their main meals. A boarder or lodger may or may not be included in the household for statistical purposes.

Average number of persons per room - total, urban, and rural average number of persons per room in all urban, and rural occupied conventional dwellings, respectively. Dwellings exclude non-permanent structures and unoccupied parts.

Access to Electricity (percent of dwellings) - total, urban, and rural - Conventional dwellings with electricity in living quarters as percentage of total, urban, and rural dwellings respectively.

EDUCATION

Adjusted Enrollment Ratios

Primary school - total, male and female - Gross total, male and female enrollment of all ages at the primary level as percentages of respective primary school-age populations; normally includes children aged 6-11 years but adjusted for different lengths of primary education; for countries with universal education enrollment may exceed 100 percent since some pupils are below or above the official school age.

Secondary school - total, male and female - Computed as above; secondary education requires at least four years of approved primary instruction; provides general, vocational, or teacher training instructions for pupils usually of 12 to 17 years of age; correspondence courses are generally excluded.

Vocational enrollment (percent of secondary) - Vocational institutions include technical, industrial, or other programs which operate independently or as departments of secondary institutions.

Pupil-teacher ratio - primary, and secondary - Total students enrolled in primary and secondary levels divided by numbers of teachers in the corresponding levels.

Adult literacy rate (percent) - Literate adults (able to read and write) as a percentage of total adult population aged 15 years and over.

CONSUMPTION

Passenger Cars (per thousand population) - Passenger cars comprise motor cars seating less than eight persons; excludes ambulances, hearses and military vehicles.

Radio Receivers (per thousand population) - All types of receivers for radio broadcasts to general public per thousand of population; excludes unlicensed receivers in countries and in years when registration of radio sets was in effect; data for recent years may not be comparable since most countries abolished licensing.

TV Receivers (per thousand population) - TV receivers for broadcast to general public per thousand population; excludes unlicensed TV receivers in countries and in years when registration of TV sets was in effect.

Newspaper Circulation (per thousand population) - Shows the average circulation of "daily general interest newspaper", defined as a periodical publication devoted primarily to recording general news. It is considered to be "daily" if it appears at least four times a week.

Cinema Annual Attendance per Capita per Year - Based on the number of tickets sold during the year, including admissions to drive-in cinemas and mobile units.

LABOR FORCE

Total Labor Force (thousands) - Economically active persons, including armed forces and unemployed but excluding housewives, students, etc., covering population of all ages. Definitions in various countries are not comparable; 1960, 1970 and 1981 data.

Female (percent) - Female labor force as percentage of total labor force.

Agriculture (percent) - Labor force in farming, forestry, hunting and fishing as percentage of total labor force; 1960, 1970 and 1981 data.

Industry (percent) - Labor force in mining, construction, manufacturing and electricity, water and gas as percentage of total labor force; 1960, 1970 and 1981 data.

Participation Rate (percent) - total, male, and female - Participation or activity rates are computed as total, male, and female labor force as percentages of total, male and female population of all ages respectively; 1960, 1970, and 1981 data. These are based on ILO's participation rates reflecting age-sex structure of the population, and long time trend. A few estimates are from national sources.

Economic Dependency Ratio - Ratio of population under 15 and 65 and over to the total labor force.

INCOME DISTRIBUTION

Percentage of Private Income (both in cash and kind) - Received by richest 5 percent, richest 20 percent, poorest 20 percent, and poorest 40 percent of households.

POVERTY TARGET GROUPS

The following estimates are very approximate measures of poverty levels, and should be interpreted with considerable caution.

Estimated Absolute Poverty Income Level (US$ per capita) - urban and rural - Absolute poverty income level is that income level below which a minimal nutritionally adequate diet plus essential non-food requirements is not affordable.

Estimated Relative Poverty Income Level (US$ per capita) - urban and rural - Rural relative poverty income level is one-third of average per capita personal income of the country. Urban level is derived from the rural level with adjustment for higher cost of living in urban areas.

Estimated Population Below Absolute Poverty Income Level (percent) - urban and rural - Percent of population (urban and rural) who are "absolute poor".

Economic and Social Data Division
Economic Analysis and Projections Department
May 1983

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ECONOMIC INDICATORS - NEPAL

GNP PER CAPITA IN 1982: US$170

GROSS DOMESTIC PRODUCT IN 1981/82

	US$ Mln.	%
GDP at Market Prices	2,514	100.0
Gross Domestic Investment	389	15.5
Gross Domestic Saving	216	8.6
Current Account Balance (exc. official grants)	-120	-4.8
Exports of Goods, NFS	277	11.0
Imports of Goods, NFS	450	17.9

ANNUAL RATE OF GROWTH, 1970-1981 a/

(%, constant prices)

2.1

OUTPUT, LABOR FORCE AND PRODUCTIVITY IN 1979/80

	Value Added		Labor Force b/		Value Added Per Worker
	US$ Mln.	%	Mln.	%	US$
Agriculture	1,065	57	6.9	93	155
Industry c/	251	14	0.1	2	1,696
Services	543	29	0.4	5	1,468
Total/Average	1,859	100	7.4	100	251

GOVERNMENT FINANCE

	CENTRAL GOVERNMENT Rs. Mln.				
	1979/80	1980/81	1981/82	1982/83	% of GDP 1982/83
Current Receipts	1,853	2,403	2,866	3,001	8.3
Regular Expenditures	1,055	1,264	1,589	2,025	5.6
Current Surplus	798	1,139	1,277	976	2.7
Development Expenditure	2,309	2,731	4,034	4,808	13.2
External Assistance (Net)	1,318	1,374	1,953	2,607	7.3

MONEY, CREDIT AND PRICES

	1979	1980	1981	1982	1983
	(Million Rs outstanding mid-July)				
Money and Quasi Money	4,512	5,285	6,308	7,459	8,780
Bank Credit to Government	1,176	1,362	1,357	2,132	3,185
Bank Credit to Public Enterprises	436	501	668	618	981
Bank Credit to Private Sector	1,976	2,547	3,231	3,363	3,717
Money and Quasi Money as % of GDP	20.3	22.6	21.7	22.9	24.2
General Price Index (1974/75 = 100)	116.6	125.5	148.0	159.7	180.5
Annual Percentage Changes in:					
General Price Index	10.0	7.6	17.9	7.9	13.0
Bank Credit to Government	21.8	15.8	-0.4	57.1	49.4
Bank Credit to Public Enterprises	24.3	14.9	33.3	-7.5	58.7
Bank Credit to Private Sector	24.3	28.9	26.9	4.1	10.5

Note: All conversions to US dollars in this table are at the average exchange rate prevailing during the period covered.

a/ World Development Report 1983.
b/ Total labor force; unemployed are allocated to sector of their normal occupation.
c/ Includes mining, manufacturing, construction and utilities.

.. not available

TRADE PAYMENTS AND CAPITAL FLOWS

BALANCE OF PAYMENTS

	1980/81	1981/82	1982/83 a/
	(Millions US$)		
Exports, f.o.b. c/	134.4	115.4	67.3
Imports, f.o.b. c/	352.6	363.6	408.3
Trade Balance	-218.2	-248.2	-341.0
Services, net	75.4	87.3	78.1
of which: Tourism	64.5	51.4	61.4
Transfers, net	46.4	40.5	37.6
of which: Private Remit.	38.9	34.5	..
Indian Excise Refund	4.7	3.1	2.5
Current Account Balance (exc. grants)	-96.4	-120.4	-225.3
Official Grants	71.7	39.3	102.5
Official Capital, net	52.3	59.3	72.1
Private Capital, net	-12.0	10.3	14.6
Change in Reserves (- = Increase)	-16.1	-39.0	36.1
Gross Official Reserves (mid-July)	195.8	232.6	159.7

MERCHANDISE EXPORTS 1981/82 b/

	US$ Mln.	%
Agricultural products	92.0	80.0
Manufactures	23.0	20.0
Total	115.0	100.0

EXTERNAL DEBT, DECEMBER 31, 1982

	US$ Mln.
Public Debt, inc. guaranteed	296.6
Non-Guaranteed Private Debt	-
Total Outstanding & Disbursed	296.6

DEBT SERVICE RATIO for 1982/83 d/

	%
Public Debt, inc. guaranteed	7.0

IBRD/IDA LENDING, March 31, 1984 (Millions US$)

	IBRD (US$ Mln.)	IDA (US$ Mln.)
Outstanding & Disbursed	-	186.3
Undisbursed	-	194.2
Outstanding, incl. undisbursed	-	380.5

RATE OF EXCHANGE

Through October 1975
US$1.00 = NRs 10.56
NR 1.00 = US$ 0.095

From October 1975 to March 20, 1978
US$1.00 = NRs 12.5
NR 1.00 = US$ 0.08

From March 20, 1978 to September 18, 1981
US$1.00 = NRs 12.00
NR 1.00 = US$ 0.083

From September 19, 1981 to December 16, 1982
US$1.00 = NRs 13.2
NR 1.00 = US$ 0.076

From December 17, 1982 to May 31, 1983
US$1.00 = NRs 14.3
NR 1.00 = US$ 0.070

Most Recent Rate e/
March 31, 1984
US$1.00 = NRs 15.3
NR 1.00 = US$ 0.063

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a/ Estimate
b/ Customs basis.
c/ Payments basis.
d/ Ratio of Debt Service to Exports of Goods and Services.
e/ Since June 1, 1983, the Nepal Rastra Bank announces the exchange rate daily, based on a trade-weighted basket, with the US dollar as the intervention currency. The rate shown here is the mid-rate on the date indicated.

. not applicable
.. not available

South Asia Programs Department
April 9, 1984

APPENDIX C

U. S. WATER RESOURCE TEAM

ITINERARY

May 31, 1984	
Evening	Arrived in Manila.
June 1, 1984	
Morning	Met with USAID/Manila missions staff: Jerry Edwards, Jim Dawson, Randy Cummings, and Doug Clark (phone). Met with Mr. Minobu Horie, Senior Project Engineer, Asian Development Bank.
Afternoon	Talked on phone with Wayne Tate, US Representative, ADB
June 2-3, 1984	Travel to Kathmandu.
June 3, 1984	Lunch with Director Brennan and Jack Pinney at Director's house.
June 4, 1984	
Morning	Met with Ambassador Carleton S. Coon; Met with Mr. N. A. Ansari, Deputy Director General, DIHM, on schedule for visit and DIHM structure and procedures. Toured mission and met other mission personnel.
Afternoon	Lunch with Gil Levine and Deep Joshi, Ford Foundation/New Delhi, at Pinney's house. Met again with Mr. Ansari. Talked informally with Gil Levine and John Cool, A/D/C Representative in Kathmandu.
June 5, 1984	
Morning	Read background materials.
Afternoon	Met with John Cool and Mike Wallace at APROSC (A/D/C).

June 6, 1984	
Morning	Read background materials.
Afternoon	Met with Mr. B. K. Pradhan and Mr. Upadhyaya at WECS. Met with Mr. M. M. Shrestha, Chief Water Utilization Officer, FIWUD. Afternoon drink with Mike Wallace, A/D/C.
June 7, 1984	
Morning	Traveled to Pokhara with Mr. C. P. Rauniyar, Regional Director for Central Region, DIHM, and Mr. R. Malla, DIHM.
Afternoon	Toured Phewatal and Seti Irrigation Projects. Dinner and program hosted by Mr. Karki, DIHM Western Regional Director.
June 8, 1984	
Morning	Traveled to Chitwan. Met with Project Manager, Mr. Som N. Poudel, the Agricultural Coordinator, Mr. Joshi, and Engineering Consultants from Agrar-und Hydrotechnik GmbH, Mr. D. E. Farsky and Mr. H. Van Krugten. Inspected pump installations.
Afternoon	Toured Chitwan command area and drove along 20 km of the old Khagery Main Canal to its headworks. Visited Upper Khagery system where a group of springs have been utilized for irrigation.
June 9, 1984	
Morning	Drove to Birgunj.
Afternoon	Visited Parwanipur Well # 2. Drove along 20 km of Main Canal to India border. Spoke briefly with agricultural extension people met along the way.

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June 10, 1984	Examined Parwaniput Agriculture Research Station and Training Center as possible site for planned HMG/Water Management Synthesis Project DA training course.
June 11, 1984	Had breakfast with Mr. D. E. Farsky and Mr. H. Van Krugten, Consultants to ADB Chitwan Irrigation Project. Discussed DA training with Jack Pinney and began drafting report.
June 12, 1984	
Morning	Worked on report at USAID office.
Aternoon	Met with Mr. P. P. Shah, Joint Member, National Planning Commission on the Seventh Plan, currently in preparation. Met with Mr. Jack Baker, Project Manager, CIDA assistance team to WECS.
June 13, 1984	
Morning	Worked on Report. Met with Mr. M. M. Shrestha, FIWUD, on DA training.
Afternoon	Worked on Report. Met Mr. Chitra D. Bhatt, Director General, DIHM.
June 14, 1984	
Morning	Work on Report
Afternoon	Debreifing for Mission Director and Staff.
June 15, 1984	
Morning	Debriefing for Ambassador Coon.
Afternoon	Depart.

APPENDIX D

SUGGESTIONS FOR IMPROVING PROJECT O&M

1. Establish an O&M Division within the Irrigation Department-- This would provide a permanent professional O&M staff to perform O&M duties as necessary and to assist and train O&M personnel at the user-group level.

2. Reduce Sediment Intake--Heavy sediment loads in the canal system is a costly O&M problem and reduces canal capacities. Diversion structures where sediment is a problem will require detailed studies to determine how the structures may be modified and/or operated to reduce or correct the problem.

3. Schedule Water Deliveries--Lack of concern for timely water delivery to the farm turnout appears to be a major problem. This, coupled with excessive and uncontrolled use of water by upstream users make other users apprehensive about irrigation development.

4. Form User Groups--Encourage farmers to become involved with development and management of their irrigation projects and provide assistance to them in organizing for water management purposes.

5. Measure Water--Very few measuring devices were observed on the projects we visited. Devices and structures that did exist were in a poor state of repair and were often not being used. Good water measurement is the key to water management.

6. Reduce Erosion in Conveyance System--Erosion of the canal section is extensive below structures. Design modification to correct these deficiencies would greatly reduce annual O&M costs.

7. Install Canal Lining--Heavy water losses from canals can be reduced by canal lining. Concrete and rock masonary lining is extensively used in Nepal because the construction material and labor are readily available. Buried PVC plastic membrane lining has been successfully used in the United States as an alternative to more expensive concrete lining. It is also tighter than concrete or masonry lining and is less expensive to maintain in colder climates. Test reaches installed in one or two larger canals in Nepal would be worthwhile to determine if its use is cost-effective.

8. Conduct O&M Management Training--Workshops could be conducted to train personnel in all aspects of O&M work. This would include, but not be limited to, water measurement, water scheduling, sediment and erosion control, equipment operation and repair, concretes, accounting, fund budgeting, personnel management, public relations, etc.

9. Develop, with Farmers, Rational System Operating Rules and Establish Stronger Authority to Enforce Them--This may be needed at both national and local levels.

10. Establish A Groundwater Level Monitoring Program--As irrigation progresses, high groundwater conditions will occur causing water-logged land and loss of production. Professional drainage staff-members should be assigned to the recommended O&M Division staff at Central and Regional office level to set up a monitoring program. Drainage problem should be controlled as they occur, or many hectares of land will be lost before drain systems can be constructed.

11. Establish a Review of Operation and Maintenance Program--Periodic reviews (every 2 or 3 years) are conducted by a team of water users and operating agency people to inspect the project facilities and discuss mutual problems. A report is prepared containing a general discussion of the condition of the facilities and any recommendations for improving project O&M.

APPENDIX E

SUGGESTED FOLLOW UP

A. Improved Design and Implementation Methodologies

1. Irrigation projects should not be looked upon as civil engineering problem alone, rather they should take into account social, agricultural and water management aspects. Suggestions were made to bring about necessary changes in the orientation of the engineering personnel through appropriate training and at the same time, to improve the investigation and design methodologies.

2. There is a need for improvement of general data base relating to physical, socio-economic, and organizational aspects of irrigation and water management. Farmers constitute one major source of information on local conditions and problems, and therefore, this source should be tapped.

3. For large irrigation projects, detailed technical studies are justified. However, for smaller systems, the available scanty information should be integrated with farmers' knowledge and experience of local conditions in project identification.

4. There is a need for flexibility in system design to incorporate changes in basic information resulting from improved data base. It was suggested that the characteristics of a flexible system should be defined and the methodology of flexible design should be developed.

5. Monitoring of the performance of the completed projects should be instituted so that necessary changes could be effected at the right time.

6. In order to safeguard the water rights of the farmers while formulating new projects, detail investigation of the existing uses of water together with careful and cautious efforts at minimising the problems of conflicting uses (at the project design stage) were suggested. To the extent possible, existing infrastructures should be utilized and only surplus water should be tapped when new systems are constructed.

[1] From: Min. of Agriculture, et.al (1983).

7. Farmers' involvement in a project should be at the earliest stage to obtain cooperation, voluntary participation, and knowledge of local conditions. A methodology for working effectively with farmers should be developed.

8. As much could be learned from the farmers' managed systems, experience with these systems should be documented and disseminated.

B. Improved Institutional Linkages in Irrigation Development and Water Management

1. Close cooperation between the Department of Irrigation and the Department of Agriculture is essential for improved performance of irrigated agriculture. Suggestions were made to strengthen institutional linkages at several levels at the central level, at district level, and at local level. In order to make the institutional structures at these levels work better, a number of specific suggestions were made: a) Training of Government personnel to work in a multi-disciplinary manner so that engineers, agronomists, economists, etc can speak common language and collaborate better. b) Building up monitoring and evaluation capacity for giving guidance and feedbacks at all levels on the performance of irrigation systems. c) Cultivating and encouraging informal patterns of communication and consultations.

2. Linkages between the Government agencies and the farmers should be strengthened. Efforts should be channeled in two directions. Firstly, there should be a change in the orientation of Government staff towards working with the farmers. Secondly, active user groups that can work in an organized way with the officials should be built-up. Informal contacts and cost sharing should also be promoted as they reinforce the linkages.

3. Water users groups should be established in all the projects as presently found in the community managed systems and as provided for under the Decentralization

Act 1982. The Village Panchayats should also be activated for coordination of agricultural activities and for local level planning which would support the efforts at improving irrigation and water management.

4. Noting that the Decentralization Act 1982 would have beneficial impact on community managements of irrigation systems by its emphasis on institutional strengthening at the local level and establishment of service centres to backstop the local users' institutions, it was suggested that the services centres should be greatly strengthened to concentrate and coordinate government technical supports.

5. In the Government funded projects, water users groups should have responsibility for the operation and maintenance of tertiary canal level and below in the larger systems, while in the smaller ones the full responsibility of system operation and maintenance should be borne by the farmers in the model of community managed projects. It was also suggested that the subject of optimum control of farmers (vis-a-vis the project authority) over a system from resource endowments, efficiency and equity considerations should be studied and appropriate models be developed.

6. Possibilities of involving beneficiaries (ie water users group) in the collection of water tax and providing incentives to the tax collecting farmers should be explored. Giving the mandate of collecting water tax to the group would significantly increase the group's influence in the matters relating to repair and maintenance and thus help strengthen the linkages among the water users themselves.

7. The Government should provide technical and financial assistance to the communal irrigation schemes whenever needed, but should make strong efforts to avoid creating a dependency syndrome and destroying the spirit of self-help.

8. Water users groups should be a corporate body with the legal authority to collect taxes, and obtain credit, but should be non-political. Formal legal status for groups would help establish better linkages with Government agencies.

9. Government policies should be consistent. Inconsistencies in policies and activities undermine the process of developing strong institutional linkages.

C. Formation of Irrigation Management Working Group

1. Realising the need for in-depth and multi-disciplinary analysis of the issues on irrigation and water management, the seminar suggested the formation of a three-tiered working body to undertake these tasks. The broadest group would be a "Water Management Network", followed by a "Water Management Panel", and finally a "Support Group". The Water Management Network comprises all (professionals, administrators, farmers, etc) concerned with the development of irrigation and water management. This network would be periodically informed of the research results for necessary actions and, in turn, would provide feed-backs to the research group through seminars and informal discussions. The more focussed group would be the Water Management Panel that includes representatives from the relevant Government departments and agencies including farmer - users groups, local and foreign consultants and academic researchers. The panel would have specific responsibilities of examining issues, setting priorities for research, undertake field study tours, and formulate policy recommendations. The support group is an inter-disciplinary cell acting as secretariate of the panel, and would provide administrative support, undertake special studies and research, disseminate publications and reports, organise trainings and assist in monitoring and evaluation systems.

2. Given the general lack of information on existing irrigation systems and method of management, and the need to develop management system linking the farmers and the Government, it was suggested that further

study and research should be carried out on the following topics: (i) the nature of communal irrigation systems; (ii) reassess of past failure in irrigation development; (iii) alternative methods of creating institutional linkages between the farmers and the Government; (iv) mechanisms for donor financing of relatively small and geographically dispersed irrigation schemes.

3. The national academic community should develop a sense of national priority in order to direct the limited national capabilities for research towards areas providing maximum benefits to the nation. These should be a greater meeting of minds between the bureaucracy and academic community of the country.

4. The donor agencies should give technical and financial assistance to the proposed water management panel and associated network and support group.

D. Other Specific Follow-up

1. For effective utilization of water, non-water inputs should be made available in a package. Use of private agencies, SFDP groups and other enterprises for enhancing farmers' access to the needed inputs should be provided in line with the objective of building a balanced and effective network of local institutions to serve agriculture.

2. Watercess collection should be related to project cost and should be based on the actual land irrigated.

3. It was suggested that the present laws on water rights should be reviewed for there is a need to make certain amendments in the existing laws and to frame certain new regulations for regularising the behaviour of those who enjoy such rights and also for giving due consideration to the existing appropriation of water while constructing new projects.

4. The use of local consultants should be encouraged for building up a cadre of national professionals.

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The international consultants should be used with a view to improving technical skills of their Nepali counterparts until local capacity is developed.

5. Over dependence on consultants hinders the development of the technical capability of the department. Strengthening the technical capability of the department was suggested for which need for additional training for technical staff is proposed.

6. Considering the wide geographical dispersion of farmer managed systems and relatively small investment required per system, the donor agencies should explore ways to be more flexible in their lending operations.