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Draft Benefit/Cost Studies: Nepal,
Resource Conservation and Utilization
Project

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The South-East Consortium for International Development

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MEMORANDUM

DATE: 22 March 1985

TO: Participants in Workshops for the Draft Benefit/Cost Studies of RCUP

FROM: Edward Vickery

Accompanying this memorandum is your set of draft benefit/cost studies on six components of the Resource Conservation and Utilization Project. Included in this set are analyses of forestry, watershed management, appropriate technology/energy, irrigation, drinking water, and the Institute of Renewable Natural Resources. The studies for the agriculture/horticulture and livestock components will probably be completed in May.

Our studies represent progress reports on our efforts thus far. They are drafts which will be revised based on the comments received in these workshops. For some of the studies, additional data will be required before they can be completed. Nevertheless, they are products which, we believe, provide a useful preliminary evaluation of RCUP.

We welcome your critique and look forward to sharing ideas in these workshops.

Edward Vickery

I. FORESTRY[1]

Forests provide the resource base associated with two of Nepal's greatest conservation problems: (1) a diminishing timber inventory, source of fuelwood, tree fodder, and ground forage; and (2) the associated severe watershed erosion. Thirty percent of Nepal is covered by forest and this forest cover has decreased by one quarter in ten years (Ganguli et al., 1983). Erosion has resulted in soil loss in the neighborhood of 20 to 50 tons per hectare per year and ranging to extremes of 200 to 500 metric tons per hectare per year (DSCWM, 1977). The significance of this loss of forest cover and associated erosion is emphasized when we consider the fact that wood provides 90% of the Nepal's domestic energy source (Levenson, 1979). The extreme watershed erosion implies further loss of forestland, decreasing water tables and drying up of the natural springs, and downstream cropland damage from scouring caused by the eroding sediment. The net effect on existing cropland is severely negative and very important in this highly agricultural country.

The human pressure on the forestland is a function of the demand for fuel, fodder, and forage and of the open access nature of the resource. Open access means that the resource is available to everyone. There is no initiative for anyone to conserve the forest because one person's conservation for tomorrow loses to another person's preference for harvest today.

The objective of the Resource Conservation and Utilization Project (RCUP) is to improve the quality of forestland. Its approach has three features: (1) reforestation, (2) work within the appropriate institutions for overcoming the open access problem, and (3) sustainability. The village panchayats, or legislative bodies, are probably the appropriate institutions with which RCUP might work because they can establish a sense of local ownership and a sense of local gain (identifiable with personal gain and, therefore, with personal incentive) from restricting access and managing the forest. RCUP hopes to achieve sustainability through both demonstration projects and local involvement leading to local implementation of further reforestation projects. These projects emphasize relative labor intensity and biological over mechanical means. This is because, as general rules in Nepal, labor is plentiful relative to capital and biological means are locally less expensive than mechanical means. For forestry, this suggests nurseries and reforestation projects, hand planting, stone fences in preference to wire fences, and preference for local species and local seed gathering. It does not rule out, however, research-based improvements in species and in general forest management.

Our problem in this chapter is to examine the forest management experience of RCUP, to find a measure of its success and to provide insight to its reasonable future direction. Our approach is social benefit-cost accounting as described in our introductory chapter. In order to accomplish this, we propose to search for distinguishing characteristics of successful forest management projects. Characteristics may mean species, geographical locations, institutions, or management activities. Successful projects, for our purposes in this chapter, are those projects with social benefits exceeding social costs. Identification of the characteristics attached to successful projects has implication to future successes. That is, identifying the characteristics associated with current successful projects suggests those characteristics which may attach to future target expansion and/or successful new projects.

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[1]This study was prepared by W. Hyde, K. Kanel, and K. Livengood in February 1985.

This chapter is divided into five major sections. The first comments on the relevant local institutions and their historical development. Its intent is to explain the relationship between open access and forest depletion as well as the institutions which may be useful in overcoming the open access and forest depletion problems. The second reviews project targets and completions for each RCUP forest management activity to date. The third is a case study, a one hectare panchayat forest plantation. We chose to examine the benefits and costs of this case because it occurs within the institution which potentially overcomes open access and because it possesses physical features (land and outputs) which are similar to other RCUP forest management activities. The case study features detailed benefit-cost analyses of both fuelwood and fodder plantations with emphasis on the characteristics impacting the benefit-cost outcomes.

Each panchayat forest is planned to the same general standard. Therefore, panchayat forests have many similarities from one to another and our single case can be representative. We shall find, however, that panchayat forest production costs vary with their demand for labor (particularly for forest protection) and with local wage rates. Furthermore, the anticipated benefits of panchayat forests vary with anticipated physical yields and with the costs of hauling these yields to their location of sale or final use. Therefore, we anticipate a range of net benefits for different panchayat forests depending on attention to employment, wage, yield and market location characteristics in the original selections of sites to establish "standard" forests.

The brief fourth section of the chapter examines variations from the panchayat forest plantation case study which describe national forest, panchayat protected forest, and floodplain plantations, the remaining primary RCUP forest management activities. This section also summarizes and draws implications from our benefit-cost observations for future adjustments in RCUP forest management targets. Section 4 does not include the detail which we go into in the case study of Section 3 because that level of detail would be repetitous. Thus, Section 4 is briefer. It focuses on underlying differences and on conclusions. The fifth section of the chapter contains two appendices, one which reviews the benefit-cost analysis for nurseries, the major support activity for the RCUP forest management effort and one which reviews the aggregate flow of RCUP forest management costs to date and associates these costs with their anticipated total budgets.

1. Open Access and Panchayat Forestry

The pattern of forest management in the hills of Nepal prior to 1957 was to cut prime fuelwood and timber trees leaving a scrub forest to regrow. No further harvest occured until the scrub forest was of fuelwood size again, and even then the best trees were left as growing stock until they were of sufficient size to make housing timbers. The Forest Nationalization Act of 1957 changed this. Forest ownership and management became the responsibility of His Majesties Government (HMG). Beginning with this act, villages had to pay for use of the forest. The Forest Nationalization Act was well-intentioned but it removed identifiable (local) responsibility. What became everybody's forest in theory was nobody-in-particular's forest in practice.

The new national authority provided forest guards but these were insufficient to limit access. The village rights to harvest timber were gone. Thus the incentive to protect and manage the forest was gone. The net result became a free-for-all to exploit the forest. Future gains from anyone's conservation and management effort were lost to unidentifiable others. There was competition for resources without regard to their production costs and the national responsibility for planting and growing could not keep up with the pace of free-for-all harvest. In sum, the Forest Nationalization Act led to forest use and depletion at a rate greater than the social optimum.

One solution in many similar cases of open access or free entry is to privatize the resource. This creates a single, identifiable owner with full responsibility and to whom accrue full future benefits of conservation and management. This solution is not viable for Nepal's forests. Neither one citizen nor even one extended family can manage to protect an area large enough to support a sustained yield forest.

A reasonable alternative might be a level of public ownership small enough so that users perceive personal gain from management but large enough to operate a sustainable forest unit. This description fits the 18th century New England town commons. It also fits contemporary tribal grazing arrangements in Botswana (Runge, 1982). More important to us, it provides the understanding behind the community forestry/social forestry movement throughout Asia. In particular, it explains the 1977 ammendment to the Forest Nationalization Act in Nepal which permits the transfer of some poorly stocked forest back to the village panchayats (panchayat protected forest) and the creation of other forest plantations from eroded or otherwise unused land (panchayat forest). In both cases,. individual panchayats share the gains from forest management with His Majesty's Government. There is a partial, but not complete, transfer of the forest from the central government to the panchayats (APROSC, 1979, v. 1).

It is too early to judge the impact of the 1977 ammendment with confidence. The impact will be incomplete until the period of at least one timber rotation (20-30 years) has passed and we have observed local community treatment of the forest throughout its cycle from seedling to mature trees. Nevertheless, there does exist casual evidence that the panchayats have taken responsibility for some forests and understand the potential gains to themselves. Indeed, we understand that some panchayats now refrain from all harvest on their own land and concentrate their harvest on the remaining national forests. We also understand that some panchayats so recognize their own advantage that neither guards nor fences are necesary around certain panchayat forests or panchayat protected forests. In these cases, local community social pressures apparently provide sufficient self-policing of entry. In sum, the 1977 amendment may have found a useful institutional mechanism for overcoming open access problems in Nepal's forests and watersheds.

2. Targets

RCUP is a collaborative effort of USAID and HMG. The Department of Forestry (DOF) is the focal HMG agency for the forest management projects,

although the Department of Soil Conservation and Watershed Management (DSCWM) also maintains active involvement. The current RCU project is in the fifth year of its first five year plan and is now fully operational. The primary activities of the forest management project are panchayat forest, panchayat protected forest, national forest, and floodplain plantation management. Each of these four has additional subcomponents or project management activities identified as demarkation, management plans, and management plan implementation, the latter of which is generally understood to mean forest protection from trespass by people and by foraging animals. There are two support components to these four primary activities; nurseries and research. The research component is only anticipated at this time. The nursery component includes both central and satellite nurseries (associated with national forest management) as well as individual nurseries for each panchayat participating in the project.

Panchayat forests are designed for fuelwood and fodder production. In our subsequent analysis we assume that half of all panchayat forest hectares are devoted to each of these two objectives. Panchayat forests are supported by panchayat nurseries. The objective of panchayat protected forests is to produce fuelwood, sawtimber, and poles. Together panchayat forests and panchayat protected forests intend to overcome some of the open access problem originating with the Forest Nationalization Act of 1957. The catchment conservation officer (CCO) from the DSCWM provides the administrative connection between RCUP and each panchayat forest. The district forest conservator (DFC) from the DOF is the main contact between RCUP and each panchayat protected forest.

The remaining two primary forest management activities of RCUP are national forest and floodplain management. The objective of the national forest management is, like panchayat protected forest, to provide fuelwood, sawtimber, and poles. National forests are supported by one central nursery per district and any number of satellite nurseries. Seedlings from these nurseries, which are not needed by national forest, may be distributed to the private sector. The administrative connection between RCUP and each national forest is through the DOF. The purpose of floodplain plantations is erosion control and the species planted in floodplains are generally sisal, a species of many final uses. The DSCWM provides administrative support. Neither national forest nor floodplain plantations are associated with local panchayat responsibility or reward, therefore both remain subject to open access problems.

Table I-1 shows the original annual physical targets, the revisions in these targets, and the final accomplishments for Gorkha, Myagdi, and Mustang, the three political divisions on the two watersheds in which RCUP is active. We observe that the general concentration of targets has been in Gorkha. Gorkha has the most arable land (38.7%) and the largest population of the three districts. Mustang has attracted the least attention. It is a high, cold desert with a low population, a short growing season, and only 2.5% of its land is arable. Myagdi represents an intermediate case, closer to that of Gorkha, in both topographic and demographic characteristics.

TABLE I-1

FOREST MANAGEMENT: TARGETS AND ACCOMPLISHMENTS

ACTIVITY	UNIT/ LOCATION		FISCAL YEAR 1980-81			FISCAL YEAR 1981-82			FISCAL YEAR 1982-83			FISCAL YEAR 1983-84			FISCAL YEAR 1984-85	
			TO*	TR*	ACC*	TO	TR	ACC	TO	TR	ACC	TO	TR	ACC	TO	TR
Panchayat Forest (Fuelwood)	HA.	(G)*	4.0	4.0	4.0	15.0	15.0	15.0	33.0	33.0	33.0	54.0	40.0	40.0	71.0	50.0
		(HA)*	-	2.5	2.5	8.0	8.0	8.0	19.0	19.0	19.0	27.0	27.0	27.0	38.0	38.0
		(MU)*	2.5	2.5	-	6.0	6.0	12.0	12.5	12.5	12.5	23.0	18.0	18.0	33.0	18.0
		TOTAL	6.5	9.0	6.5	29.0	29.0	35.0	64.5	64.5	64.5	104.0	85.0	85.0	142.0	106.0
Panchayat Forest (Fodder)	HA.	(G)	4.0	4.0	4.0	15.0	15.0	15.0	33.0	33.0	33.0	54.0	40.0	40.0	71.0	50.0
		(HA)	-	2.5	2.5	8.0	8.0	8.0	19.0	19.0	19.0	27.0	27.0	27.0	38.0	38.0
		(MU)	2.5	2.5	-	6.0	6.0	12.0	12.5	12.5	12.5	20.0	17.0	17.0	28.5	17.0
		TOTAL	6.5	9.0	6.5	29.0	29.0	35.0	64.5	64.5	64.5	101.0	84.0	84.0	137.5	105.0
Panchayat Forest Handover	HA.	(G)	-	-	-	-	-	-	-	-	-	-	50.0	50.0	100.0	100.0
		(HA)	-	-	-	-	-	-	-	-	-	-	100.0	100.0	70.0	76.0
		(MU)	-	-	-	-	-	-	-	-	-	-	50.0	12.5	-	35.0
		TOTAL	-	-	-	-	-	-	-	-	-	-	200.0	162.5	170.0	211.0
Preparation of Management Plan of Panchayat Forest	HA.	(G)	-	-	-	-	-	-	-	-	-	-	500.0	-	-	140.0
		(HA)	-	-	-	-	-	-	-	-	-	-	100.0	75.0	-	50.0
		(MU)	-	-	-	-	-	-	-	-	-	-	50.0	12.5	-	25.0
		TOTAL	-	-	-	-	-	-	-	-	-	-	650.0	87.5	-	215.0
Establishment of Panchayat Nursery (0.09 hectare)	HA.	(G)	3.0	3.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	3.0	1.0
		(HA)	2.0	3.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0
		(MU)	2.0	2.0	-	2.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0
		TOTAL	7.0	8.0	6.0	7.0	8.0	8.0	8.0	8.0	8.0	7.0	7.0	7.0	6.0	3.0

TABLE I-1
(Continued)

FOREST MANAGEMENT: TARGETS AND ACCOMPLISHMENTS

ACTIVITY	UNIT/ LOCATION		FISCAL YEAR 1980-81			FISCAL YEAR 1981-82			FISCAL YEAR 1982-83			FISCAL YEAR 1983-84			FISCAL YEAR 1984-85	
			TO	TR	ACC	TO	TR	ACC	TO	TR	ACC	TO	TR	ACC	TO	TR
Establishment of Panchayat Protected Forest	HA.	(G)	245.0	-	-	677.0	-	-	1,493.0	-	-	1,000.0	-	-	750.0	250.0
		(HA)	250.0	500.0	-	393.0	301.3	430.0	512.0	604.0	607.35	500.0	400.0	400.0	500.0	200.0
		(MU)	200.0	250.0	-	250.0	250.0	251.9	300.0	450.0	490.0	193.0	200.0	200.0	250.0	125.0
		TOTAL	695.0	750.0	-	1,320.0	551.3	681.9	2,305.0	1,054.0	1,097.35	1,693.0	500.0	600.0	1,500.0	575.0
Demarcation	HA.	(G)	60.0	-	-	135.0	135.0	58.5	220.0	232.0	136.0	305.0	100.0	100.0	305.0	300.
		(HA)	20.0	20.0	-	175.0	127.7	92.4	220.0	287.0	308.78	305.0	100.0	100.0	345.0	300.
		(MU)	20.0	20.0	-	115.0	85.3	82.3	100.0	150.0	135.16	100.0	80.0	80.0	125.0	50.
		TOTAL	120.0	40.0	-	345.0	348.0	233.2	540.0	669.0	579.94	710.0	280.0	280.0	815.0	650.
Preparation of Management Plan of Panchayat Protected Forest	HA.	(G)	-	-	-	738.0	738.0	-	677.0	-	-	1,000.0	1,000.0	-	1,000.0	250.0
		(HA)	-	-	-	-	-	-	500.0	677.0	191.64	615.0	615.0	362.26	540.0	250.0
		(MU)	-	-	-	-	-	-	500.0	500.0	500.0	250.0	300.0	311.5	193.0	250.0
		TOTAL	-	-	-	738.0	738.0	-	1,677.0	1,677.0	691.64	1,865.0	1,915.0	673.76	1,733.0	750.0
Implementation of Panchayat Protected Forest Management Plan	HA.	(G)	-	-	-	7.0	7.0	-	738.0	738.0	-	1,415.0	500.0	-	255.0	250.0
		(HA)	-	-	-	-	-	-	-	1,115.0	-	500.0	500.0	-	615.0	500.0
		(MU)	-	-	-	-	-	-	-	-	-	500.0	450.0	450.0	250.0	250.0
		TOTAL	-	-	-	7.0	7.0	-	738.0	1,853.0	-	2,415.0	1,450.0	450.0	1,120.0	1,000.0

TABLE I-1
(Continued)

FOREST MANAGEMENT: TARGETS AND ACCOMPLISHMENTS

ACTIVITY	INIT/ LOCATION		FISCAL YEAR 1980-81			FISCAL YEAR 1981-82			FISCAL YEAR 1982-83			FISCAL YEAR 1983-84			FISCAL YEAR 1984-85	
			TO	TR	ACC	TO	TR	ACC	TO	TR	ACC	TO	TR	ACC	TO	TR
National Forest Plantation	HA.	(G)	-	-	-	80.0	80.0	26.0	160.0	160.0	92.0	265.0	160.0	150.0	320.0	250.
		(MA)	-	-	-	100.0	20.57	18.0	200.0	200.0	200.0	320.0	100.0	100.0	325.0	200.
		(MU)	-	-	-	20.0	20.0	18.1	60.0	60.0	60.0	120.0	50.0	50.0	160.0	90.
		TOTAL	-	-	-	200.0	120.57	62.1	420.0	420.0	352.0	705.0	310.0	310.0	805.0	540.
Implementation of Management Plan of National Forest	HA.	(G)	-	-	-	-	-	-	25,670.0	25,670.0	-	25,670.0	25,670.0	-	25,670.0	25,670.
		(MA)	-	-	-	-	-	-	-	26,895.0	-	26,895.0	26,895.0	-	26,895.0	26,895.
		(MU)	-	-	-	-	-	-	-	-	-	6,398.0	6,398.0	-	6,398.0	6,398.
		TOTAL	-	-	-	-	-	-	25,670.0	52,565.0	-	58,963.0	58,963.0	-	58,963.0	58,963.
Establishment of Central Nursery	HA.	(G)	1.0	-	-	1.0	1.0	1.0	-	-	-	-	-	-	-	-
		(MA)	1.0	-	-	1.0	1.0	1.0	-	-	-	-	-	-	-	-
		(MU)	1.0	-	-	1.0	1.0	1.0	-	-	-	-	-	-	-	-
		TOTAL	3.0	-	-	3.0	3.0	3.0	-	-	-	-	-	-	-	-
Community Seedling Distribution	HA.	(G)	11.4	5.0	5.0	38.6	38.6		63.2	63.2	2.692	94.5	70.0	70.0	122.8	70.
		(MA)	-	-	-	11.8	11.8		25.0	25.0	25.0	35.7	25.0	25.0	49.1	50.
		(MU)	2.0	2.0	-	6.7	6.7		8.8	8.8	8.8	10.5	6.0	6.0	13.7	2.
		TOTAL	13.4	7.0	5.0	57.1	57.1		97.0	97.0	36.492	140.7	101.0	101.0	185.6	122.
Establishment of Satellite Nursery	HA.	(G)	-	-	-	-	-	-	-	-	-	-	5.0	5.0	4.0	4.0
		(MA)	-	-	-	-	-	-	-	-	-	-	5.0	5.0	6.0	6.0
		(MU)	-	-	-	-	-	-	-	-	-	-	5.0	5.0	4.0	4.0
		TOTAL	-	-	-	-	-	-	-	-	-	-	15.0	15.0	14.0	14.0

TABLE I-1
(Continued)

FOREST MANAGEMENT: TARGETS AND ACCOMPLISHMENTS

ACTIVITY	UNIT/ LOCATION		FISCAL YEAR 1980-81			FISCAL YEAR 1981-82			FISCAL YEAR 1982-83			FISCAL YEAR 1983-84			FISCAL YEAR 1984-85	
			TO	TR	ACC	TO	TR	ACC	TO	TR	ACC	TO	TR	ACC	TO	TR
Preparation of National Forest Management Plan	HA.	(G)	-	-	-	-	-	-	25,670.0	25,670.0	-	25,670.0	25,670.0	25,670.0	-	-
		(MA)	-	-	-	-	26,895.0	-	26,895.0	26,895.0	26,895.0	-	-	-	-	-
		(MU)	-	-	-	-	-	-	6,398.0	6,398.0	6,398.0	-	-	-	-	-
		TOTAL	-	-	-	-	26,895.0	-	58,963.0	58,963.0	33,293.0	25,670.0	25,670.0	25,670.0	-	-
Species and Provenancy Trial Plots (plot size = 0.2 hectare)	HA.	(G)	-	-	-	10.0	10.0	10.0	15.0	15.0	15.0	20.0	-	-	20.0	20.0
		(MA)	-	-	-	10.0	10.0	10.0	15.0	15.0	15.0	20.0	-	-	20.0	20.0
		(MU)	-	-	-	10.0	10.0	10.0	15.0	15.0	15.0	20.0	-	-	20.0	20.0
		TOTAL	-	-	-	30.0	30.0	30.0	45.0	45.0	45.0	60.0	-	-	60.0	60.0
Floodplain Plantation	HA.	(G)	-	-	-	40.0	40.0	32.0	40.0	10.0	10.0	40.0	-	-	40.0	-
		(MA)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		(MU)	-	-	-	-	-	-	-	-	-	-	-	-	-	10.0
		TOTAL	-	-	-	40.0	40.0	32.0	40.0	10.0	10.0	40.0	-	-	40.0	10.0

*Key
TO = original target
TR = revised target
ACC = final accomplishment
G = Gorkha
Ma = Mayagdi
Mu = Mustang

Fifteen percent of its land is arable. Myagdi has a high profile and has costs generally higher than those in Gorkha because it is criss-crossed by major trekking routes. (APROSC, 1979, v. II).

The table itself is organized such that the first five rows refer to panchayat forests and their nurseries, the next four refer to panchayat protected forests, the next six to national forests and their nurseries, and one row refers to floodplain plantations. Activities within each of these are further divided such that there is one row for each political division. The columns display anticipated and revised targets and accomplishments by fiscal year.

The act of setting the targets in Table I-1 was initially begun by either the district forest conservator from the Department of Forestry or the catchment conservation officer from the Department of Soil Conservation and Watershed Management, each in consultation with the district panchayat. The DFC and CCO took their recommendations to the headquarters of their agencies which, in turn, took the recommendations to the National Planning Council which set the targets. The target criteria are "local need, local population, remoteness, working season, amount of agricultural land, manpower, and budget". The Department of Fores ry and the Department of Soil Conservation and Watershed Management, in conjunction with the National Planning Council, make subsequent annual adjustments in the targets by comparing old targets with past accomplishments and new budgets. (This is a process not dissimilar to the budget process of U.S. public land management agencies.) The accomplishments recorded in Table I-1 are from the semi-annual reports to the South-East Consortium for International Development. They were obtained from the progress reports of the various district forest conservators and catchment conservation officers.

Table I-2 puts current land use and eventual targets in each of the three political districts in further perspective. Clearly Mustang has the poorest land when compared with Gorkha and Myagdi. Comparison of Table I-1 with Table I-2 suggests that reported progress toward 15 year goals varies considerably. For example, Table I-1 shows 284 (accomplished) hectares of panchayat forest in Gorkha. This is approximately one-tenth of the Table I-2 projection of an eventual 29 square kilometers or 2,900 hectares. In contrast, Table I-1 shows 1,066 hectares of panchayat protected forest in Mustang. This is approximately one-third of the Table I-2 projection of an eventual 32 square kilometers or 3,200 hectares.

3. Case Study: One Hectare Panchayat Forest

Panchayat forests are converted from publicly owned former forestland and eroding pastureland. These lands are unforested and have only minimal use as poor quality commons grazing land use before conversion to forest plantations, half of whose objective is fuelwood and the other half fodder. Both outputs are expected to be consumed by members of the local panchayat themselves. Therefore, this discussion of panchayat forests is divided into two parts: first fuelwood, then fodder. Each part discusses costs and then benefits. We emphasize a simulated panchayat forest in Gorkha because half of all targets and half of all accomplishments to date occur in Gorkha (142

TABLE I-2

PRESENT AND 15 YEAR PROJECTED LAND AREA IN KM^2

EVENTUAL TARGETS	GORKHA	MYAGDI	MUSTANG
Cultivated Land (private)	308-290	143-135	39-38
Improved Pastures (private)	0-17	0-8	0-0
Pasture	135-69	286-229	549-514
Panchayat Forests	0-29	0-16	0-11
Panchayat Protected Forests	0-72	0-32	0-20
National Forests	328-257	301-269	84-64
National Plantation	0-37	0-40	0-24
Snow, Rocks, etc.	24-24	214-214	894-894

Source: APROSC, 1979, v. II.

hectares in Gorkha, 155 in the combination of Myagdi and Mustang, see Table I-1). We subsequently comment on panchayat forests in Myagdi and Mustang, focusing on their differences from those in Gorkha.

a) Fuelwood Plantation

Table I-3 summarizes the standard panchayat forest fuelwood plantation costs. General reference is to DOF contract specification costs by timber management activities. These costs are an upper limit to the extent that winning contracts may be bid lower than these specifications. Table I-3 excludes the salary of the district forest conservator on grounds that it is a fixed cost. That is, the DFC is employed regardless of either the existence of RCUP or the addition of another hectare of panchayat forest. The labor costs are the same as applied throughout all chapters of this RCUP benefit-cost analysis. That is, unskilled labor costs NR 12 per man-day in Gorkha. Since there is 56% unemployment or underemployment in Gorkha this wage must be corrected to obtain the true social cost of hiring a worker during the nine months out of every twelve which might be considered the off-peak employment season. Throughout the RCUP benefit-cost analysis we corrected by assuming a NR 6 per man-day off-peak shadow price of labor.

There are five classes of timber management activities including (1) surveying the proposed panchayat forest, which means demarking boundaries, and (2) purchasing seedlings from nurseries. Seedling prices are obtained from the nursery assessment contained in the appendix to this chapter. The DOF specification is for 2,500 seedlings per hectare of which we assume 10% die in handling. We also assume 30% die in the ground during the first year and need replacement thereafter. The third class of timber management activities includes all silvicultural operations, that is, all activities designed to insure stand establishment. They include clearing the land, marking the sites for planting, digging pits for the seedlings, and making fire lanes. This collection of activities is often known as site preparation. Pitting itself is unusual to our western world and to northern hemisphere forestry. It is designed to break up the clay and to make it water permeable, thereby giving the seedlings a better chance at survival. Silvicultural operations also include the transportion of seedlings from the nursery, as well as planting and then replanting in the second year where there have been failures in the first year, and weeding in each of the first two years in order to reduce natural competition and to improve seedling survival. There is no good experience outside the terai with any of these silvicultural operations. The somewhat experimental Australian project in Chautera offers the only comparable insight to date in Nepal's hills. We might expect the cost of silvicultural operations to decrease below those shown in Table 1.3 as RCUP and other forestry projects gain experience in hill forestry.

The fourth timber management activity includes fencing, protection and maintenance. If panchayat management is successful in overcoming the open-access problem, then there should be some question as to

TABLE I-3

PANCHAYAT FOREST FUELWOOD PLANTATION COSTS: GORKHA[1/]

ACTIVITY	MAN-DAY/HA	SEASON[2/]	YEARS	COSTS IN NR DISCOUNTED			
				NOMINAL LABOR	SHADOW LABOR	CAPITAL	TOTAL
Survey (Demarcation)	7	off	1	84	42	-	42
Seedlings[3/] (2,500 + 10%)/	-	peak	1	-	-	1,182	1,182
ha 30% Replacement	-	peak	2	-	-	323	323
Silvicultural Operations	-	-	-	-	-	-	1,872
Site Clearing	7	off	1	84	42	-	-
Site Marking	5	off	1	60	30	-	-
Site Pitting (1 ft[3/])	62	off	1	754	377	-	-
Fire Lanes	5	off	1	60	30	-	-
Transporting Seedlings	30	peak	1	360	360	-	-
Planting	35	peak	1	420	420	-	-
Beating Up (30%)	30	peak	2	327	327	-	-
Weeding	25	off	1,2	572	286	-	-
Fencing[4/]	-	off	1	2,700	1,350	1,300	2,650
Maintainence (Guard)[5/]	365	all	all	2,691	1,682	-	1,682
Management Plans	-	-	-	-	-	-	-
TOTAL (social cost)							7,751

1/ Sources unless otherwise specified: HMG, Ministry of Forestry and Soil Conservation (MFSC) undated. Standard Norms for Rate Analysis. Kathmandu and DFC's T.B. Prajapati and K. Bhatterai.

2/ Refers to peak or off-peak seasons for agricultural employment, the alternative employment for these labor

3/ Discussed in Appendix (MFSC calculates at NR .31/seedling. We calculate at NR .43/seedling).

4/ Estimated by D. Upadhya, DFC and M. Wagley, CCO, Gorkha: stone; NR 6,400/100 running meters and barbed wire; NR 4,900 to NR 7,000/100 running meters.

5/ Same source as footnote 4. Calculated at one guard per 10 ha employed 365 days per year at a financial wage of NR 12 per day. Three months of the year are peak season.

whether fencing is even necessary. Nevertheless, most existing panchayat forests in Gorkha are fenced along those boundaries where livestock have easy access. Fifty percent of the fencing is barbed-wire and 50% stone walls. One-third of the cost of erecting barbed-wire fences is labor; all of the cost of erecting stone fences is labor. Maintenance, like fencing, is a protection-oriented activity. That is, the only maintenance that is done on panchayat forests is protection against trespass. Therefore, standard maintenance means the hiring of a guard to keep out both fuelwood harvesters and foraging livestock. In most villages, local social pressures are sufficient to minimize unplanned fuelwood cutting. Management plans themselves are the final class of timber management activity. For uncertain reasons (to us), the general design of RCUP forest management includes no management plan for panchayat forests. It only includes management plans for panchayat protected forests and for national forests. Nevertheless, if management plans are necessary for one it seems reasonable that they would be necessary for the others. It is difficult to anticipate the precise cost of such management plans. APROSC (1979, v. 2, p. 168) anticipates NR 20 per hectare for national forests and NR 25 per hectare for panchayat protected forests. In contrast with these estimates, faculty from the Institute of Renewable Natural Resources charge NR 50-55 per hectare for preparing forest management plans.

The discounted sum of the costs of establishing a fuelwood plantation in Gorkha are NR 7,751. Interesting comparison can be made between these costs and those estimated by the World Bank for similar projects in Nepal. The World Bank data are not strictly comparable because some of their estimates are project-wide while others are for one hectare "standard" panchayat forests (Prichard et al., 1980, p. 16 and Annex 7, Table 3). World Bank stand establishment costs are NR 894 and compare with our NR 1,872 (Table I-3). The difference lies the Bank's much lower estimated wage (NR 4 per man-day) and its disregard for any cost of transporting seedlings from the nursery to the forest. Beyond establishment costs, the Bank and RCUP differences apparently emphasize wage payment differences, although the Bank also does add a small fee for tools and water. The Bank includes payment for trained technicians, i.e., the DFC and CCO. (We include no wage for trained technicians on grounds that they are already employed regardless of the RCUP supported plantations. Their employment status does not change with the addition of a panchayat forest.) Furthermore, the Bank projects employment of forest guards at less than full-time while we project full-time employment of guards.

This emphasis on labor cost differences suggests that we might consider the potential for cost savings in future RCUP panchayat forest establishment. In particular, we might inquire into the possibilities of reducing the fencing requirement, decreasing the transportion costs associated with seedlings, and decreasing the amount of repeat planting. Each of these is a labor intensive operation. Furthermore, this insight into the significance of labor costs provides several interesting suggestions for the eventual research component to the RCUP project. It

suggests cost savings from research designed to increase the seedling survival rate and to increase the facility of planting. Moreover, this information suggests that panchayat forests are most reasonable where there are strong institutions, that is strong local panchayat governments, which would enable a smaller protection expenditure, therefore smaller fencing costs and a lesser requirement for forest guards. Identifying the panchayats with a stong internal structure is probably difficult. It requires local insight. Perhaps Peace Corps Volunteers, District Forest Conservators, and Catchment Conservation Officers can be helpful here.

(1) Benefits

The benefits of panchayat forest fuelwood plantations include those from anticipated fuelwood production as well as those anticipated from by-products of the plantations, i.e., grass and forage for livestock as well as erosion control gains due to placing formerly open and eroding land into forests. To these benefits we subtract either the annual land rental value or this value corrected for any improvement in land quality due to local erosion control. The benefits of each of these items are equal to their price per unit times their unit yields.

Fuelwood species and anticipated yields vary. Species include: ficus spp. (which is mostly used for fodder), pinus roxburghii (chir pine), leucinia (mostly fodder, an exotic) bauhinias spp. and melia (bakaino). Yield tables of the sort which we must depend upon generally overestimate actual yields. They assume normal yields and full stocking and neglect the likelihood of losses due to trespass, fire, and disease. That is, they make the unreasonably generous assumption that all goes right between the initial planting and the final harvest dates. On the other hand, the opportunity for using exotic species which produce greater yields may compensate for this overestimation problem. The only real source of improved yield estimates is, however, time and considerably more extensive sampling of existing stands.

Against this background of uncertainty in yield estimation we might examine the scattered evidence on yields which has been previously collected in other studies. APROSC (1979, Annex E, App. 15, p. 210) projects 95 metric tons per hectare or approximately 137 cubic meters per hectare in a 20 year rotation for the two lower elevation districts (Gorkha and Myagdi). The Hill Community Forestry Project estimates 72 metric tons per hectare at age 10 for plantations (App. 3, p. 14). An IRNR class field trip found field data at Chautera for nine year old stands. The class projected 10 year yields as follows:

Stand Type	Yield in metric tons per hectare (Age 9)	(Age 10)
broadleaf	21.3	23.7
mixed	17.7	19.7
conifer (chir pine)	26.0	28.9

These broadleaf yields are from good sites and good soils where the pines cannot compete. The conifer data are from ridgetops and poor sites. It should also be noted that chir pine grows slowly relative to tropical (exotic) species. The facts that these are chir pine and on poor sites both suggest that greater yields may be possible for plantations. Exotic yields may be greater yet.

For our fuelwood yield estimates we assumed an indigenous species and estimated 30 to 70 metric tons per hectare for 10 year rotations in the lower elevation districts. An even greater range may be possible although our personal judgement is that 70 metric tons is probably too high in the hill country of Nepal. We chose the 10 year rotation despite the preference of APROSC and various World Bank studies for rotations approximating 20 years. Trees attain four to five inches dbh (10 to 12.5 cm) in ten years and are easier to cut for fuelwood at this size. Indeed, it is our observation that villagers prefer trees of this size for fuelwood and would probably harvest their panchayat forests around this age. Therein lies our justification for 10 year rotations.

Fuelwood prices are even more problematic. The market prices we observe are prices in the bazaars and not prices on the stump and even these bazaar prices vary considerably from community to community. Our casual evidence from the bazaars in Myagdi is that fuelwood prices range from NR 12 to 25 per bari (approximately 25 kilograms) and are highest near the main trails. Prices decrease as we move north to less populated areas or as we move to more abundant regions with more available fuelwood which generally means regions further from the main trails. (There is also a seasonal fuelwood price increase during the monsoon.) (J. Wood, pers. comm.) Table I-4 surveys additional evidence for fuelwood prices (as well as prices of other products from fuelwood plantations). The sources in the Table I-4 survey suggest prices in the neighborhood of NR 7 to 19 per bari, prices somewhat lower than in the Myagdi bazaar.

The facts that prices are rising through time and near the main trails and, furthermore, that baris are getting smaller explain a preference for higher expected fuelwood prices at the end of the 10 year rotation. The fact that wood is more abundant and, therefore, watershed erosion is probably less a problem away from the main trails suggests that panchayats further from the main trails have less need for RCUP's panchayat forestry effort. This observation defends any political tendency to help the more accessible panchayats. Following this self-advice, our benefit-cost analysis considers fuelwood prices as if the future panchayat forest effort is concentrated near the trails. That is, we consider prices at the bazaar in the range of NR 12 to 25 per bari. From this price range we deduct labor expenditures equaling one day round-trip carrying time and chopping time in order to obtain our preferred stumpage price range of NR 6 to 19 per bari.

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TABLE I-4A

KEY VARIABLES: PRICES IN NR

VARIABLE	VALUE	SOURCE
Fuelwood Price	i) Rs. 11.17/25 kg. ii) Rs. 6.69/25 kg. iii) Rs. 520/M^3 ⇒ 19.26/25 kg. (Shadow Price) iv) Rs. 10/30 kg. ⇒ 8.33/25 kg. v) Rs. 10/25 kg. vi) Rs. 148/M^3 ⇒ 5.28/25 kg. vii)	Campbell and Bhattarai 1983 Economic Survey, HMG Ministry of Finance, 1983/84 World Bank 1980 APROSC Fox. World Bank 1983
Leaf Fodder Price	i) Rs. 5.72/25 kg. ii) Rs. 27.75/MT ⇒ 0.69/25 kg. (Shadow Price) iii) Rs. 3.0/25 kg. iv) Rs. 22.5/MT ⇒ 0.56/25 kg.	Campbell and Bhattarai 1983 World Bank 1980 APROSC, 1979 World Bank Terai Project 1983
Grass Price	i) Rs. 5.15/25 kg. ii) Rs. 13.3/MT ⇒ 0.33/25 kg. (Shadow Price) iii) Rs. 3/25 kg ⇒ 0.56/25 kg. iv)	Campbell and Bhattari 1983 World Bank 1980 World Bank Terai Project 1983
Timber Price	i) Rs. 211.86/M^3 ⇒ Rs. 6/ft^3 ii) Rs. 8.0/ft^3 ⇒ 282.50M^3 iii) Rs. 11.0/ft^3 ⇒ Rs. 388.50 iv) Rs. 284.09/M^3	APROSC, 1979 Y.R. Sharma K. Kanel's Estimate Leuschner
Kg./M^3 Wood	i) 700 ii) 600 iii) 675 Use 700 kg/M^3	APROSC Fox. Leuschner
Land Price	i) Pasture Rs. 2,000/rop Bari Rs. 4.-6000/rop Khet Rs. 6-12,000/rop ii) Rs. 2,000/rop iii) Rs. 2,000/rop for bari land	Campbell's Informal Survey as quoted by Leuschner SECID 1979 Gorkha Land Registration Average Price

TABLE I-4B

KEY VARIABLES: YIELDS

VARIABLE	VALUE	SOURCE
Fuelwood		
a. Panchayat Forest (Fuelwood)	i) 95MT/Ha. age 20, 25 ⇒ MAI 20 ⇒ 6.78M^3/Ha., MAI 25 ⇒ 5.43M^3/Ha.	APROSC 1979 Appendix
	ii) 5M^3/Ha. at Year 14 plus 160M^3/Ha. at Year 16 ⇒ 10.31M^3/Yr./Ha. (MAI)	World Bank 1980 (pp. 43)
	iii) 73MT/Ha. Yr. 20 and 25 MAI 20 ⇒ 5.21M^3/Ha. MAI 25 ⇒ 4.17M^3/Ha.	APROSC 1979
	iv) 210M^3/Ha. ⇒ 5.25M^3/Ha./Yr. Excludes 1M^3/Yr./Ha. of poles and sawlog	World Bank 1983
	v) Age 5, 20 MT/Ha. ⇒ 28.57M^3/Ha. Age 11-36, 8 MT/Ha./Yr. ⇒ 11.43M^3/Ha.	Hill Development Forestry Project
b. Panchayat Protected Forests	i) Year 1-16 ⇒ 1.6M^3/Ha. Year 17-30 ⇒ 5.0M^3/Ha.	World Bank 1980
	ii) 0.3M^3 (greater than 0.2MT/ha)	Applegale guess
	iii) 3.24M^3/Ha. after year 4 (lower region)	APROSC
	2.475M^3/Ha. after year 4 (upper (region)	Volume include timber and fuelwood - APROSC
c. National Forests	i) 3.24M^3/Ha. after year 4 (lower region) 2.475M^3/Ha. after year 4 (upper region)	Volume include timber and fuelwood - APROSC
Leaf Fodder		
a. Plantation	i) 25 kg./Tree-Yr. 6-9 for lower region	APROSC
	ii) 50 kg./Tree-Yr. Above 10 for lower region 25 kg./Tree-Yr. 9-14 for upper region 50 kg./Tree-Yr. 15 for upper region	
	iii) Year 5, 5MT/Ha. Year 6, 15MT/Ha. Year 7, 30MT/Ha Year 8-30, 60MT/Ha./Yr.	World Bank 1980, Private Planting
	iv) 4 to 6MT/Ha.	World Bank 1983 Terai
	v) Age 1-5, 2MT/Ha./Yr. Age 6-36, 5.6MT/Ha./Yr.	Hill Forestry Development Project

TABLE I-4B
(Continued)

KEY VARIABLES: YIELDS

VARIABLE	VALUE	SOURCE
b. Panchayat Protected Forests	i) at age 5, 0.6MT/Ha. age 6, 1.9MT/Ha. age 7, 3.8MT/Ha. age 8-30, 7.5MT/Ha.	World Bank 1980 Table 3,
c. National Forest Improvement	i) age 1-5: 1.4 MT/Ha 6-10: 1.6 MT/Ha. 11-15: 3.7 MT/Ha. 15-30: 3.3 MT/Ha.	Hill Forest Development Project
Grass - Without Plantation	i) 7MT/Ha. ii) 4MT/Ha. iii) 2MT/Ha. iv) 2MT/Ha. v) 5MT/Ha	APROSC 1979 World Bank 1980 G. Campbell Rajbjandari World Bank 1983 (terai)
- With Plantation	i) 500 kg./GW/Ha./Yr. for Year 1-3 (250 kg./GW/Ha./Yr. for upper region) ii) 4MT/Ha./Yr. for Year 1-5 2.5 MT/Ha./Yr. Two Year 6-10 1.0 MT/Ha./Yr. Two Year 11-16	APROSC, RCUP World Bank 1980 pp. 43

There is probably no price effect from the increase in fuelwood yields due to panchayat forest production. If there were a price effect then it would show up in the tea shops where demand is more elastic. Local subsistence farmers have a relatively inelastic demand for fuelwood as it is a basic necessity.

Let us, nevertheless, consider further the potential for a price effect. The RCUP objective is to establish 125 hectares of panchayat forest per local panchayat. One-half of these would be for fuelwood. With 10 year rotations, this means there would be 6.25 additional hectares of fuelwood harvested per year per panchayat, or 187.5 to 281.3 additional metric tons per panchayat per year. If the panchayat population falls in the range of four to five thousand people and each person burns .6 to .7 metric tons annually, then the entire population burns twenty-four to thirty- five hundred metric tons per panchayat per year. At this rate, 125 acres of panchayat forest would add 7.5 to 8% to annual fuelwood consumption (Levenson, 1979). We might hypothesize that this 7.5 to 8% increase is insufficient to effect price substantially, particularly given the opportunity to transport some fuelwood to neighboring areas which may not have additional panchayat forests (at least for the next several years). Certainly there is some opportunity to transport fuelwood to the high demand areas near the trekking trails.

Finally, let us consider the forage, erosion control and final land values. Without panchayat forests this same land would be poor pastureland producing perhaps three metric tons of forage per hectare per year. With the protection from uncontrolled grazing of domestic livestock provided by panchayat forests there may even be an increase in forage production during the first five years of the timber rotation. Forage would decrease, however, in the second five years after tree crowns begin to close. This second five year decrease may be somewhat offset by the fact that the land itself is of higher quality. That is, it will hold water better after forest establishment and, therefore, may continue to grow some forage. Nevertheless, we make the conservative assumption of no change in forage production during the first five year period and a loss of one metric ton per hectare per year from what would have occurred in the second five years of the fuelwood rotation. If the price of fodder is NR 5.15 per kilogram (see Table I-4) and one person carries four baris or 100 kilograms per day and charges a shadow wage of NR 6 per day, then the price on the stem of 100 kilograms of fodder should be NR 14.6. The value of the one metric ton of forage foregone per hectare per year for each year in the second five years of the timber rotation would be NR 146. Accumulating and discounting across the five years yields a forgone discounted revenue of NR 344.

The decrease in soil erosion includes a previously unaccounted for decrease in downstream soil sedimentation. This is probably a minor value for any single hectare. APROSC estimated it to approximate NR 12 per hectare per year or a present value of NR 88 for the discounted value of the perpetual time stream (APROSC, 1979, App. L, Table 4, p. 49).

To obtain the land value, we compared the current use value of the land with the discounted value of the good forestland which this land might become after 10 years of panchayat forest management. That is, the initial value in the land's current use is the value of forage on the stem divided by the interest rate, which equals NR 146 per hectare divided by .1 or NR 1,460. The final value (from Table I-4) for the good pastureland that would remain after one forest rotation is equal to NR 2,000 per ropani or NR 40,000 per hectare. Discounted at 10% for the 10 year fuelwood rotation, this is NR 15,420. The difference between initial value and discounted final land value is a gain of NR 15,420 - 1,460, or NR 13,960. For sensitivity, we also consider land of one-half this final value. In either case, conversion of poor pastureland to panchayat forestland for the 10 years of one timber rotation has a substantial positive effect on land value.

(2) Net Revenue

The discounted net revenue for one hectare of panchayat forest fuelwood plantation is the discounted sum of the price times the yield for both fuelwood and forage outputs minus the sum of their discounted costs, plus the erosion control and land value differences, also properly discounted. Table I-5 summarizes these costs and benefits for plantations in Gorkha. It distinguishes between financial and (shadow) social costs and it distinguishes benefits for each output, all in Nepali Rs. in present value terms. Where questions may exist about a cost or a range may exist in our estimates for either benefits or costs, then Table I-5 displays both high and low values. Table I-5 also displays benefit-cost ratios, subject to these variations in value estimates, which summarize our judgment of the effect of RCUP's panchayat forest fuelwood plantation effort in Gorkha.

The conclusions to be derived from these benefit-cost ratios are generally favorable. Indeed, if we shadow value unskilled wages during the nine months per year when there is approximately 50% unemployment or underemployment, then only the extreme cases fail to produce a satisfying social benefit-cost ratio (greater than one). Whenever and wherever we can conserve on labor in any way, then the benefit-cost ratio exceeds one -- regardless of our yield and output price estimates. Thus, we can say with considerable confidence that panchayat forest fuelwood plantations can be socially justifiable enterprises in Gorkha.

Under a conservative future estimate scenario we might anticipate that strong local institutions prevent trespass thereby removing the fencing requirement and reducing the initial labor requirement to 170 man- days per hectare. (This is not a best estimate of past performance because that estimate would reflect

TABLE I-5

GORKHA
PANCHAYAT FOREST FUELWOOD PLANTATION BENEFITS AND COSTS
(IN DISCOUNTED NR/HA)

SENSITIVITY FACTORS	ESTIMATES	
COSTS	FINANCIAL	SOCIAL
(1) TI-3 Base Case	11,686	7,751
(2) Without Fencing	7,686	5,101
(3) Reduce to 160-180 Man-days/Ha	10,262	6,887
(4) Reduce to 170 Man-days/Ha Without Fencing	6,262	4,237
BENEFITS	LOW	HIGH
(1) Fuelwood		
a. Price	6/25 kg.	19/25 kg.
b. Quantity	30 MT/Ha	70 MT/Ha
c. Total Fuelwood Revenue	2,776	20,510
(2) Forage	-344	0
(3) Erosion Control	88	88
(4) Land Value	6,260	13,960
TOTAL BENEFITS	8,780	34,558

BENEFIT/COST RATIO	FINANCIAL LOW	FINANCIAL HIGH	SOCIAL LOW	SOCIAL HIGH
(1) Base Case	.75	2.96	1.13	4.46
(2) Conservative Future Estimate: Cost Case (4), Fuelwood Yield 35 MT/Ha, Fuelwood Price NR 15/bari and Land Value NR 3,000: total benefits, NR 10,839	1.7		2.6	

cost estimate (1), not cost estimate (4) or its associated and recommended wiser choice of strong panchayat management.) A conservative expected benefit estimate might anticipate 35 metric tons of fuelwood (for ten year rotations) which then sells at NR 15 per 25 kg. These costs and anticipated benefits plus the lower bound on land value yield both financial and social benefit-cost ratios considerably in excess of 1.0 - i.e., 1.7 for the financial and 2.6 for the social benefit-cost ratio. Panchayat forests in Gorkha are activities with which all involved should expect to be pleased over the years. Expanding the targets for this RCUP activity would be a reasonable decision so long as new panchayat forests are chosen with an eye to the labor cost and institutional criteria mentioned above.

(3) Panchayat Forest Fuelwood Plantations in Myagdi and Mustang

Tables I-6 and I-7 summarize the fuelwood plantation costs for Myagdi and Mustang, respectively. They compare with Table I-3 for Gorkha. Tables I-8 and I-9 summarize the benefits and costs associated with Myagdi and Mustang fuelwood plantations, respectively. They compare with Table I-5 for Gorkha. The major differences in these tables have to do with wages and with outputs. Nominal wages for Myagdi are NR 16 per day and for Mustang are NR 22 per day. The shadow wage retains the same proportion to the nominal wage for Myagdi and Mustang as it did for Gorkha. That is, for nine months out of twelve the shadow wage is one-half the nominal wage. Any change in outputs between Gorkha and either Myagdi or Mustang must focus on fuelwood. Forage, erosion control and land value are items of lesser magnitude. It is reasonable to expect that forage production in Myagdi would be the same as in Gorkha because the areas are topographically similar. It is also easy to assume that the change in forage value in Mustang due to fuelwood plantations is the same as in Gorkha because the Mustang production is so small, therefore, any different assumption would have small impact on our outcome. Similarly, any change in erosion control from the impact we observed in Gorkha would have small impact on our final benefit-cost ratios for either Myagdi or Mustang.

The impact of land value may be moderatly greater, however. Comparable land values may be somewhat greater in Myagdi and Mustang than in Gorkha because the areas in question may be nearer the heavily used trekking routes in Myagdi and in Mustang they may be among the few land areas of any agricultural value. Nevertheless, our empirical observations suggest that a range in land values of NR 15,000-30,000 per hectare of good pastureland may be reasonable. (This range actually overlaps that for Gorkha.) Good pastureland identifies the improved condition of the panchayat forests if they were to be converted to other use after one fuelwood rotation. Therefore, the value of good pastureland is a good proxy for the undiscounted final value of the land after panchayat forest timber rotations.

Fuelwood values in Myagdi and Mustang deserve greater attention. Market prices of fuelwood range from NR 12-25 in Myagdi and NR 20-30 in Mustang. The greater price in Mustang is explained by the greater hauling cost. If much of the fuelwood burnt in Mustang is hauled from Myagdi then an increase in hauling time to as much as 2.5 days per bari is not unreasonable. This leaves a very wide possible range for stumpage values. Reasonable stumpage values for fuelwood collected near the towns might range from NR 6-19 per bari in Myagdi and NR 14-24 per bari in Mustang.

Physical yields of fuelwood also change as we move from Gorkha to Myagdi or Mustang. Because these latter areas are dryer, the initial forest plantings are spaced further apart, approximately one seedling per every 2.5 square meters. This greater spacing implies a decrease in yield by five metric tons per hectare in Myagdi. The even greater dryness occurring as we increase elevation to Mustang suggests either smaller yields yet or an addition of, perhaps, three years to Mustang fuelwood rotations producing the same yields at harvest as in Myagdi. In general, anticipated rotations remain approximately one-half of those recommended by APROSC because that matches the preferences of the local fuelwood consuming public.

As the greater spacing suggests fewer trees per hectare it also suggests a reduction in the man-day requirement for silvicultural operations from 231 man-days per hectare in Gorkha to 132 man-days in Myagdi and Mustang. The 2.5 square meters spacing is the recommendation of the catchment conservation officers in Myagdi and Mustang. It contrasts with an APROSC recommendation of 2.0 square meters for these districts. The greater spacing, therefore fewer seedlings planted, is enough to offset increased labor costs per worker hour in Myagdi. This can be seen by comparing costs of silvicultural operations in Myagdi with those in Gorkha (Table I-6 with Table I-3). The greater spacing is not enough to offset Mustang wages which are higher yet. (Compare costs of silvicultural operations in Table I-7 with those in Table I-3.)

The net effects can be seen by comparing the benefit-cost ratios at the bottoms of Tables I-8 for Myagdi and I-9 for Mustang. The Myagdi results are quite comparable to those for Gorkha. The range of both financial and social benefit-cost ratios are similar to those for Gorkha, as are the estimates for our conservative future estimate. The conservative future estimate should be instructive for setting new targets. It suggests our opinion that a reduction in fencing is advisable and that, where the village panchayats are strong enough to enforce panchayat forest protection, then the social gain from panchayat forests in Myagdi may be in the neighborhood of NR 2-4 for every NR 1 invested. Expanding targets for Myagdi's plantations could be a good idea.

TABLE I-6

PANCHAYAT FOREST FUELWOOD PLANTATION COSTS: MYAGDI

ACTIVITY	MAN-DAY/HA	SEASON	YEARS	COSTS IN NR DISCOUNTED			
				NOMINAL LABOR	SHADOW LABOR	CAPITAL	TOTAL
Survey (Demarcation)	7	off	1	112	56	-	56
Seedlings (2,500 + 10%)/ha	-	peak	1	1,496	1,003	1,003	1,003
30% Replacement	-	peak	2	408	273	273	273
Silvicultural Operations	-	off	-	-	-	-	1,620
Site Clearing	5	off	1	80	40	-	-
Site Marking	3	off	1	48	24	-	-
Site Pitting (1 ft)	40	off	1	640	320	-	-
Fire Lanes	4	off	1	64	32	-	-
Transporting Seedlings	19	peak	1	304	309	-	-
Planting	22	peak	1	352	352	-	-
Beating Up (30%)	19	peak	1	304	304	-	-
Weeding	16,16	off	1,2	489	244	-	-
Fencing[1/]	-	off	1	3,500	1,750	-	1,750
Maintainence (Guard)	365	all	all	2,588	2,243	-	2,243
Management Plans	-	-	-	-	-	-	-
TOTAL (social cost)				10,385			6,945

1/ Fences of stone walls only. Source: K. Shesthra, CCO, Myagdi.

TABLE I-7

PANCHAYAT FOREST FUELWOOD PLANTATION COSTS: MUSTANG

ACTIVITY	MAN-DAY/HA	SEASON	YEARS	COSTS IN NR DISCOUNTED			
				NOMINAL LABOR	SHADOW LABOR	CAPITAL	TOTAL
Survey (Demarcation)	7	off	1	154	77	-	77
Seedlings (2,500 + 10%)/ha	-	peak	1	2,073	1,003	1,003	1,003
30% Replacement	-	peak	2	565	273	273	273
Silvicultural Operations	-	off	-	-	-	-	2,223
Site Clearing	5	off	1	110	50	-	-
Site Marking	3	off	1	66	33	-	-
Site Pitting (1 ft)	40	off	1	880	440	-	-
Fire Lanes	4	off	1	88	44	-	-
Transporting Seedlings	19	peak	1	418	418	-	-
Planting	22	peak	1	486	484	-	-
Beating Up (30%)	19	peak	1	418	418	-	-
Weeding	16,16	off	1,2	672	336	-	-
Fencing[1/]	-	off	1	4,000	1,500	1,000	2,500
Maintainence (Guard)	365	all	all	4,333	2,915	-	2,915
Management Plans	-	-	-	-	-	-	-
TOTAL (social cost)				14,261			8,991

1/ Fencing cost: stone walls NR 46/m
barbed wire NR 38/m
average price: NR 42/m

TABLE I-8

MYAGDĪ
PANCHAYAT FOREST FUELWOOD PLANTATION BENEFITS AND COSTS
(IN DISCOUNTED NR/HA)

SENSITIVITY FACTORS	ESTIMATES	
COSTS	FINANCIAL	SOCIAL
(1) TI-6 Base Case	10,385	6,945
(2) Without Fencing	6,885	5,195
(3) Reduce to 90-110 Man-days/Ha	9,343	6,229
(4) Reduce to 100 Man-days/Ha Without Fencing	5,843	4,479
(5) Case (4) But Reduce Seedling Costs By 25%	5,367	4,160
(6) Protection Only, (Natural Regeneration), Without Plantation, No Fencing	2,700	2,299
BENEFITS	LOW	HIGH
(1) Fuelwood		
a. Price	6/25 kg.	19/25 kg.
b. Quantity	25 MT/Ha	65 MT/Ha
c. Total Fuelwood Revenue	2,314	19,045
(2) Forage	-297	0
(3) Erosion Control	88	88
(4) Land Value	3,263	10,306
TOTAL BENEFITS	5,368	29,439

BENEFIT/COST RATIO	FINANCIAL LOW	FINANCIAL HIGH	SOCIAL LOW	SOCIAL HIGH
(1) Base Case	.52	2.83	.77	4.24
(2) Conservative Future Estimate: Cost Case (4), Reduce Land Value to NR 2,500, Fuelwood Yield 30 MT/Ha, Fuelwood Price NR 15/bari: total benefits, NR 9,320	1.72		2.22	

TABLE I-9

MUSTANG
PANCHAYAT FOREST FUELWOOD PLANTATION BENEFITS AND COSTS
(IN DISCOUNTED NR/HA)

SENSITIVITY FACTORS	ESTIMATES	
COSTS	**FINANCIAL**	**SOCIAL**
(1) TI-7 Base Case	14,261	8,991
(2) Without Fencing	10,261	6,491
(3) Reduce to 90-110 Man-days/Ha	12,824	8,124
(4) Reduce to 100 Man-days/Ha Without Fencing	8,824	5,624
(5) Protection Only, (Natural Regeneration) Without Plantation, No Fencing	4,487	2,992
BENEFITS	**LOW**	**HIGH**
(1) Fuelwood		
a. Price	14/25 kg.	24/25 kg.
b. Quantity	25 MT/Ha	15 MT/Ha
c. Total Fuelwood Revenue	4,055	18,075
(2) Forage	-344	0
(3) Erosion Control	88	88
(4) Land Value	1,501	5,846
TOTAL BENEFITS	5,300	24,009

BENEFIT/COST RATIO	FINANCIAL LOW	FINANCIAL HIGH	SOCIAL LOW	SOCIAL HIGH
(1) Base Case	.37	1.68	.59	2.67
(2) Conservative Future Estimate: Cost Case (4), Fuelwood Yields 30 MT/Ha, Fuelwood Price NR 19/bari and other benefits of low estimates: total benefits, NR 9,349	1.00		1.57	

Mustang is different, however. Panchayat forest establishment may be a socially beneficial investment in Mustang, but the range of our benefit-cost ratio starts lower and does not extend as high. Apparently the higher labor cost and lower yields more than offset the expected increased price per unit of fuelwood output in Mustang. In sum, expanding panchayat forest targets in Mustang is probably a good idea, but choice of location for Mustang's forests is more important than choice of location in Myagdi or Gorkha. Near the villages and near trekking trails and on good land panchayat forests in Mustang may be a very good idea -- where the local panchayat is a strong institution (and if there is no higher valued use for the land).

b) Panchayat Forest Fodder Plantation

The general objective of these plantations is to produce fodder for livestock. Nevertheless, the output of these plantations includes not only fodder, but also fuelwood produced from the boles of the trees at the end of their productive lifetimes, or after the annual fodder output diminishes. There are also by-product outputs of erosion control and some forage from the forest floor. The land for these fodder plantations, like the land for panchayat forest fuelwood plantations, originates from mostly publicly-owned former forestland and eroding pastureland. The intention is to convert this mostly public land to fodder stands for management by and for the village panchayat.

The data for our fodder plantation assessment originates from known contract costs and actual observations. In general, our fodder plantation presentation will be briefer than the fuelwood presentation because there are so many similarities between the two. Again, we use Gorkha as our basic model. As we observe new panchayat forest fodder plantations in Gorkha, however, we believe that they are planted too densely. Therefore our Myagdi assessment with the correct density of trees per hectare provides a good contrast with what is actually happening in Gorkha. We also have a final comment on fodder plantations in Mustang.

The fodder plantation costs are basically similar to those for fuelwood. There is a difference, however, in the species used. Fodder plantations generally plant ficus spp, praximus floribunda, bauhinia dariegala, leucaena leucephala, or arrocarpus spp. These are all broadleaved species. Seedlings have been planted approximately 2,500 per hectare in Gorkha. This is approximatley the same as for fuelwood plantations and is too great if fodder is the intended product. Fodder trees should be spaced further apart than fuelwood trees in order to encourage crown growth and, therefore, larger fodder yields. The recommended spacing is approximately 816 seedlings per hectare (3.5 x 3.5 meter spacing). This recommended spacing not only should increase fodder yield but also should decrease costs in comparison with the denser fuelwood plantings. In this assessment we use the 2,500

seedlings per hectare from our Gorkha observations for the Gorkha benefit-cost estimate and the recommended 816 trees per hectare for our Myagdi and Mustang observations. (Most plantations to date are in Gorkha but we might expect greater concentration in Myagdi in the future.) All other costs are identical to those we observed for Gorkha panchayat forest fuelwood plantations. The Gorkha costs are reviewed in Table I-10, the Myagdi and Mustang costs are reviewed in Table I-11.

The outputs from panchayat forest fodder plantations are fodder, fuelwood at the end of the 30 year rotation, grass (forage), erosion control, and some change in the land value. We chose 30 year rotations because the physical productivity of fodder is very low for trees older than 30 and, furthermore, the discount factor overwhelms all benefits beyond the 30th year.

Age	Fodder Yield	Fuelwood Yield
0-5	0	0
6-10	25 kg/tree x 816 trees/ha	0
11-30	50 kg/tree x 816 trees/ha	0
30	0	35 MT/ha

Sources: Hill Forest, p. 50 and APROSC, Annex E, p. 39

Panchayat forest fodder plantations produce the same amount of grass or forage in their first five years as they would have if they had remained poor pastureland unconverted to fodder trees. Subsequent to the fifth year, grass or fodder production declines due to shading from the new tree crowns but it increases because the trees hold the ground water better than the previous poor pastureland did. We assume these two impacts balance each other out in the second five years of the fodder plantation. Subsequent to the tenth year, the impact of shading dominates and there is a further decrease in grass or forage production per hectare. We assume that between year 10 and year 30 the grass production decreases one metric ton per hectare per year.

We make the same assumptions about erosion control as for the previous panchayat forest devoted to fuelwood in Gorkha. Similarly land values are as they were for fuelwood plantations except there is greater discounting of the final value because fodder rotations are 30 years for fodder instead of 10 years for fuelwood. Prices are the same for panchayat forest fuelwood plantations for both grass or forage and the fuelwood output. Fodder price requires closer examination. Fodder costs approximately NR 5.75 per 25 kilogram load in the market. (See Table I-4. The World Bank price is low because it is derived from milk prices which were unusually low at the time of the estimate.) If the average person can carry eight loads per day to the market and his/her shadow wage is NR 6 per day then this converts into a fodder price at the site of NR 5 per 25 kilogram load.

TABLE I-10

PANCHAYAT FOREST FODDER PLANTATION COSTS: GORKHA

ACTIVITY	MAN-DAY/HA	SEASON	YEARS	COSTS IN NR DISCOUNTED			
				NOMINAL LABOR	SHADOW LABOR	CAPITAL	TOTAL
Survey (Demarcation)	7	off	1	84	42	-	42
Seedlings (2,500 + 10%)/ha	-	-	1	-	-	1,182	1,182
30% Replacement	-	-	2	-	-	323	323
Silvicultural Operations	-	-	1	-	-	-	1,872
Site Clearing	7	off	1	84	42	-	-
Site Marking	5	off	1	60	30	-	-
Site Pitting (1 ft)	62	off	1	754	377	-	-
Fire Lanes	5	off	1	60	30	-	-
Transporting Seedlings	30	peak	1	360	360	-	-
Planting	35	peak	1	420	420	-	-
Beating Up (30%)	30	peak	1	327	327	-	-
Weeding	25	off	1,2	572	286	-	-
Fencing	-	off	1	2,700	1,350	1,300	2,650
Maintainence (Guard)	365	all	all	2,691	1,682	-	1,682
Management Plans	-	-	-	-	-	-	-
TOTAL (social cost)							7,751

TABLE I-11

PANCHAYAT FOREST FODDER PLANTATION COSTS: MYAGDI AND MUSTANG

ACTIVITY	MAN-DAY/HA	SEASON	YEARS	COSTS IN NR DISCOUNTED			
				NOMINAL LABOR	SHADOW LABOR	CAPITAL	TOTAL
rvey (Demarcation)	7	off	1	112-140	57-70	-	57-70
edlings (2,500 + 10%)/ha	-	-	1	-	-	351	351
0% Replacement	-	-	2	-	-	127	323
lvicultural Operations	-	-	-	-	-	-	863-1,066
Site Clearing	7	off	1	112-140	57-70	-	-
Site Marking	4	off	1	64-80	32-40	-	-
Site Pitting (1 ft)	20	off	1	324-405	162-203	-	-
Fire Lanes	5	off	1	64-80	32-40	-	-
Transporting Seedlings	9	peak	1	144-180	144-180	-	-
Planting	11	peak	1	176-220	176-220	-	-
Heating Up (30%)	12	peak	1	174-218	174-218	-	-
Weeding	5	off	1,2	152-190	76-95	-	-
cing	-	off	1	3,600-4,500	1,800-2,250	-	3,100-3,550
ntainence (Guard)	365	all	all	3,588-4,485	1,794-2,243	1,300	1,794-2,243
gement Plans	-	-	-	-	-	-	-
AL (social cost)							6,292-7,007

We have no firsthand information for making adjustments in these Gorkha estimates to reflect prices, costs and output levels in Myagdi and Mustang. Instead we assume that Myagdi and Mustang outputs and prices are consistent with other experiences except for the spacing modification previously mentioned. Myagdi should compare with what Gorkha would be except with the less frequent spacing. Mustang's results should reflect the higher altitude, shorter season, dryer climate, and more difficult access. Mustang also reflects the use of different fodder species (populus and celix), higher wages, and different prices. Nevertheless, these differences between Mustang and Gorkha are consistent with the differences we observe for panchayat forest fuelwood plantations between Mustang and Gorkha. The one exception is that we now have to incorporate fodder price. Our estimates of fodder prices at the tree are NR 2-5 per 25 kilogram load in Myagdi and NR 5-10 per 25 kilogram load in Mustang. Table I-11 reports our costs estimates for panchayat forest fodder plantations in Myagdi and Mustang.

In summary, the benefit-cost analysis for panchayat forest fodder plantations is strongly favorable in all three districts. There is little doubt about Gorkha where the benefit-cost range is from .99 to 3.13. In Myagdi and Mustang the range of the benefit-cost analysis is extended at both the high and the low ends relative to its range in Gorkha. The conservative future estimate social benefit-cost ratio, however, is well over 3 in all three districts. It is most impressive for Gorkha where the previous costs have been unnecessarily high due to excessive planting in each hectare and yet the benefit-cost ratio is still high. Reducing the excessive planting to 816 seedlings per hectare only raises the benefit-cost ratio further yet.

In general, panchayat forest fodder plantations are socially profitable investments. They are even more socially profitable than the panchayat forest fuelwood plantations appear to be. The important factors in the selection of future panchayat forest fodder plantations targets are seedling spacing and the anticipated price of fodder at the tree. Of course, distance from the market can have a lot to do with the price of fodder at the tree and, therefore, distance has a lot to do with the choice of best locations for panchayat forest fodder plantations.

4. Summary, Conclusions and Implications to Future Targets

Panchayat forest establishment is a generally socially wise investment, whether for fuelwood or for fodder. The benefit-cost analysis of both fuelwood and fodder plantations suggest that previously established plantations have been generally well chosen and that expansion of future targets for these plantations is probably a good idea in all three districts -- particularly if targets can be expanded in areas near the larger villages and trails, or where final product prices are high and transportation costs can be minimized. There is, nevertheless, some uncertainty in our predictions

TABLE I-12

PANCHAYAT FOREST FODDER PLANTATION BENEFITS AND COSTS

SENSITIVITY FACTORS	ESTIMATES					
	GORKHA		MYAGDI		MUSTANG	
COSTS	FINANCIAL	SOCIAL	FINANCIAL	SOCIAL	FINANCIAL	SOCIAL
(1) TI-10 (Gorkha) & TI-11 Base Case	11,688	7,751	11,788	6,292	12,416	7,007
(2) Without Fencing	7,686	5,101	5,388	3,192	6,616	3,857
(3) Reduce to 63 Man-days/Ha (170 in Gorkha)	10,262	6,887	9,946	6,069	11,988	7,113
(4) Reduce to 63 Man-days/Ha Without Fencing (170 in Gorkha)	6,262	4,237	5,046	2,969	6,188	3,614
BENEFITS	LOW	HIGH	LOW	HIGH	LOW	HIGH
(1) Forage:						
a. Price	5/Kg.		2/Kg.	5/Kg.	5/Kg.	10/Kg.
b. Total Fodder Revenue	7,999	21,830	3,201-8,732	7,999-21,830	5,632-15,061	11,264-30,122
(2) Fuelwood	963	2,006	963	2,106	1,605	2,507
(3) Erosion Control	88	88	88	88	88	88
(5) Fodder (Grass)	-479	0	-413	0	-532	0
(4) Land Value	-887	316	-539	458	-2,708	-2,062
TOTAL BENEFITS	7,684	24,240	3,300	24,482	4,085	30,655

BENEFIT/COST RATIO	GORKHA FINANCIAL LOW	GORKHA FINANCIAL HIGH	GORKHA SOCIAL LOW	GORKHA SOCIAL HIGH	MYAGDI FINANCIAL LOW	MYAGDI FINANCIAL HIGH	MYAGDI SOCIAL LOW	MYAGDI SOCIAL HIGH	MUSTANG FINANCIAL LOW	MUSTANG FINANCIAL HIGH	MUSTANG SOCIAL LOW	MUSTANG SOCIAL HIGH
(1) Base Case	.66	2.07	.99	3.13	.28	2.08	.52	3.89	.33	2.47	.58	4.37
(2) Conservative Future Estimate:	2.31		3.41		2.36		4.01		2.12		3.64	
Cost Case (4)												
Benefits: Lower Land Value, Lower Fodder Value												
Forage Price (Gorkha 5/25kg., Myagdi 4/25kg., Mustang 7/25kg.												
Forage Yield:												
Yr. 6-10: 10MT/Ha, Gorkha & Myagdi												
10-30: 15MT/Ha, Gorkha & Myagdi												
Yr. 9-14: 10MT/Ha, Mustang												
15-30: 15MT/Ha, Mustang												
Fuelwood Price at age 30 (15/25 kg.: Gorkha & Myagdi; 25/25 kg.: Mustang)												

and there are areas where cost savings can be made in future plantations. The uncertainty stems from the difficulty of predicting future fuelwood and fodder prices and yields. This will always be a problem inherent in price estimation, but yield estimates can be improved with more sampling of existing stands. Such sampling is something which may occur as more well-trained foresters become established in the field and as IRNR faculty begin their own research projects. The potential cost savings invariably arise from reduced use of labor in panchayat forest management. This labor reduction can come from a decrease in excessive silvicultural effort, as from increased spacing, thereby decreased planting and stand establishment costs for fodder plantations, or it can come from effective enforcement against trespass by the village panchayat. If enforcement comes in the form of peer pressure and common understanding by villagers of the gains to be had by all from good panchayat forest management, then expenditures for fences and for forest guards can be decreased.

We have yet to consider panchayat protected forests, national forests and floodplain forest establishment. Panchayat protected forests represent a case generally similar to panchayat forests. They may be either fuelwood or fodder plantations. The difference is that panchayat protected forests originate from current forestland rather than from initially unstocked land, as do the panchayat forests. Panchayat protected forests, therefore, do not require initial silvicultural investments to the extent required by panchayat forests. Some silvicultural investment for stand establishment is necessary, however, to the extent that these current forests are sparcely stocked with standing trees. It is difficult to make a general estimate of the costs of such cases because these costs vary with the current stocking in each new panchayat protected forest. Each is different from all others in this respect. Panchayat protected forests, like panchayat forests, become the responsibility of the village panchayat. Thus they provide the same solution to the open access problem as provided by the panchayat forests. And for the same reason, panchayat protected forests work out best where village panchayats are strong and expenditures for fences and guards can be minimized.

National forests and floodplain plantation establishment pose a different problem because their objectives vary somewhat from panchayat forests and panchayat protected forests and because the village panchayats do not have responsibility over these forests. The objective of national forests is to produce timber. The objective of floodplain plantations is to anchor the soil and to protect the floodplain from further erosion. Fuelwood and fodder are only byproducts of national forests and of floodplain plantations. The costs of establishing either national forests or floodplain plantations should be comparable to the cost of establishing panchayat forests as shown in Tables I-3, I-6, and I-7 or I-10 and I-11 with the special caveat that protection against trespass is an all-important variable. Since national forests and floodplain plantations are the responsibility of HMG agencies and not of the village panchayats, they do not solve the open access problem. Therefore, a full complement of fencing and guards

is necessary in order to permit successful management of the national forests and the floodplain plantations. These forests are wise investments only where protection is easy and not where either livestock or fuelwood and forage harvesters can easily capture the forest product unchallenged. Thus, choice of the best locations for national forests and floodplain plantation establishment requires good knowledge of local terrain and of the strength of authority of the local CCO or DFC responsibile for enforcing the law regarding harvesting and forest boundaries.

APPENDIX I-A

NURSERIES

Table I-A.1 shows nursery construction costs in Gorkha for a 25,000 see (509M^2) nursery fenced either with barbed wire or stone walls. Table shows seedling production costs once the nursery has been constructed. To o production costs per seedling we first annualize the nursery construction (assuming it will completely depreciated without maintenance in five years), add the seedling production costs and, finally, divide by 25,000, the numb seedlings produced. Tables I-A.3A and I-A.3B review this calculation for f cial and economic costs per seedling. The difference between financial economic costs depends on whether wages are shadow-priced at half the m price for the nine month off-peak season. The economic cost per seedling i 0.43 and the financial cost ranges from NR 0.64 to 0.67 depending on the fe around the nursery.

We have overlooked the opportunity cost of the land used for the nurse our calculation because it is negligible for a 0.05 ha. pasture plot, partic ly since the quality of the plot is improved during its use as a nursery.

TABLE I-A.1

NURSERY CONSTRUCTION COST
GORKHA DISTRICT

This is a Panchayat nursery. Its capacity to produce seedlings is 25,000 per year. The area required for this nursery is 509 square meters. The cost details are given below:

S.N.	DESCRIPTION OF WORK	AMOUNT	MAN-DAYS REQUIRED	SEASON	TOTAL COST 1/ (NR)
1.	Site clearing of 509 M^2 (30% slope)	509 M^2	10.18	off	122.16
2.	Five nursery bed construction (22.5 x 4 m^2), thickness 0.6M	270 M^3	151.2	off	1,814.40
3.	To fill these beds with 50cm thick concrete	5 beds	3.3	off	39.60
4.	Cover seed beds with unscreened soil (0.035M thick)	0.75 M^3	0.36	off	4.32
5.	Cover these beds with screened soil from the forest (0.75M thick)	2.25 M^3	0.45	off	5.40
6.	To cover the transplanting seed beds with 5cm thick concrete stones	3.5 M^3	11.5	off	138.00
7.	Cover these transplanting seed beds with 2.5M^3 thick soil from the forest area	1.75 M^3	0.35	off	4.20
8.	Construct the frames of there beds (10) with stones	5.50 M^3			
	a. Skilled Laborer		1.65	-	49.50 2/
	b. Unskilled Laborer		4.95	off	59.40
9.	Make irrigation (small) channels along the nursery beds or (soil ___ for drainage)	5.64 M^3	2.76	off	33.12

1/ Unless specified otherwise, the market wage rate of the unskilled laborer in Gorkha is 12/man-day.

2/ The wage rate of skilled labor is NR 30/man-day in Gorkha.

TABLE I-A.1
(Continued)

NURSERY CONSTRUCTION COST
GORKHA DISTRICT

S.N.	DESCRIPTION OF WORK	AMOUNT	MAN-DAYS REQUIRED	SEASON	TOTAL COST (NR)
10.	Water Supply				
	a. Polythene pipe of 300M long and 12cm diameter	300 m.	-	-	2,250.00
	b. Transportation cost of this pipe	-	2.0	off	24.00
11.	Soil moved for water reservoir tank	3.95 M^3	2.21	off	26.52
12.	Masonry work for the construction of water reservoir				
	a. Collection of stones	2.64 M^3	3.96	off	47.52
	b. Transportation of stones	2.64 M^3	2.64	off	31.68
	c. Mason (skilled worker) @ NR 30/man-day	2.64 M^3	1.87	off	56.10
	d. Labor	2.64 M^3	3.85	off	46.20
13.	Construction of the distribution (water) tank				
	a. Soil working	4.27 M^3	2.39	-	28.68
	b. Stone wall and other	2.3 M^3			
	i) stone collection	2.3 M^3	3.45	-	41.40
	ii) stone transportation	2.3 M^3	2.30	-	27.60
	iii) mason (skilled labor)	2.3 M^3	1.95	-	58.50
	iv) laborer	2.3 M^3	3.90	-	46.80
	c. Cement concrete worker				
	i) stone collection and transportation	0.18 M^3	0.64	-	7.68
	ii) cement (@ NR 150/day)	1.43 bags	-	-	214.50
	iii) sand	0.079 M^3	1.62	-	19.44
	iv) skilled worker (mason)	0.18 M^3	0.25	-	7.50
	v) stone rubbles	0.16 M^3	1.86	-	22.32
	vi) laborer	0.18 M^3	0.76	-	9.12
	d. 12M.M Cement plaster (at 1:2 ratio)	5.61 M^3			
	i) cement	0.034 M^3	1.1	-	165.00
	ii) sand	0.068 M^3	0.79	-	9.48
	iii) skilled laborer @ NR 30/day	-	1.06	-	31.80
	iv) laborer	-	1.06	-	12.72

TABLE I-A.1
(Continued)

NURSERY CONSTRUCTION COST
GORKHA DISTRICT

S.N.	DESCRIPTION OF WORK	AMOUNT	MAN-DAYS REQUIRED	SEASON	TOTAL COST (NR)
14.	Nursery hut (college) construction (to store the equipment)				
	a. Pillars (wooden) @ NR 30/piece	9	-	-	270.00
	b. Transportation	-	9.0	off	108.00
	c. Rubber, ropes, etc.	-	10.0	off	120.00
	d. Other	-	15.0	off	1,800.00
		FINANCIAL COST		SOCIAL COST	
	1-14 SUBTOTAL in NR				
	a. Unskilled worker	2,728.76		1,364.38	
	b. Skilled worker	203.40		203.40	
	c. Materials	3,199.50		3,199.50	
	SUBTOTAL	6,131.66		4,767.28	
15.	a. Stone wall around the nursery	31.95 M^3	17.89	off	214.68
	i) Digging the soil for foundation				
	ii) Masonry worker				
	(a) mason (skilled worker) @ NR 30/day	74.55 M^3	52.93	-	1,587.90
	(b) laborer	74.55 M^3	105.8	-	1,269.60
	(c) stone extraction and collection	93.18 M^3	209.65		2,515.80
	(d) bamboo poles	1	-		25.00
		FINANCIAL COST		SOCIAL COST	
	15a in NR				
	a. Unskilled worker	4,000.08		2,000.04	
	b. Skilled worker	1,587.90		1,587.90	
	c. Materials	25.00		25.00	
	SUBTOTAL	5,612.98		3,612.94	
15.	b. Barbed wire fencing around the nursery				
	i) wooden post @ NR 120/ft.	15.34 $ft.^3$ (0.434 M^3)	-	-	1,840.80
	ii) checking the poles	-	6.3	-	75.60
	iii) barbed wire @ 20/kg.	54.15 kg.	-	-	1,083.00
	iv) U nail	-	-	-	20.00
	v) Straightened the wire (barbed) and other	-	10.15	-	121.80

TABLE I-A.1
(Continued)

NURSERY CONSTRUCTION COST
GORKHA DISTRICT

S.N.	DESCRIPTION OF WORK	AMOUNT	MAN-DAYS REQUIRED	SEASON	TOTAL COST (RS.)
		FINANCIAL COST		SOCIAL COST	
15b in NR					
	a. Unskilled worker	197.40		98.70	
	b. Skilled worker	-		-	
	c. Materials	2,943.80		2,943.80	
	SUBTOTAL	3,131.20		3,042.50	
		FINANCIAL COST		SOCIAL COST	
Total Nursery Construction Cost With the Stone Wall Fencing					
	a. Nursery Construction	6,131.66		4,767.28	
	b. Stone Wall Fencing	5,612.98		3,612.94	
	TOTAL	11,744.64		8,380.22	
	Add 10% Contingency	1,174.46		838.02	
	GRAND TOTAL	12,919.64		9,218.24	
Total Nursery Construction Cost With the Barbed Wire Fencing Around					
	a. Nursery Construction	6,131.66		4,767.28	
	b. Barbed Wire Fencing	3,131.20		3,042.50	
	TOTAL	9,262.86		7,809.78	
	Add 10% Contingency	926.28		780.97	
	GRAND TOTAL	10,189.14		8,590.75	

TABLE IA.2

SEEDLING PRODUCTION COST
NURSERY CAPACITY: 25,000 SEEDLING/YEAR
FROM PANCHAYAT NURSERY

Annual seedling production cost excluding the cost of nursery construction.

DESCRIPTION OF WORK	MAN-DAYS	SEASON	TOTAL COST (NR)
1. Seed collection	10.00	off	120.00
2. Soil collection from the forest area	81.40	off	976.80
3. Sand collection	40.40	off	484.80
4. Mixing soil with sand, etc.	25.00	off	300.00
5. Filling the polythene bags with appropriate soil and sand	125.00	off	1,500.00
6. Sowing of seeds in the seed bed	30.00	off	360.00
7. Transplanting seedlings in the polythene bag	90.00	off	1,080.00
8. Weeding	10.00	off	120.00
9. Grading of seedlings	5.00	off	60.00
10. Prunning	5.00	off	60.00
11. Construction of shades over the seedlings	40.00	off	480.00
12. Nursery foreman	360.00	all	4,320.00
13. Polythene bags (56.25 kg.) @ NR 401/kg			2,250.00
TOTAL Financial Cost			12,111.00
Social Cost			7,720.80

TABLE IA.3A

FINANCIAL COST CALCULATION PER SEEDLING
NURSERY CONSTRUCTION COST
(NR) FOR 25,000 SEEDLING

	Total Cost	Annuity
With Stone Wall Fencing:	12,919.64	3,408.17
With Barbed Wire Fencing:	10,189.14	2,687.87

Seedling (25,000) Production Financial Cost: 13,322.10

	With Stone Wall Fencing of the Nursery	With Barbed Wire Fencing Around the Nursery
Construction Cost	3,408.17	2,687.87
Production Cost	13,322.10	13,322.10
	16,730.27	16,009.97
Per Seedling Cost	0.67	0.64

TABLE IA.3B

ECONOMIC COST OF SEEDLING

Assume that the economic life of a panchayat nursery is 5 years provided no maintenance is undertaken.

The social cost of the nursery construction alone:

a. with stone wall fencing: NR 9,218.24
b. with barbed wire fencing: NR 8,590.75

Then applying the capital recovery formula, its discounted annual cost is:

a. with stone wall fencing: NR 2,431.75
b. with barbed wire fencing: NR 2,266.22

The total social cost of seedling production for 25,000 seedlings is:

	With Stone Wall Fencing of the Nursery	With Barbed Wire Fencing Around the Nursery
Construction Cost	2,431.75	2,266.22
Production Cost	8,492.80	8,492.80
	10,924.55	10,759.02
One seedling Cost (NR)	0.43	0.43

Appendix 1B

Total Net Annual Benefits: Past and Projected

Tables 1B.1 and 1B.2 display our present net benefit estimates in thousands of Nepali rupees for the bulk of all RCUP forest management activities. Table 1B.1 provides estimates for the first five years of the Project, or through fiscal year 1984-85, while table 1B.2 projects estimates for the next ten years. Each table is comparable to table 1.1 in the management activities which it lists and the political districts; Gorkha, Myagdi and Niustang; among which it divides the management activities. Benefits and costs for the first four years through fiscal year 1983-84 reflect the accomplishments for each year (as shown in table 1.1). Benefits and costs in the fifth year reflect an assumption that all revised targets for fiscal year 1984-85 (as shown in table 1.1) are accomplished. In all cases the benefits, costs and present net benefits reflect the one timber rotation discounted time stream anticipated for those benefits or costs on the relevant hectares, the hectares moved into the specific management activity in the year in question. These benefits and costs repeat themselves every timber rotation. They do not reflect only the current benefits or costs occurring in that year. Total net discounted benefits for all RCUP activities on all hectares introduced to management in a given year are shown at the bottom of the final page of tables 1B.1 and 1B.2.

Within table 1B.1, panchayat forest (fuelwood) benefits reflect the conservative future estimates for those benefits established in tables 1.5, 1.8 and 1.9 for Gorkha, Myagdi and Mustang, respectively. The panchayat forest (fuelwood) costs reflect base case costs from the same tables. These costs already have been incurred at this time. They reflect none of our recommendations for improved future management. Panchayat forest (fodder) benefits and costs are taken from table 1.12 in an identical manner. Panchayat forest management plans are not accounted for in these tables. We mentioned a NR 20-25 per hectare cost in the text itself, however, and apply the NR 20 estimate in the fourth row of table 1B.1. Appendix 1A estimates nursery costs and seedling values so that all nurseries just break even. Table 1B.1 continues the break-even assumption -- implying zero present net value for nurseries.

Panchayat protected forests are comprised of intermediate aged and intermediate stocked timber stands returned to panchayat management from national forest management. It is impossible to identify generalized benefit or cost streams to these forests until the indeterminate beginning of their second rotations. We arbitrarily assume that these second rotations begin in the fifth year after panchayat management begins. Panchayat protected forest demarcation and management plan costs are one time only costs attached to the establishment of the panchayat protected forest. We assume they compare, on a per hectare basis, with panchayat forest demarcation (tables 1.3, 1.5 and 1.7) and management plan costs.

National forest plantation benefits and costs might be similar to those of panchayat forests except for the open access problem attached to national forests. Open access suggests no impact on costs but a loss of benefits. Therefore, we estimated national forest costs as equal to panchayat forest (fuelwood) costs and national forest benefits as equal to the lower estimate of panchayat forest (fuelwood) benefits. National forest management plans are comparable to panchayat forest management plans. Nurseries, once more, break even. Floodplain plantations are treated identically to national forests. They suffer the same open access problem.

Table 1B.2 requires calculation of per hectare estimates as well as discounted benefit and cost estimates. For the estimates of numbers of hectares we referred to table 1.1 which shows accomplishments to date and to table 1.2 which shows fifteen year RCUP projections. Subtracting one from the other yields the remainder of hectares to be brought into each category of RCUP management in the remaining ten years. We asked what the discounted net benefit stream would be if one-tenth of this remainder were brought into RCUP management in each year.

The only changes in discounted benefits and costs were as follows: We assumed that our advice from the body of this chapter is taken regarding choice of locations for future panchayat forests and panchayat protected forests. Therefore, their per hectare benefits remain the conservative future benefit estimates from tables 1.5, 1.8, and 1.9 for fuelwood and from table 1.12 for fodder. Their per hectare costs become the preferred cost estimates (with fewer fences and fewer forest guards) shown at the bottom of these same tables.

The final calculations show net social gains for all years except fiscal year 1982-83. The reason net gains were negative that year and are only marginally positive in the following year is that the preparation of national forest management plans is so very expensive in those two years. Our projects, assuming full accomplishment of the hectarage goals in table 1.2 and assuming RCUP managers choose to follow our advice, are very positive for all future years. This implies a positive overall benefit-cost ratio for the increment of all RCUP forestry activities.

TABLE 1B-1

FOREST MANAGEMENT: COSTS AND BENEFITS (in 1000's of RUPEES)

ACTIVITY	UNIT/ LOCATION		FISCAL YEAR 1980-81			FISCAL YEAR 1981-82			FISCAL YEAR 1982-83			FISCAL YEAR 1983-84			FISCAL YEAR 1984-85		
			B	C	PNV	B	C	PNV	B	C	PNV	B	C	PNV	B	C	PNV
hayat Forest elwood)	HA.	(G)*	43.3	31.0	12.3	162.6	116.3	46.3	357.7	255.8	101.9	433.6	310.0	123.6	541.9	387.6	154.3
		(MA)*	23.2	17.4	5.7	73.8	55.6	18.2	175.4	132.0	43.4	249.2	187.5	61.7	350.7	263.9	86.8
		(MU)*	-	-	-	112.2	107.9	4.3	116.9	112.4	4.5	168.3	161.8	6.5	168.3	161.8	6.5
		TOTAL	66.4	48.4	18.0	348.6	279.8	68.6	650.0	500.2	149.8	851.1	659.3	191.7	1060.9	813.3	247.6
hayat Forest odder)	HA.	(G)	57.8	31.0	26.8	216.7	116.3	100.4	476.8	255.8	221.0	577.9	310.0	267.9	722.4	387.6	334.8
		(MA)	29.7	15.7	14.0	95.2	50.3	44.9	226.2	119.5	106.7	321.5	169.9	151.6	452.4	239.1	213.3
		(MU)	-	-	-	157.9	84.1	73.8	164.4	87.6	76.8	223.6	119.1	104.5	223.6	119.1	104.5
		TOTAL	87.5	46.7	40.8	469.8	250.7	219.1	867.4	462.9	404.5	1123.0	599.0	524.0	1398.4	745.8	652.6
nchayat Forest ndover	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
aration of Man- ement Plan of Panchayat Forest	HA.	(G)										0	-	-	0	2.8	-2.8
		(MA)										0	1.5	-1.5	0	1.0	-1.0
		(MU)										0	.25	- .25	0	.5	- .5
		TOTAL										0	1.75	-1.75	0	4.3	-4.3
tablishment of nchayat Nursery (0.09 hectare)	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															

TABLE 1B-1
(Continued)
FOREST MANAGEMENT: COSTS AND BENEFITS (in 1000's of RUPEES)

ACTIVITY	UNIT/ LOCATION		FISCAL YEAR 1980-81			FISCAL YEAR 1981-82			FISCAL YEAR 1982-83			FISCAL YEAR 1983-84			FISCAL YEAR 1984-85		
			B	C	PNV	B	C	PNV	B	C	PNV	B	C	PNV	B	C	PNV
Establishment of Panchayat Protected Forest	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
Demarcation	HA.	(G)				0	2.5	-2.5	0	5.7	-5.7	0	4.2	-4.2	0	12.6	-12.6
		(MA)				0	5.2	-5.2	0	17.3	-17.3	0	5.6	-5.6	0	16.8	-16.8
		(MU)				0	6.3	-6.3	0	10.4	-10.4	0	6.2	-6.2	0	3.8	-3.8
		TOTAL				0	14.0	-14.0	0	33.4	-33.4	0	16.0	-16.0	0	33.2	-33.2
Preparation of Management Plan of Panchayat Protected Forest	HA.	(G)							-	-	-	-	-	-	0	5.0	-5.0
		(MA)							0	3.8	-3.8	0	7.2	-7.2	0	5.0	-5.0
		(MU)							0	10.0	-10.0	0	6.2	-6.2	0	5.0	-5.0
		TOTAL							0	13.8	-13.8	0	13.4	-13.4	0	15.0	-15
Implementation of Panchayat Protected Forest Management Plan	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															

TABLE 18-1
(Continued)
FOREST MANAGEMENT: COSTS AND BENEFITS (in 1000's of RUPEES)

ACTIVITY	UNIT/ LOCATION		FISCAL YEAR 1980-81			FISCAL YEAR 1981-82			FISCAL YEAR 1982-83			FISCAL YEAR 1983-84			FISCAL YEAR 1984-85		
			B	C	PNV	B	C	PNV	B	C	PNV	B	C	PNV	B	C	PNV
National Forest Plantation	HA.	(G)				228.3	201.5	26.8	807.8	713.1	94.7	1404.8	1240.2	164.6	2195.0	1937.8	257.2
		(MA)				96.6	125.0	-28.4	1073.6	1389.0	-315.4	536.8	694.5	-157.7	1073.6	1389.0	-315.4
		(MU)				95.9	167.7	-71.8	318.0	539.5	-221.5	265.0	449.5	-184.5	477.0	809.2	-332.2
		TOTAL				420.8	494.2	-73.4	2199.4	2641.6	-442.2	2206.6	2384.2	-177.6	3745.6	4136.0	-390.4
Implementation of Management Plan of National Forest	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
Establishment of Central Nursery	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
Community Seedling Distribution	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
Establishment of Satellite Nursery	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															

TABLE 1B-1
(Continued)
FOREST MANAGEMENT: COSTS AND BENEFITS (in 1000's of RUPEES)

ACTIVITY	UNIT/ LOCATION		FISCAL YEAR 1980-81			FISCAL YEAR 1981-82			FISCAL YEAR 1982-83			FISCAL YEAR 1983-84			FISCAL YEAR 1984-85		
			B	C	PNV	B	C	PNV	B	C	PNV	B	C	PNV	B	C	PNV
Preparation of National Forest Management Plan	HA.	(G)							-	-	-	0	513.4	-513.4			
		(MA)							0	537.9	-537.9	-	-	-			
		(MU)							0	128.0	-128.0	-	-	-			
		TOTAL							0	665.9	-665.9		513.4	-513.4			
Species and Provenancy Trial Plots (plot size = 0.2 hectare)	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
Floodplain Plantation	HA.	(G)							281.0	248.0	33.0	87.8	77.5	10.3			
		(MA)							-	-	-	-	-	-			
		(MU)							-	-	-	-	-	-			
		TOTAL							281.0	248.0	33.0	87.8	77.5	10.3			
GRANDE TOTAL					58.8			259.3			-568.0			3.8			457.3

*Key
G = Gorkha
MA = Myagdi
MU = Mustang

TABLE 1B-2

FOREST MANAGEMENT: AGGREGATE BENEFITS AND COSTS, PROJECTED (in 1000's of RUPEES)

ACTIVITY	UNIT/ LOCATION		Hectares	1985-86 B	1985-86 C	1985-86 PNV	86-87 PNV	87-88 PNV	88-89 PNV	89-90 PNV	90-91 PNV	91-92 PNV	92-93 PNV	93-94 PNV	94-95 PNV		
Panchayat Forest (Fuelwood)	HA.	(G)*	130.8	1417.1	554.2	862.9					862.9						
		(MA)*	70.5	650.7	315.8	334.9					334.9						
		(MU)*	47.3	442.2	266.0	176.2					176.2						
		TOTAL	248.6	2510.0	1136.0	1374.0					1374.0						
Panchayat Forest (Fodder)	HA.	(G)	130.8	1889.8	554.2	1335.6					1335.6						
		(MA)	70.5	839.3	209.3	630.0					630.0						
		(MU)	47.3	622.2	170.9	451.3					451.3						
		TOTAL	248.6	3351.3	934.4	2416.9					2416.9						
Panchayat Forest Handover	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
Preparation of Management Plan of Panchayat Forest	HA.	(G)	251.6	0	5.2	-5.2					-5.2						
		(MA)	141.1	0	2.8	-2.8					-2.8						
		(MU)	94.6	0	1.9	-1.9					-1.9						
		TOTAL	497.3	0	9.9	-9.9					-9.9						
Establishment of Panchayat Nursery (0.09 hectare)	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															

52.

TABLE 1B-2
(Continued)
FOREST MANAGEMENT: AGGREGATE BENEFITS AND COSTS, PROJECTED (in 1000's of RUPEES)

ACTIVITY	UNIT/ LOCATION		Hectares	1985-86 B	1985-86 C	1985-86 PNV	86-87 PNV	87-88 PNV	88-89 PNV	89-90 PNV	90-91 PNV	91-92 PNV	92-93 PNV	93-94 PNV	94-95 PNV		
Establishment of Panchayat Protected Forest (Fuelwood)	HA.	(G)	347.5	3766.6	1472.4	2294.2					2294.2						
		(MA)	78.1	720.9	349.8	371.1					371.1						
		(MU)	46.7	436.6	262.6	174.0					174.0						
		TOTAL	472.3	4924.1	2084.8	2839.3					2839.3						
Establishment of Panchayat Protected Forest (Fodder)	HA.	(G)	347.5	5020.7	1472.4	3548.3					3548.3						
		(MA)	78.1	929.8	231.9	697.9					697.9						
		(MU)	46.7	614.3	168.8	445.5					445.5						
		TOTAL	472.3	6564.8	1873.1	4691.7					4691.7						
Demarcation	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
Preparation of Management Plan of Panchayat Protected Forest	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
Implementation of Panchayat Protected Forest Management Plan	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															

TABLE 1B-2
(Continued)
FOREST MANAGEMENT: AGGREGATE BENEFITS AND COSTS, PROJECTED (in 1000's of RUPEES)

ACTIVITY	UNIT/ LOCATION			1985-86			86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	
			Hectares	B	C	PNV	PNV	PNV	PNV	PNV	PNV	PNV	PNV	PNV	PNV	
National Forest Plantation	HA.	(G)	317.2	2785.0	2458.6	326.4					326.4					
		(MA)	348.2	1869.1	2418.2	-549.1					-549.1					
		(MU)	218.2	1156.5	1961.8	-805.3					-805.3					
		TOTAL	883.6	5810.6	6838.6	-1028.0					-1028.0					
Implementation of Management Plan of National Forest	HA.	(G)														
		(MA)														
		(MU)														
		TOTAL														
Establishment of Central Nursery	HA.	(G)														
		(MA)														
		(MU)														
		TOTAL														
Community Seedling Distribution	HA.	(G)														
		(MA)														
		(MU)														
		TOTAL														
Establishment of Satellite Nursery	HA.	(G)														
		(MA)														
		(MU)														
		TOTAL														

TABLE 1B-2
(Continued)
FOREST MANAGEMENT: AGGREGATE BENEFITS AND COSTS, PROJECTED (in 1000's of RUPEES)

ACTIVITY	UNIT/ LOCATION			1985-86			86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95		
			Hectares	B	C	PNV	PNV	PNV	PNV	PNV	PNV	PNV	PNV	PNV	PNV		
Preparation of National Forest Management Plan	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
Species and Provenancy Trial Plots (plot size = 0.2 hectare)	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
Floodplain Plantation	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
	HA.	(G)															
		(MA)															
		(MU)															
		TOTAL															
GRAND TOTAL						10212.0					10212.0						

II. WATERSHED MANAGEMENT[1]

The severe erosion in widespread evidence in the hills of Nepal justifies our general interest in watershed management and argues specifically for its central position in the RCUP effort. The erosion itself is widespread in origin and even more extensive in impact. It follows a pattern begun by upstream land loss and associated foregone productivity, the former which often induces a further decline in the local water table and, therefore, further productivity loss on the remaining land adjacent to the original point of erosion. The pattern continues as the lost upstream land ends up as downstream sediment deposited both within the steambanks and on the floodplains. Flooding becomes more frequent because the upsteam land is not as able to retain groundwater and because the raised streambed means that the downstream channel can no longer hold as great a flow of water. Upstream productivity loss affects Nepal's already stressed timber resource (also its pastureland and cropland) while downstream sedimentation, as it includes deposits from the heavy clay and gravel subsoils, often decreases productivity of staple agricultural crops, notably rice.

RCUP addresses the general watershed management problem with a number of smaller and site-specific land stabilization technologies plus a general activity which it labels community water source protection. The land stabilization technologies intend to focus on expanding landslides and gullies, eroding streambanks and poorly constructed or deteriorating terraces. In order to get men and equipment to the locations of these physical damages, however, RCUP has also found it feasible to include secondary stabilization technologies focusing on eroding roads and trails. Community water source protection is less specific in nature, including forage, fodder and fuelwood production activities because each contributes to maintaining the downstream water supply and water quality. Water source protection may have joint outputs in its intent, and therefore may require coordination with several other RCUP activities; e.g., forestry, drinking water, irrigation and range/livestock. Assessment of its benefits and costs requires a straightforward integration of our forestry and drinking water analyses.

Throughout its application of these technologies, RCUP's watershed program has argued from three basic premises: (1) It argues that emphasis should be placed on upper drainage basins as the proper beginning for watershed rehabilitation in highly degraded and stressed environments. Downstream improvements would only be damaged again by further upstream erosion unless the latter were corrected first. (2) Simple and inexpensive technologies are preferred. This often implies a preference for biological over mechanical technologies. Biological technologies are the easiest for the local population to maintain and, therefore, contribute to premise (3), sustainability. RCUP intends for good watershed conservation practices to outlive the project itself. This objective is best achieved by training local workers and local farmers in resource conservation, both formal training and the local learning which occurs through the demonstration and the on-the-job training attached to implementation of the various watershed management technologies.

These premises are general and are not inviolable. Where the threat of further environmental deterioration is locally both great and immediate then stopgap measures may be necessary. In such cases, RCUP may not shun more capital intensive technologies.

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[1]This study was prepared by W. Hyde, K. Kanel, and V. Sainjo in February 1985. This draft does not include the section on Terrace Improvement which requires additional information before it can be completed.

The external and common property effects of watershed management complicate RCUP's conservation problem by making appropriate technologies alone insufficient to induce the desired level of conservation. The problem would be more easily resolved if the gains from protection against erosion fully accrued to the property owner who makes the watershed improvement. Some gains, however, accrue to downstream landowners and, in the case of community water source protection, some gains accrue to the community as a whole. Downstream landowners cannot usually identify the original source of sediment deposited on their land. Therefore, they are unlikely to provide the proper inducement for erosion control by landowners at the source of the erosion. Individual members of communities, even if they are able to identify the source of damage to their water source, can often free ride on the collective action of their neighbors. Therefore, they too are unlikely to provide the proper inducement for erosion control to landowners at the source of the erosion. In the absence of sophisticated institutions for commons management, landowners at the source have incentive to manage the watershed only to the extent that they obtain personal gain. In sum, RCUP's problem is not only to encourage improved management but also to find and to encourage local institutions which can sustain the improved practices. Private property is not sufficient and local participation is essential.

Our objective in the body of this chapter is to examine the RCUP watershed management experience with the intent of providing insight to its reasonable future direction. Our approach is that of social benefit-cost analysis as described in the introductory chapter. We propose to conduct our analysis of RCUP's previous accomplishments with the intent of isolating characteristics of successful technologies, geographic locations and institutional arrangements. Knowledge of these characteristics should help identify appropriate future physical targets and target levels for the RCUP watershed management activity.

The chapter itself is organized into five main parts. The first part reviews past targets and accomplishments in physical terms. The second and third select empirical case studies for emphasis from among the various primary technologies. We chose stream stabilization and gulley control for these case studies because of the presumed substantial benefits of the first and because a qualitative list of the basic resource values each impact is similar to those impacted by most of the other primary and secondary technologies (APROSC, Leuschner). The substantial costs of gulley control are another reason for reviewing examples of it. The case studies begin with a background discussion of the previous local experience and include discussion of the general engineering technology and its desired impacts. They continue with the detailed benefit-cost analyses of the example projects, emphasizing the features to which these example projects are most sensitive. We complete the case studies with a discussion of the implications of our observations for the setting of future targets. The fourth part of the chapter summarizes our benefit-cost observations for terrace improvement. The project has made many and varied terrace improvements in a variety of locations. We select a case (much like those for forestry in the previous chapter) as the focus of our assessment. The fifth and final part summarizes and presents our full comments on future targets for the technologies reviewed in our case studies. It also adds comment on the secondary watershed technologies, trail improvement and road stabilization, as well as the final primary technology,

community water source protection. We go into little detail for this latter technology bucause it is so similar to our forestry examples in the previous chapter.

A. Targets

The Resource Conservation and Utilization Project began in 1979 as a collaborative effort between the U.S. Agency for International Development and His Majesties Government of Nepal. The first on-the-ground conservation activities began in mid-fiscal year 1980-1981 and the project is now in the fifth year of the first of three anticipated five-year programs.

The project's conservation activities are concentrated on two adjacent watersheds within three political districts. The most remote and least populated district is Mustang on the upper Gandiki watershed about five days travel by road and foot-trail from Kathmandu. It is a high elevation district (approximately 3,000 meters) in the rainshadow of the Annapurna range of the Himalayas. Much of the land in the district is cold desert although there is some seasonal agricultural cropland (2.5% of total lands (APROSC Survey, 1979)). The most populated district is Gorkha on the Daraundi watershed about four hours drive from Kathmandu. The RCUP watershed effort in Gorkha includes 32 large panchayat or village legislative units and it possesses the most and the best agricultural land in any of the three districts (38.7% of total land area (APROSC Survey, 1979)). These accessibility, population and land quality characteristics explain the somewhat greater level of RCUP activity occuring in Gorkha. The third district, Myagdi, on the lower Gandiki watershed has intermediate access, population and land quality characteristics which are somewhat nearer to those of Gorkha than to those of Mustang.

Table II-1 identifies target levels and accomplishments for each watershed activity within these three districts. The table lists first primary (terrace improvement, streambank stabilization, gulley and landslide control), then secondary (trail improvement and road bank stabilization) activities together with their basic units of physical measure. It closes with community water source protection.

There are two additional but unlisted activities worthy of comment. Fish ponds were an activity in the initial watershed management program. Three were built in Gorkha and all await stocking. This was a minor RCUP activity not traditionally associated with watershed management. For the latter reason, it is of little interest to the Department of Soil Conservation and Watershed Management (DSCWM), the lead HMG agency for this part of the RCUP program and it has a very low profile today. The final activity, multiple purpose impoundments, integrates drinking water, energy, agriculture, range and watershed programs. The design phase for this activity is only now nearing completion, therefore its initial targets are, as yet, unidentified. It is known that RCUP recommends no major impoundments and no hydroelectric output. The former would inundate more agricultural land than they would bring into protection and the latter would be redundant when a neighboring hydroelectric (and irrigation) project is completed in Pokhara.

TABLE II-1
WATERSHED MANAGEMENT (DSCWM): TARGETS AND COMPLETIONS

ACTIVITY	UNIT	FIRST 5 YEAR PROGRAM												TARGETS FOR		
		1980/81		1981/82		1982/83		1983/84		1984/85		TOTAL		SECOND 5 YEAR	THIRD 5 YEAR	15 YEAR TOTAL
		T	A	T	A	T	A	T	A	T	A	T	A			
A. Terrace Improvement																
1. Gorkha	ha	2.0	0.3	10.0	10.0	10.0	10.0	15.0	15.0	15.0	15.0	52.0	5.0	225.0	225.0	502.0
2. Myagdi	ha	2.0	-	10.0	9.6	10.0	10.0	20.0	20.0	10.0	10.0	52.0	4.0	75.0	75.0	202.0
3. Mustang	ha	-	-	-	-	10.0	8.0	10.0	10.0	10.0	10.0	30.0	2.0	200.0	200.0	430.0
B. Stream Bank Stabilization																
1. Gorkha	km	-	-	-	-	0.1	0.22	0.1	0.1	0.1	0.1	0.3	0.22	0.1	0.1	0.4
2. Myagdi	km	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. Mustang	km	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. Gully and Landslide Control																
1. Gorkha	no	-	-	1.0	1.0	1.0	1.0	1.0	0.8	2.0	2.0	5.0	5.0	2.5	2.5	10.0
2. Myagdi	no	-	-	-	-	1.0	0.7	2.0	1.0	1.0	1.3	4.0	1.7	2.5	2.5	9.0
3. Mustang	no	-	-	-	-	-	-	1.0	2.0	-	-	1.0	2.0	-	-	1.0
D. Trail Improvement																
1. Gorkha	km	-	-	1.0	1.0	1.0	0.62	0.7	0.55	2.3	1.84	5.0	4.01	10.0	10.0	30.0
2. Myagdi	km	1.0	0.15	4.0	3.88	4.0	4.0	10.0	10.0	-	1.0	19.0	18.03	5.0	5.0	29.0
3. Mustang	km	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E. Road Slope Stabilization																
1. Gorkha	km	0.4	0.06	0.4	0.34	0.8	0.8	0.7	0.7	-	-	2.3	19.0	-	-	2.4
2. Myagdi	km	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. Mustang	km	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Community Water Source Protection																
1. Gorkha	ha	10.0	-	30.0	30.0	20.0	20.0	10.0	10.0	30.0	30.0	100.0	90.0	100.0	100.0	300.0
2. Myagdi	ha	-	-	10.0	10.0	20.0	20.0	5.0	5.0	15.0	15.0	50.0	50.0	50.0	50.0	150.0
3. Mustang	ha	-	-	10.0	10.0	20.0	10.27	5.0	5.0	15.0	15.0	50.0	40.0	100.0	100.0	250.0
G. Multipurpose Impoundments																
1. Gorkha		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Myagdi		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3. Mustang		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

The targets themselves reflect our previously suggested emphasis on Gorkha. Indeed, reference to the tables shows that targets for each activity are highest for Gorkha and two activities, streambank stabilization and road slope stabilization, have targets only within Gorkha.

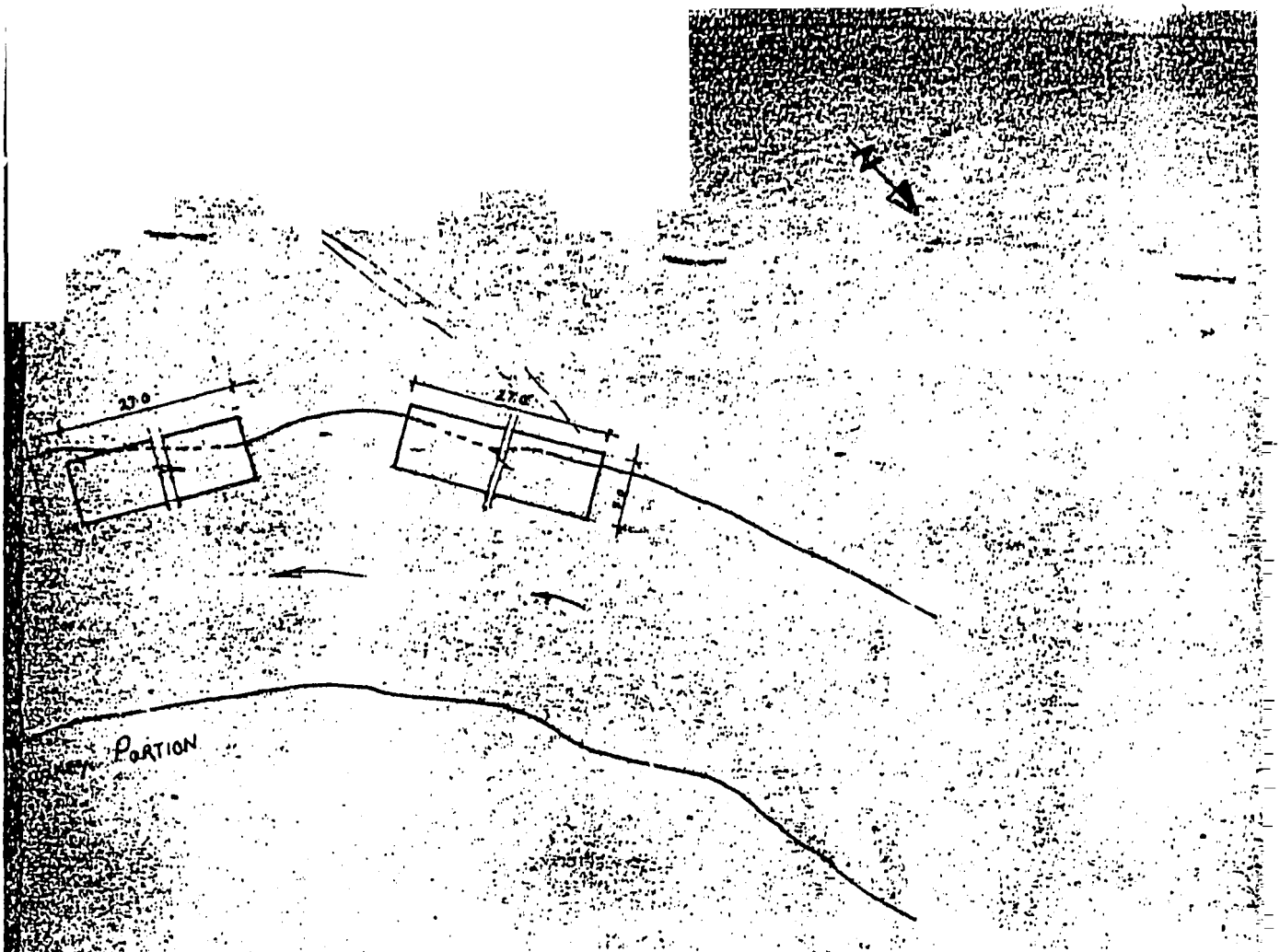
The initial five year's targets were set in a process begun by the Catchment Conservation Officer (CCO, a representative of DSCWM) in consultation with the district panchayat. The CCO took the recommendation of this group to the DSCWM which, in turn, reported its recommendations to the National Planning Commission (NPC) which set the targets. The criteria for our initial target selection included local need, local population, remoteness, working season, amount of agricultural land, available manpower and budget. The targets are revised annually by the DSCWM and the NPC after consulting their budgets and the CCO's progress reports. The table reports revised targets for years 1981-82 to 1984-85. The revision process is similar to that used by U.S. public land management agencies. That is, the tie between annual target revision and local demand is not clear. Budgets and the completed share of past targets are the apparent dominant factors for making choices about new target levels.

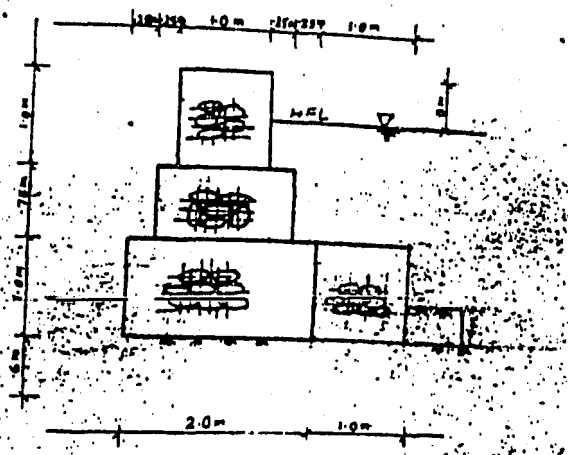
Thus, the accomplishments reported in Table II-1 have considerable importance for future target setting. They also provide the basic physical measure of benefits in our benefit-cost analysis. We have only one internal check on their accuracy. J. Wood (1984) in conversation with the overseer of construction - Mustang, found that terrace improvement and gulley control actually exceeded reported accomplishments. Ten hectares of terraces were improved in 1982-83 rather than the reported eight hectares (the 1983-84 terrace improvement report is correct) and three rather than two gulleys were controlled in 1983-84. This spot check suggests the unexpected (to us) conclusion that accomplishments are perhaps somewhat under-reported.

B. Streambank Stabilization: A Case Study

The choice of streambank stabilization for our first case study is, to repeat, a function of both its large anticipated net benefits and the qualitative similarity of its values at risk to those of all remaining primary and secondary technologies. Leuschner (1983) suggested that potential streambank stabilization benefits may dominate those for all other RCUP watershed management activities combined. With a statement of this emphasis as background, we would be negligent if we failed to examine the one existing streambank stabilization project in careful detail. The fact that there has been only one project and few more are currently planned suggests, however, that either this one project was uniquely beneficial or someone (Leuschner or RCUP) has misestimated.

Our project is on the Khahare River, a tributary of the Chhoprak, in the Chhoprak village panchayat. Figure II-1 provides some reference. The main thrust of the river was eroding good khet (paddy) land and depositing gravel sediment on its right bank. The Archale River entering the Khahare near the point where the floodplain widens, reinforces this action. The project objective was to protect the right bank at the points of greatest erosion and also to protect the cultivable land in the floodplain.





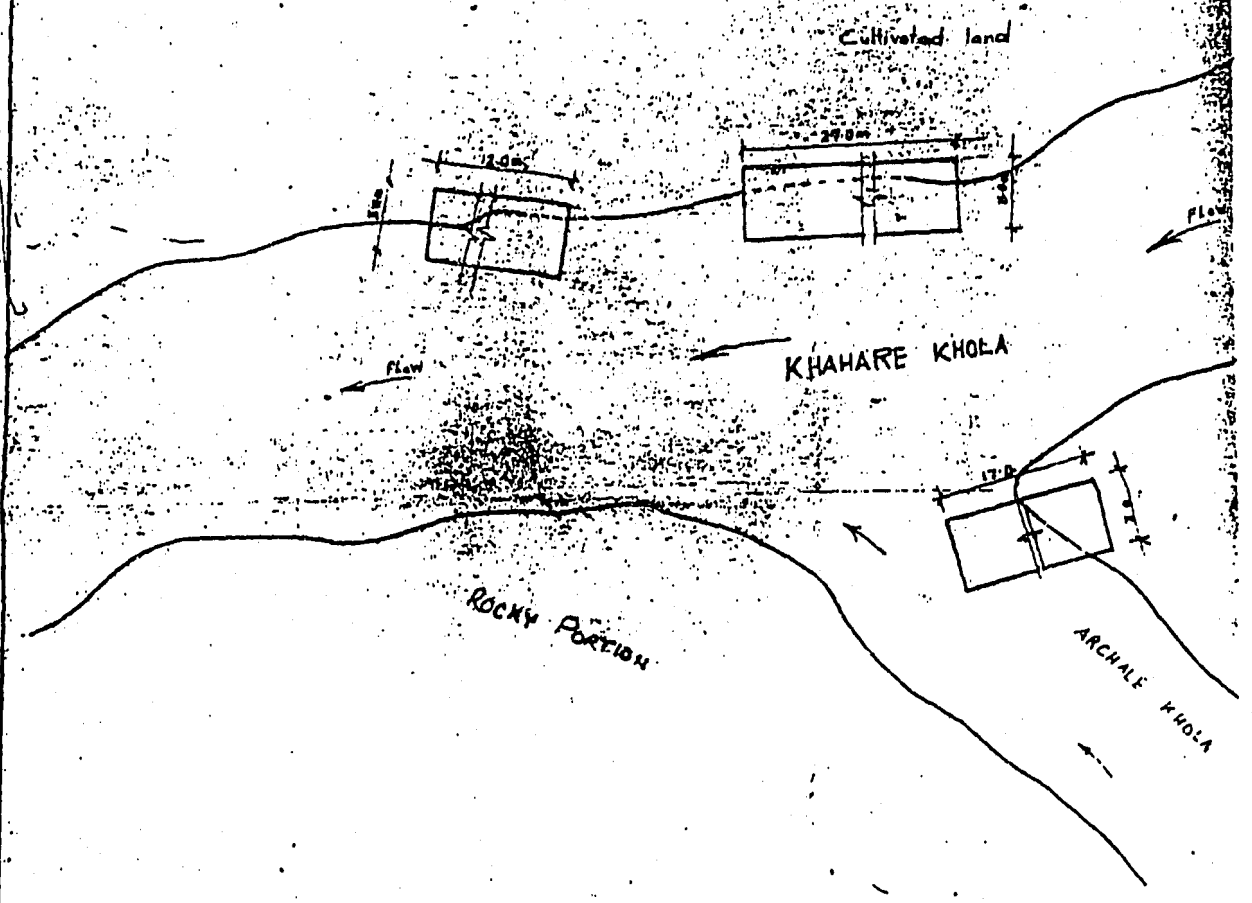
SECTION OF THE GABION WALL

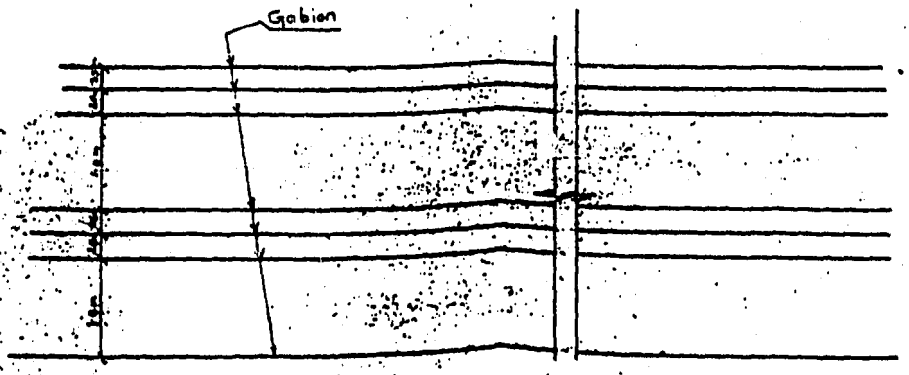
RCUP/DSCWM

STREAM BANK STABLIZATION WORK

CHHOPI AK V.P.

SECTION KHOLA





PLAN OF GABION

Scale 1:80

The physical situation at this project is common on the Daraundi and Gandiki watersheds: thin topsoil with a substrate of clay and gravel, steep terrain, and a rapidly moving river which scours more than it deposits. Especially at monsoon flood levels, the river's rapid pace and heavy clay and gravel load has a detrimental impact on local floodplain productivity. Only as the force of the main river (the Daraundi in this case) slows after it joins first the Marsyandi and then the Narayani and reaches more gently sloping land in Nepal's terai, may its flood stage deposits become beneficial to agricultural production. Thus, both in general and for our specific case, the gains from streambank stabilization occur from land saved upstream in the immediate neighborhood of the project (at the right bank) and from productivity saved in the neighboring downstream floodplain. Impacts in the terai are difficult to trace to any single upstream erosion site. There are also in a less critical area wholly outside RCUP's area of responsibility.

The appropriate engineering technology requires installation of either riprap or gabions to cut the river's impact at the eroding bank. The strong preference of the Nepalese is for gabions, which are wire baskets of stone and which can be constructed on the site. Only the wire needs to be transported from any distance. The Nepalese reliance on local stone over imported iron and their relative labor intensity make gabions the preferred technology. (Stones may, however, provide an occasional problem. They are everywhere available on local hillsides but landowners may prefer that the stones remain on the hills as protection against further erosion.) They were used at five locations on this project as shown in the figure.

As a first step in assessing the benefits and the costs of this project we inquired whether other watershed management projects in Nepal had collected comparable information. Apparently there are three other projects: an FAO project near Pokhara designed to control lakeside erosion and to produce hydropower and both the Swiss/TINAN and the DSCWM/Bagmati projects which concentrate on tree planting to control erosion. Two of these projects are in their initial stages and none of them provide experiences fully comparable with RCUPs. The only two detailed watershed project assessments were SECID's ex-ante and Leuschner's preliminary ex-post benefit-cost analysis. The former had no streambank stabilization component. We referred to the latter earlier in this chapter. It suggests that the area of upstream productive land protected and the lifetime of the stabilization project are the key variables.

Annual scouring and flooding tended to cause two kinds of losses prior to the RCUP construction activity: loss due to permanent erosion of the streambank and loss due to annual crop loss on the adjacent land. The force of the river eroded a strip of land on the west (right) bank of the Khahare river beginning at the eventual location of the furthest upstream gabion in Figure II-1 and continuing downstream approximately 189 meters to the last gabion, or until the river straightens and its main force returns to the center of the stream. This strip is approximately two meters wide in the first year and adds approximately two meters each successive year. Annual flooding, also on the west bank, causes loss of at least one of two annual rice crops as well as loss of some productivity for subsequent annual crops because of the heavy scouring by the rocky river sediment. Flooding affects approximately four hectares as shown in Figure II-1.

The RCUP engineer's record shows the financial cost of construction for the Chhoprak project to be NR 141,000. The off-season use of unskilled labor was only 1,970 man-days. Adjusting for the shadow wage or social cost of hiring these workers reduces the social cost only NR 12,000 to a total social cost of NR 129,000.

The benefit from constructing the gabions is measured as the rice crop gain from retaining the annually eroding strip along streambank plus the gain from one additional rice crop annually on the flooded area (plus the maintenance of some unmeasured subsequent production on the latter area). (We label the first benefit "erosion control" and include in it both losses at the site and downstream. Downstream losses are due to sediment deposition. We label the second benefit "flood control".) These benefits continue for the lifetime of the project which might be from 1 to 10 years, without maintenance, depending on the unknown river hydrology, i.e., river force and flooding frequency.

Assuming Gorkha khetland values of NR 5-6,000 per ropani or NR 100 to 120,000 per hectare and potential project lifetimes of 1, 5, and 10 years, then the combined erosion and flood control benefits are:

Project Life	BENEFITS IN NR		
in years	Erosion Control	Flood Control	Total
1	3454 - 4145	18181 - 21818	21600 - 26000
5	14497 - 17379	75820 - 90984	90300 - 108400
10	23620 - 28323	122900 - 147480	146500 - 175800

Apparently, the benefits only cover the construction costs (either social or financial) in the event that the gabions withstand the rivers force for 10 years or more.

This suggests that net benefits are not always so great as previously anticipated. (Leuschner anticipated benefits on both sides of the stream, rather than on just the one side which gains in the Chhoprak project. Leuschner could be correct in other topographic configurations.) More important, our analysis suggests that the lifetime of the project and the area protected from flooding are the critical measures determining the social gains from streambank control. The lifetime of the project is a function of river hydrology and knowledge of river hydrology is sparce at best. Benefits from the area protected from flooding are more than five times as important as benefits from erosion control in this particular case and would increase further yet for areas where greater than four hectares are protected. For example, if eight hectares were protected, then even projects similar in cost but with somewhat less than five years anticipated lifetime would be justified. Clearly, the larger the floodplain, the more justifiable future RCUP streambank stabilization projects may be.

C. Gully Control: Case Studies

Once more, there are few examples of projects of this category which have been completed at this early date in RCUP's history (three in Gorkha, two in Myagdi, two in Mustang). Therefore, there is only sparce evidence on which to base our analysis. We will review three of these projects briefly, the only

three for which there are available blueprints. Two are in Myagdi and the other, an unusual example, is in Gorkha. The Gorkha example is unusual because it was a temple rather than prime agricultural land or other commercial activity which the gully threathened.

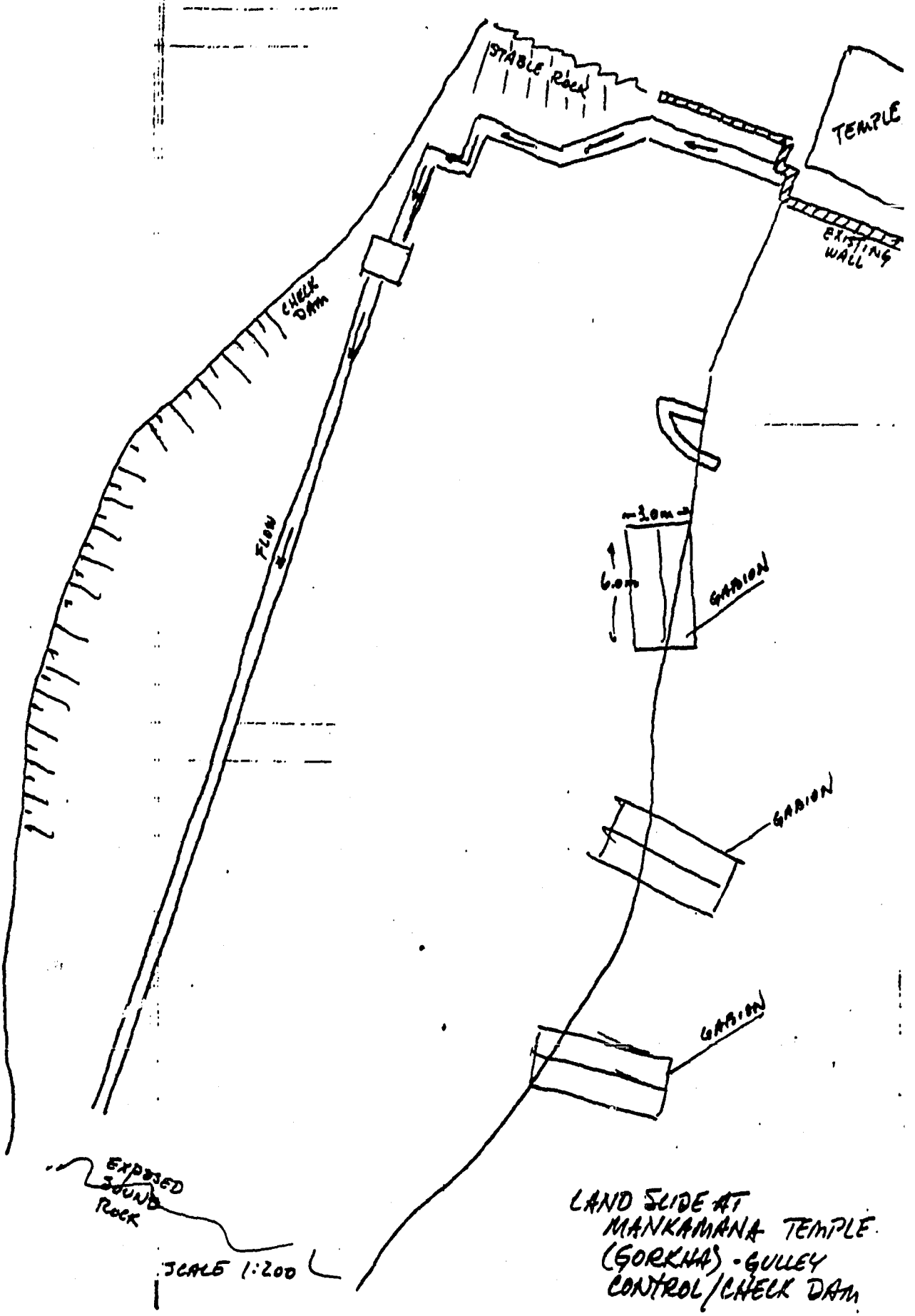
Figure II-2 is a duplicate of the engineers blueprint for check dams and gabion construction to control the landslide threatening Manakamana temple in Gorkha. It should be clear from this figure that the landslide is large relative to the temple and that it poses serious threat to the temple. Indeed, virtually any expansion of the landslide whatsoever to the upper right would threaten first the existing protective wall and then the temple itself. The slide is currently within one meter of the temple itself.

The benefits from this landslide control project are (1) protection of the temple, initially protection of the lower left corner of the temple but eventually the entire temple, (2) saving each years anticipated incremental erosion along both sides of the landslide and some along the current head of the landslide, (3) eventual recovery of some land within the gully's current boundaries, and (4) halting the landslide's contribution to downstream sediment deposition.

Temple protection is undoubtedly the most important benefit. Its value is also nye impossible to quantify. An engineer's rule of thumb has it that the landslide will eventually stablize at two times its current size, or at approximately four-tenths of a hectare in ten years. This means that landslide control saves the two-tenths of the hectare expansion from its current size from ever occurring. This land is packho or upland maize field which currently sells at approximately NR 30,000-60,000 per hectare in Gorkha which implies a protected land value of approximately NR 6,000-12,000. Recovery of the current two-tenths hectare slide would be slow and, therefore, of small discounted value. This discounted value would only be NR 600-1200, even if we can anticipate full recovery in the tenth year and full conversion of the land to packho at that time. Reversal of downstream sedimentation has smaller impact yet because, while the slide is visually impressive, its addition to the downstream sediment load is insignificant. Previous estimates used in the forestry chapter suggest NR 88 per hectare per year or, for this slide, the maximum range NR 18 currently up to NR 35 in the tenth of successive years in absence of landslide control. Even these downstream sedimentation values are only possible if the landslide is halted immediately and completely and there is absolutely no more sediment deposition originating from this slide area. The discounted value for immediately halting the sediment deposition is altogether less than NR 100. The summary gross discounted benefits are less than a generous NR 13,500 plus the important unmeasured benefits from protecting the temple.

The RCUP engineer's cost records show a bill of NR 451,383 for this project, a cost which only depreciates NR 7,700 when unskilled labor is shadow priced. Clearly the benefit-cost calculation argues that the social value temple protection must equal or exceed approximately NR 438,000 in order to justify this project. Just as clearly, decisions like the decision to protect this temple cannot be made on financial judgement alone. Rather the predominant decision criteria must have to do with local perceptions of the temple, local understanding of the alternate project outputs foregone when RCUP resources are spent on temple protection, and RCUP's own perception of the longer term benefits it gains from high

Figure II-2 : Landslide at Manakamana Temple



visibility local projects like this. It is quite reasonable to expect that a few well chosen projects like this may increase substantially RCUP's local creditability and, therefore, its ability to accomplish other resource management objectives.

The second gully control project is in Arthunge village panchayat only 100 meters upstream from Beni, the principle town of Myagdi. Figure II-3 replicates the engineering blueprints for this project. The purpose of this project is to slow the erosion caused by the generally smaller stream running down the gully and, thereby, to restrict potential for future erosion particularly along the left bank of the gully. The left bank is a proposed hospital site and, in absence of control, the gully would likely expand and eventually collapse hospital walls much as the Manakamana temple walls may erode.

The RCUPs engineers cost records show a bill of NR 219,917 for this project, a cost which depreciates NR 11,300 when adjusted for 1,417 days of unskilled off-peak labor. The net social cost is NR 208,617. Once more we anticipate sediment control, land recovery, and incremental erosion control benefits much as these benefits existed for the Manakamana temple project. These first two benefits were insignificant in the Manakamana temple project and we anticipate them to remain insignificant here. The incremental erosion value could easily be substantial, however, if the project succeeds in protecting the hospital site. If good khatland is worth NR 100-120,000 per hectare then it is not unreasonable to expect one hectare of commercial land only 100 meters from Beni to be worth double that, or enough to justify this project.

The final gully control project for which we have engineer's blueprints is also in Arthunge village panchayat outside of the town of Beni in Myagdi district. Its objectives are less spectacular in that they do not include protection of a large public institution like a temple or hospital. Its objectives are to protect prime agricultural land from further erosion along a 150 meter stretch of stream or gully and simultaneously to decrease downstream sediment deposition.

The engineering cost for this third gully control project were NR 189,000 or NR 180,300 after adjusting for the shadow wage of 1,218 underemployed unskilled man-days of labor. There are potential erosion control benefits on each side of the stream but even if these extended back for 33 meters on each side, beginning immediately and continuing into perpetuity, would they protect the equivalent of one permanent hectare of land worth NR 100-120,000? (The protected land value would be even less if the land were not all good khatland.) Adding NR 500 for the value of the discounted flow of downstream sediment avoided, changes the gross benefits very little. The net gain for the project as a whole is negative and the benefit-cost ratio is less than one.

After reviewing all three landscape and gully control projects we arrived at a fairly obvious set of conclusions. These are expensive projects. Their engineering and construction costs are large relative to many other single RCUP activities. They may well be justified, however, where something more is at

Figure II-3: Gulley Control: Myagdi Hospital

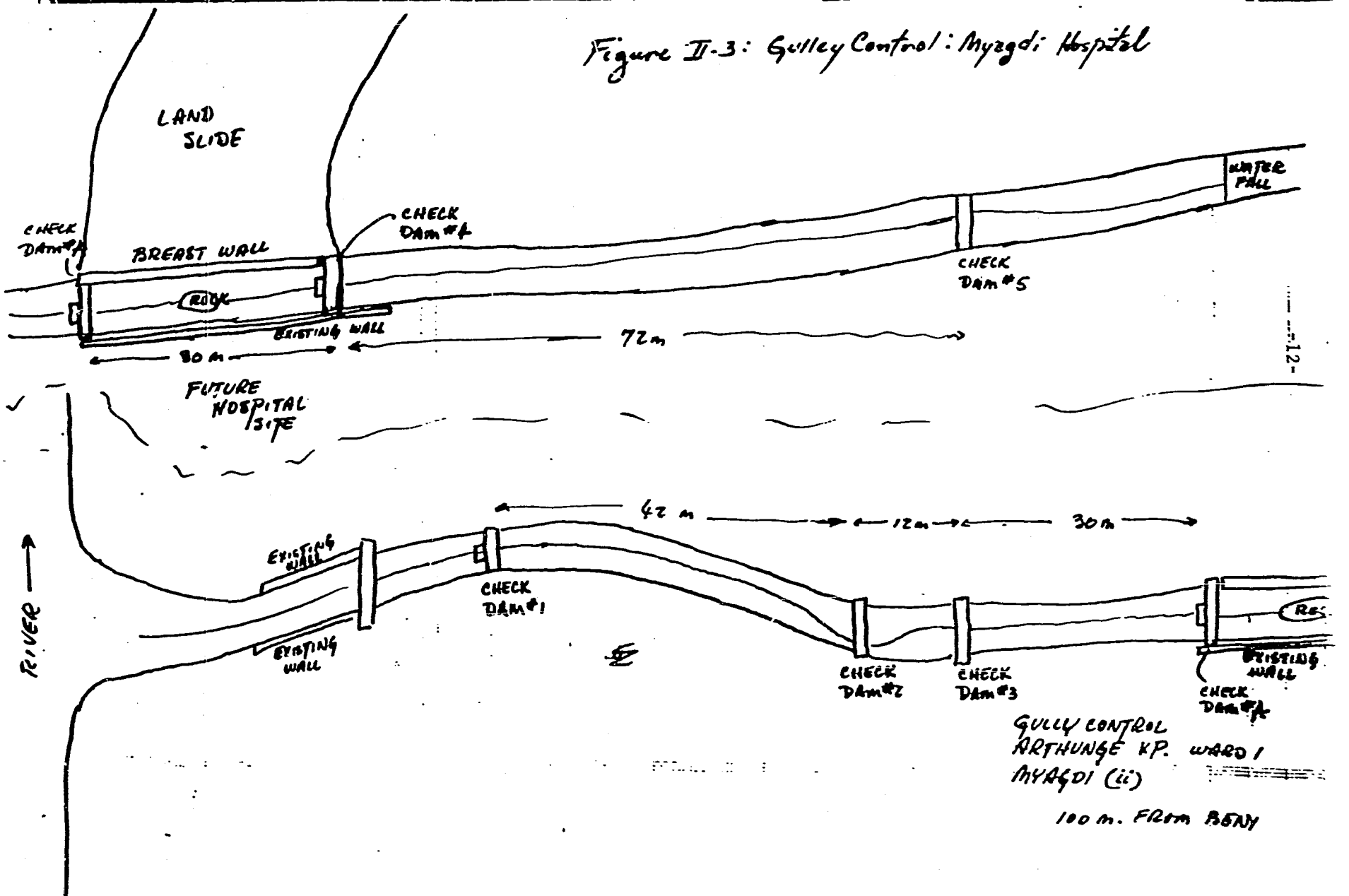
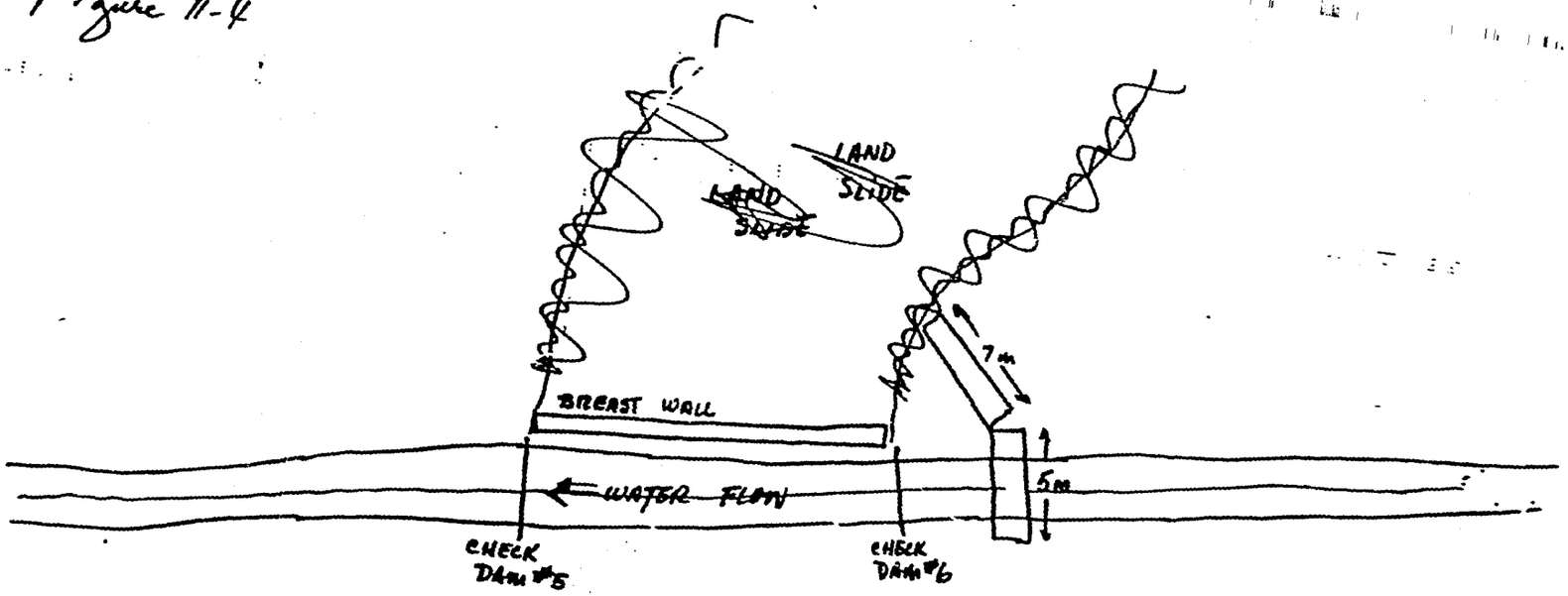
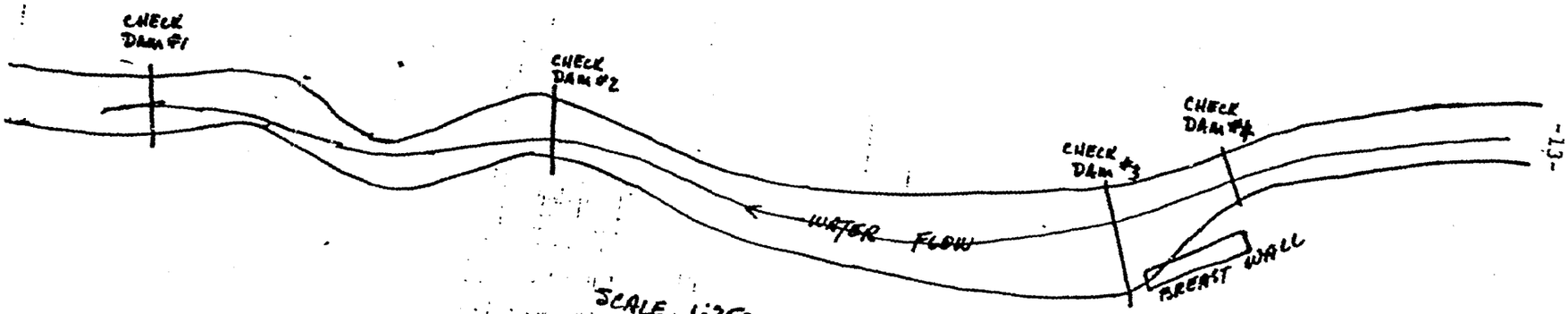


Figure 11-4





SCALE 1:250

GULLY CONTROL
ARTHUNGE V.P. UNIT 1
MYAGDI (i)

stake than erosion of adjacent agricultural land and avoidance of downstream sediment deposition. For example, in the second case gully control protects the anticipated new hospital and is easily justified on economic criteria. In the third case, focus on agricultural land only was insufficient to justify gully control on economic grounds. What this recommends for future targets is close attention to associating landslide and gully control projects with protection of lands occupied by large important institutions or other high profile resources of substantial value to the local population.

D. Terrace Improvement

Terrace improvement is the major RCUP watershed activity. Reflection on Table II-1 shows it to be the watershed activity which has received the earliest and greatest attention in the first five years of RCUP's program. The objective of terrace improvement is to repair deteriorating terraces, thereby halting their continued erosion. The production impact occurs both at the site of the improvement and downstream where there is a reduction in sediment deposition as a result of upstream control of the sediment source, the deteriorating terrace.

The RCUP terrace improvement effort concentrates on upland terraces because these are the least productive as well as the larger source of sediment. Upland terraces are less likely candidates for private repair because they are less fertile and have shallower soils than the less steep lowland terraces. Therefore,, landowners have less personal economic incentive to make the necessary repairs on upland terraces. Meanwhile, because they are steeper, upland terraces are a larger source of off- site sedimentation than are lowland terraces. Therefore, upland terraces are a greater source of external production losses imposed on downstream landowners. The public nature of downstream benefits from terrace improvement plus the large demonstration effect potentially associated with a few well placed projects justifies RCUP's activity. The private gains to upland landowners which also are associated with the RCUP's effort also suggest, however, some private stake in the activity. Together, they explain the 70-30 cost sharing arrangement which currently exists between RCUP and the upland landowner, respectively.

The technology involved in terrace improvement is quite simple, and therein lies an additional attraction to it. Unskilled laborers are hired during the off peak agricultural season to excavate the upper half of the deteriorating terraces. The excavated soil is then used to fill out the lower half of the same terrace. The technology is neat, simple and tidy. It is also hard work.

The costs of this terrace improvement are the costs of hiring laborers to do the excavating plus the opportunity cost of foregoing production of one of two annual crops while the terrace improvement activity is going on. Benefits can be measured either in the form of increased land values subsequent to the improvement or in the form of a combination of increased crop output and decreased agricultural labor input necessary to work the terraces for future crops. Reduction in downstream sediment deposition is the second important benefit.

The remainder of this discussion turns, first, to the selection process by which certain farmers are chosen to receive RCUP terrace improvement assistance and then, to the explicit measure of these benefits and costs. We first examine

TABLE II-2

SOIL WORKING (EXCAVATION) COST OF TERRACE IMPROVEMENT IN RCUP, GORKHA

(This is reproduced from Measurement Book No. 15 of RCUP (CCO) Gorkha)

Case No. I. Name of the project: Terrace Improvement
Location: Tara Nagar V.P., ward no. 6, Charkune Gairo; Gorkha
Farmer's name: Krishna Bahadur Addhikari
Working agency: Land owner
Date of Agreement: 2040-10-6 (1983 February)
Date of Work Completion: 2040-11-15 (1984 March)
Date of Measurement: 2040-11-18 (1984 March)
Description of Work: Earthwork excavation in gravel mixed soil for making levelled terrace in Scope of Bars land

S. No.	No	L (M)	B (M)	H (M)	Content (M^3)	Area (Sq. M)
1	1	20.0	3.3	0.50	33.00	66
2	1	30.0	3.0	0.45	40.50	90
3	1	31.0	5.0	0.70	108.50	155
4	1	44.0	2.0	0.60	52.80	88
5	1	45.0	4.5	0.83	168.07	202.5
6	1	33.0	3.5	0.58	66.99	115.5
7	1	60.0	5.0	0.90	270.00	300
8	1	30.0	5.25	1.05	165.37	157.5
9	1	24.0	3.80	0.95	86.64	91.2
10	1	30.0	3.0	0.70	63.00	90
11	1	30.0	4.0	1.10	132.00	120.6
12	1	38.0	2.70	0.80	84.08	102
13	1	33.5	3.25	1.20	130.64	108.9
14	1	33.0	3.25	1.10	117.97	107.2
15	1	32.0	3.40	0.70	76.16	108.8
16	1	31.0	4.0	0.65	80.60	124.0
					1674.32	2027.2
						=4.05 (Rupanis)

Total volume of Excavation = 1674.32 x 1/2 x 1/2 x 1/2
= 1674.32/8
= 209.29 M^3

Rate per M^3 for gravel mixed soil excavation = NR 13.20

Total cost = Total volume x Rate per M^3
= 209.29 x 13.2
= NR 2672.63

70% cost of the total cost is to be borne out by the project = NR 1933.84

30% cost of the total cost is to be borne out by the land owner NR 828.74

Checked by _____ Date _____
Supervised by _____ Date _____
Paid by _____ Date _____
Signature of the land owner:
_____ Date _____
Approved by Mohal Wagley Date _____

benefits and costs from the perspective of two farmers from Gorkha who have received RCUP assistance, and then turn to generalized cases for Gorkha-Myagdi and Mustang. We discuss the generalized cases from the broader social perspective of benefits and costs. We close with some summary observations.

D.1 Selection of Panchayats and Farmers

An invitation to participate in the terrace improvement program is sent to select village panchayats in November. Ten of 32 village panchayats in Gorkha received such notice in the 1983-84 fiscal year. It is clear, however, that selection is the choice of the CCO. It is also clear that the CCO's alternate their choices from year to year such that all village panchayats eventually have a chance to participate in the terrace improvement program. In each village panchayat the pradham pancha and ward chairman receive the invitation to participate and they transmit this information to individual farmers. They obtain applications for RCUP terrace improvement assistance from the individual farmers and forward these to the CCOs within 30 days after their own original notification. The applications include information about the areas and boundaries of the land to be improved, certification of ownership, a copy of the land revenue payment receipts (taxes), and identity of land use and crop patterns on this land both before and after the terrace improvement.

Many more farmers apply for the terrace improvement program than the program has finances to assist. For example, in Manakamana village panchayat five farmers were chosen for participation in 1983-84 out of 150 who applied. The criteria for choice among farmers restrict assistance to currently cultivated land of slope between 15 and 50%.

After the farmer has been selected, sometime in the third week in December, an agriculture or forestry technician or surveyor measures all the terraces to be improved, calculates the volume of soil to be excavated and the area for improvement, and draws up a document for the signatures of the farmer and the CCO. Table II-2 is an example. The conditions of the agreement, are that the farmer finish the terrace improvement work within 30 days and that he pay 30% of the total costs. The cost calculation formula itself multiplies the district legal minimum wage rate times the number of man-days required per cubic meter of soil excavated (0.88) times the total volume of soil to be excavated.

Finally, the farmer reports the completed terrace improvement work in approximately the fourth week of February. He reports to the CCO who in turns sends a technician to check on the finished activity before the farmer receives payment from the RCUP in approximately the first week of March.

F. Two Examples: Farmers In Gorkha

We visited two Gorkha farmers who received RCUP assistance for improving their terraces in 1983-84. Mr. Krishna Bahadur Addhikari has a total of nine-tenths of a hectare of upland maize field (bari). He works as a puen in a nearby veterinary clinic and his family works the fields. Last year he improved terraces on 4 ropani (0.2 hectares) with RCUP assistance. Mr. Addhikari contracted the

terrace improvement with a local villager for NR 3,000. He eventually received NR 1,938 (65%) from RCUP and bore the remaining costs himself. We inquired what the benefits were to Mr. Addhikari and he supplied the following information:

The somewhat higher than average land values supplied by Mr. Addikari may be attributed to his land's proximity to the Mugling-Gorkha metot road. Appendix A reports the soil excavation in cost sharing details.

Mr. Mitra Lal Lamichane owns .5 hectare about 150 meters uphill from the Mugling-Gorkha metot road. His family of five can subsist for six months each year from this land. (They supplement their farming with work in the village.) Last year Mr. Lamichane's 2.96 ropani of upland maize field received terrace improvement assistance. The total cost of soil excavation and leveling the terraces amounted to NR 2,092, out of which NR 1,464 (69%) was contributed by RCUP, and the remaining NR 628 by Mr. Lamichane himself. Appendix B reproduces the details of the soil excavation and cost sharing. We requested Mr. Lamichane to compare the benefits to him before and after the terrace improvement. He gave the following details:

III. APPROPRIATE TECHNOLOGY/ENERGY COMPONENT[1/]

A. Introduction

The original plan for this component included a diverse collection of appropriate technology and energy activities. The "Energy Development Sub-Project Implementation Plan"[2/] contained targets for wooden bridges, solar kilns, hydram pumps, haybox cookers, ropeways, beehives, peddle threshers, improved water mills (water powered grindstones), a multi-purpose impoundment, toilets, and windmills as well as improved stoves (chulos), solar water heaters, solar crop dryers, mini-hydro plants, and bio-gas plants. Implementation of the project has diverged significantly from the Plan, the emphasis having been placed on five kinds of energy technologies: improved stoves, solar water heaters, solar crop dryers, improved water mills, and a bio-gas plant. Feasibility studies have been completed for three mini-hydro installations, but none have been constructed.

This analysis concentrates on the five energy technologies which have actually been installed. A summary of the feasibility studies on mini-hydro units is also provided, since they have absorbed a large fraction (80%) of RCUP resources allocated to the energy component, and since three mini-hydro units will be installed beginning in FY 84/85.

An overview of physical activity targets and completions is presented in the next section. Following the overview are case studies and estimates of benefits and costs for each of the five energy technologies. The final section, Conclusions and Policy Recommendations, presents suggestions for adjusting targets during the period 1985-88.

B. Physical Activity Targets and Completions

Presented in Table III-1 is a comparison of the original four-year targets versus actual completions for the five technologies being analyzed. Targets for FY 84/85 are also presented. It is clear from Table III-1 that improved chulos represent the major success of RCUP. In fact, the actual completions through July 1984 represent 323% of the original targets for improved chulos. Across Districts, the main effort has been expended in Gorkha (499% completions vs. targets) and only in Mustang (84% completions vs. targets) were the original targets not exceeded. Further, the rate of completions has accelerated: 59% of the total occurred during FY 83/84.

Solar water heaters are characterized by inability to achieve the original targets in all three Districts. Actual completions by July 1984 represent 33% of

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1/ This study was done by Edward Vickery and Jennifer Wood. We are grateful to John Ashworth, Andreas Bachman, Gabriel Campbell, and Daniel Jantzen for excellent critiques of preliminary results. A list of references is presented in Appendix 1.

2/ Alton Byers, "Energy Development Sub-Project Implementation Plan", September 1981. See pages v-vi for a summary of the original targets.

TABLE III-1

ENERGY COMPONENT: SUMMARY OF PHYSICAL ACTIVITY
TARGETS AND COMPLETIONS, FY 81/82 THROUGH FY 84/85

	ORIGINAL TARGETS, FY 80/81-FY 84/85	ACTUAL COMPLETIONS BY HMG FY					TARGETS, FY 84/85
		80/81	81/82	82/83	83/84	TOTAL	
A. Improved Stoves							
1. Gorkha	95	-	140	74	130	344	300
2. Myagdi	51	-	7	20	68	95	74
3. Mustang	44	-	7	3	9	19	26
TOTAL	190	-	154	97	207	458	400
B. Solar Water Heaters							
1. Gorkha	9	-	2	2	1	5	
2. Myagdi	15	-	2	4	2	8	
3. Mustang	14	-	1	4	1	6	
TOTAL	38	-	5	10	4	19	4
C. Solar Crop Dryers							
1. Gorkha	4	-	-	2	-	2	
2. Myagdi	6	-	1	2	-	3	
3. Mustang	6	-	1	9	6	16	
TOTAL	16	-	2	13	6	21	6
D. Improved Water Mills							
1. Gorkha	2	-	-	1	-	1	
2. Myagdi	2	-	-	-	-	-	
3. Mustang	1	-	-	-	1	1	
TOTAL	5	-	-	1	1	2	2
E. Bio-gas Plants							
1. Gorkha	5	-	1	-	-	1	
2. Myagdi	4	-	-	-	-	-	
3. Mustang	1	-	-	-	-	-	
TOTAL	10	-	1	-	-	1	-
F. Mini-Hydro Plant Feasibility Study							
1. Gorkha	1	-	-	-	-	1	
2. Myagdi	1	-	-	-	-	1	
3. Mustang	1	-	-	-	-	1	
TOTAL	3	-	-	-	-	3	-

Sources: Targets are from "Energy Development Sub-Project Implementation Plan," pp. 2 and 10; completions are from reports by the RCUP Energy Specialist.

targets in Gorkha, 47% in Myagdi, and 43% in Mustang. The rate of completions has declined recently, with only one-fourth of the total having been completed in FY 83/84.

Solar crop dryers show total completions at 131% of the original targets by July 1984. However, this composite outcome includes only 50% of the original targets in Gorkha and Myagdi. In Mustang, by contrast, actual completions are equivalent to 267% of targets. Similar to the experience with solar water heaters, the pace of installing solar crop dryers slackened considerably in FY 83/84. Less than half of the FY 82/83 level of completions was attained in FY 83/84, and all of those were in Mustang.

Improved water mills have total completions at just 40% of the original targets by July 1984. That total includes attaining 100% of the target for Mustang, 50% for Gorkha, and zero for Myagdi.

Bio-gas plants display the most striking discrepancy between targets and completions. Only one plant has been installed (in Gorkha) compared to ten which were targeted.

The three feasibility studies which were targeted for mini-hydro plants were completed on schedule. Installation of these plants is planned for FY 84/85 and FY 85/86.

A final observation is that the greatest activity for field work occurs during April-July. Not only is the weather more cooperative (pre-monsoon), but also the HMG budgetary procedures typically release more funds during the last quarter of a fiscal year. Consequently, benefits claimed during the year of installation, e.g. an improved stove, should only be about 25% of annual totals claimed thereafter.

The benefits and costs associated with these physical activities are quantified in the next five sections. First to be analyzed are improved stoves. Since work in Gorkha has dominated activities, it is appropriate that the analysis should begin with a case study about Chhoprak Panchayat, Gorkha District.

C. Improved Stoves

1. A Case Study: Improved Stoves in Chhoprak Panchayat, Gorkha District

a) Conducting An Energy Needs Assessment

During February-July 1982, only a few months after the original targets were specified in the "Energy Development Sub-Project Implementation Plan", an action research project was initiated in Chhoprak Panchayat.1/ The objective of this effort was to involve local people

1/ A description of this research is provided in the paper by Deepak Bajracharya, "Organizing for Energy Needs Assessment and Innovation: Action Research in Nepal", January 1983.

in identifying those energy technologies which seemed most appropriate, planning for implementation, and decision-making for the sharing of benefits.

Discussions and public meetings with local people led to different perceptions of priority energy needs. The Kumhal and Gurung communities identified their own needs for a water mill.[1/] Representatives of the remainder of the communities -- a heterogeneous group of different castes and ethnic groups such as Brahmins, Chketris, Newars, Kamis, Sarkis, and Damais -- in a public meeting chose smokeless chulos and peddle threshers for paddy as their highest priorities. Initially the Pradhan Pancha (elected chairman of Chhoprak Panchayat) attempted to impose his judgement that an improved water mill would be most appropriate. He was, however, overruled at the public meeting held to make the final choices. According to Bajracharya's report, their interest in smokeless chulos had been stimulated by his having installed five demonstration units earlier in the fiscal year.

Planning for implementation focused on the resolution of three questions about the new stoves: (1) What should be done about the chimneys? (2) Who would make the stoves? and (3) What would be the local contributions?

Regarding questions (1) and (2), experiments were carried out to have both the chimneys and the stove inserts made in Chhoprak. A group of potters from the Kathmandu Valley, who regularly spent their winters in Chhoprak, expressed interest in producing the chimneys. They actually made about 140 sets. Similarly, the manufacture of stove inserts locally was attempted by training several artisans. After the new road to Gorkha was opened, local manufacturing was discontinued in favor of transporting prefabricated chimneys and stove inserts from Kathmandu via lorry.

Question (3) was resolved by having the RCU Project pay for the cost of the stove inserts and chimneys, transportation to the District Center (Gorkha), and the wages of skilled personnel required to install the stove inserts and chimneys. The recipient household agreed to absorb the time and money costs of transporting (about a two-hour trek each way) the stoves and chimneys from District Center to the household. In addition the households agreed to provide bricks (about twenty) for building a frame around the ceramic stove insert, clay, water, and someone to assist the stove installer. Obviously this division of resource costs offers a large subsidy to the recipient households.

b) Organizing to Obtain and Install Improved Stoves

The RCUP has hired a full-time Energy Specialist (Mr. Gyani Shakya) who supervises implementation of the entire energy program in all three

1/ See Section F of this report for an analysis of this innovation.

Districts -- Gorkha, Myagdi, and Mustang. In Gorkha, as in each of the other districts, a full-time Energy Technician (Mr. Hira Man Shresta) and a full-time Stove Technician (Mr. Dina Nath Koirala) have also been hired. The Energy Specialist is responsible for arranging for the purchase of stoves and chimneys in Kathmandu, then having them transported to the District Center in Gorkha. He also supervises decisions with respect to choosing those households which are to receive the improved stoves, and he oversees the work of the Energy Technician and the Stove Technician regarding installation of the stoves and dissemination of operating and maintenance instructions.

The choice of which type of stove to purchase was based on advice from the Stove Improvement Unit of the World Bank's Community Forestry Project. The so-called Magan design[1/] was selected since it was smokeless, inexpensive, manufactured in Kathmandu from local clay, and corresponded closely with the traditional cooking facilities in rural Nepalese houses. The Magan design had also been thoroughly field tested by 1982, when the distribution of stoves was initiated by RCUP in Chhoprak Panchayat.

Illustrations of the Magan stove design, as well as several alternatives, are presented in Appendix 2. The design with two cooking holes is traditional for Nepalese mud chulos, but the chimney represents an innovation. The addition of the chimney achieves a smokeless environment in the house, but one consequence is a slower rate of cooking. The cost of the chimney represents about two thirds of the total Rs. 80 cost of the complete stove assembly prefabricated in Kathmandu. The decision to promote the adoption and use of stoves with chimneys, therefore, implicitly allocates more importance to health benefits than to increased fuel efficiency.

After the prefabricated stove assemblies are purchased and ready to be sent to the field, HMG staff from DSCWM arrange for transportation via lorry to Gorkha, the District Center. When the stove assemblies arrive in Gorkha, they are unloaded and stored at one of the HMG District offices. The Energy Technician for Gorkha is responsible for storage of these assemblies until someone from a household designated to receive one arrives to carry the stove assembly to the installation site.

The process of selecting which households will receive the improved stoves is controlled by the Energy Specialist. He develops and maintains a list of potential recipient households through a series of discussions with local leaders. Impressions that the Gorkha Energy Technician and the Gorkha Stove Technician obtain from their fieldwork are also important in determining which households will be approved as recipients.

1/ One source of additional information about this design is the paper by T. Kalluppati, "Magan Chulo", 1955.

When a household has been approved, a member of that household comes to collect the stove assembly and transport it to the place of installation. Eventually, the Stove Technician goes to the household and, assisted by some household member, installs the stove insert and chimney. The Energy Technician oversees the stove installation and provides some instructions to household members on how to operate the improved stoves. For the initial three years of the stove program, there were no pamphlets of written instructions. Beginning in FY 83/84, copies of a pamphlet entitled "New Nepali Cooking Stoves" (see Appendix 2) prepared by UNICEF and ADB/N were obtained and distributed by RCUP.1/ No other follow-up or extension work is provided systematically, but a few adult education meetings have been held in Gorkha to promote greater understanding about proper operating techniques and maintenance procedures.

In Chhoprak Panchayat, household members were asked reasons for their desire to have an improved stove. According to Bajracharya's report (p. 41), the aspects dealing with smokelessness (71% of respondants) and fuelwood savings (62%) were mentioned most. Other reasons given were "because others had it" (38% of respondants), "anticipated ease and comfort in the cooking process" (20%), and "because it was new" and "it might have potential benefits (13%). Only 9% were reported as interested "because the government is giving it for free."

c) Evaluating Stove Use

Bajracharya's study also includes perceived benefits and complaints of stove users after installation. Perceived benefits were "no smoke" (71% of respondants), "fuelwood definitely saved" (54%), "fuelwood maybe saved" (37%), "easy and convenient" (25%), "cooks fast" (21%), and "easy to wash pots and pans" (8%). Complaints included "cooks slow" (50% of respondants), "afraid that thatched roof might catch fire" (26%), "fire doesn't burn well" (14%), and "fuelwood not saved" (9%).

Investigation of the "cooks slow" complaint revealed the need for instruction on how to cook efficiently using the new design. Traditional chulos supply equally intense flames to both cooking holes. In smokeless chulos only one cooking hole receives direct flame; heat for the other is provided by hot gases moving along the flue toward the chimney. Thus, the second cooking hole is not as hot and cooks slower. However, if the pots were interchanged periodically, the slow cooking problem could be overcome. Slow cooking was also caused by some users pushing the firewood too far into the stove, thereby causing an inadequate air supply.

1/ Although an English language version of this pamphlet is included in Appendix 2, a Nepali version was the one actually distributed in the three Districts affected by RCUP.

Concern about the roof catching fire was caused to a large extent by a failure of the stove technician to seal the chimney joints. As a result the hot exhaust flame ate away at a wooden beam against which the chimney was resting. The beam was starting to smoke and catch on fire when the household head detected the problem. A considerable amount of convincing (via assorted demonstrations) was required to calm users' fears about the potential fire hazard of the improved stoves.

A follow-up study by Karen Roesing[1/] in December 1982 and February 1983 also conducted a survey in Chhoprak Panchayat of 60 households which had received improved stoves. Households using the new stoves to some extent represented just 58% of the sample; 42% were not using the new stoves. Nearly 72% reported having and using an agena,[2/] especially in preparing feed for animals, distilling alcohol, making tea or snacks, and keeping warm during the cold season.

Users' perceptions were that the new stoves required a longer time to cook meals (63% of respondants), but they resulted in the same or greater convenience (68%) and yielded fuel savings (50%) compared to the traditional chulo. Most respondants also answered that adequate light and heat were produced by the new stoves. Poor promotion and extension effectiveness was a complaint of 65% of the respondants.

Only 30% of the households surveyed had stoves which did not require repairs of some type. Nearly two thirds of the new stoves exhibited breaks or cracks. However, most of these damaged chulos were still functioning effectively.

All interviewees responded positively towards the smokelessness of the new stoves. Some individuals acknowledged the beneficial health impact of less smoke. Several interviewees remarked that their houses stayed cleaner since they began using the smokeless chulos. However, many of the households sampled had never, or only infrequently, cleaned their chimneys.

d) Implications for Benefit-Cost Analyses

The observations from Bajracharya's and Roesing's studies suggest several paths for investigation through benefit-cost analysis:

(1) Alternative Pricing Policies -- Since the chimney comprises about two thirds of the total cost of purchasing a stove assembly, the households receiving smokeless chulos should probably be required to absorb a large fraction of the cost for the

1/ See Karen Roesing, "Early Progress of the New Stove Program in Gorkha: Report to the RCUP", unpublished paper, December 1983.

2/ An agena is a tripod constructed of metal upon which a single pot is placed over an open fire.

chimney. The rationale is that the household members capture almost all of the benefits produced by chimneys, i.e., improved health. Although the household captures all fuelwood savings, it shares many other benefits (less soil erosion, less time for gathering fuelwood, increased fodder) from decreased fuelwood consumption with society as a whole. Sound public finance theory would suggest, therefore, that Nepalese households should receive significant subsidies for accepting and using the improved stove inserts, but much smaller subsidies should be given for chimneys.[1/]

(2) A Stove Extension and Repair Program -- The high incidence of cracks and breaks in the improved stoves, as well as the significant fraction of those installed which are not being used frequently, suggest that the introduction of a systematic program of repair and instruction in proper maintenance and operation might yield an impressive flow of net benefits. A repair program will probably be a cost effective alternative to installing a new stove. Such a program promises to extend considerably the economic life of the new stoves, which currently is estimated to average approximately five years.[2/]

(3) Manufacture of Stove Assemblies in Rural Areas -- In the early days of the stove program in Gorkha, local artisans were trained to manufacture stove inserts and chimneys. This approach was discontinued in Gorkha but is being utilized in Myagdi.[3/] Further analysis might reveal net benefits from either expanding production in Myagdi to supply all districts from that source, or manufacturing improved stoves in Gorkha and Mustang as well as Myagdi.

(4) Test Additional Designs -- Household complaints about various aspects of the Magan stove and its chimney suggest that additional experimentation is required with respect to design. Incremental benefits and costs should be estimated for alternative designs such as iron ring stoves and improved access to chimneys for cleaning.

2. Benefit-Cost Analysis of Improved Stoves Program

a) Description of Installations in Each District

The distribution of improved stoves within Gorkha District has concentrated on Chhoprak and Gorakhkali Panchayats. In Myagdi District the

1/ A caveat, of course, is that households might not want to switch to using improved stoves unless they can receive the smokeless benefits produced by chimneys.

2/ See Campbell and Bhattarai (1983), p. V-17.

3/ This experience is discussed in Section b(1).

Program began in Beni, but more recently the area near Arghunge has been emphasized. With respect to Mustang District, the program began in Muktinath, but more recently has concentrated on Jomsom, Lete, and Marpha.

Compared to Gorkha, the special problem presented by Myagdi is high transportation cost. The cost is Rs. 44 to transport a prefabricated stove assembly from Kathmandu to Pokhara; an additional Rs. 200 is required to move it on up to Myagdi. The stove inserts and chimneys could be manufactured in Phanga Panchayat (Parba District) for Rs. 100 (versus Rs. 80 in Kathmandu), but the transportation cost from Phanga Panchayat to Myagdi is only Rs. 80. If the quality of Phanga Panchayat stove assemblies can be maintained at an acceptable level, they will clearly be a cost-effective substitute for purchasing them in Kathmandu. Further, breakage loss will almost certainly be reduced. The FY 83/84 target for Myagdi was not met because the first shipment of 37 chulos arrived broken.

In Mustang the type of improved stove distributed in Gorkha has proved unsatisfactory, since it gives off little heat. Consequently, all the stoves installed during FY 83/84 were iron-ring chulos with chimneys. The iron-ring chulo has been given priority in Mustang because, in addition to cooking, it radiates more heat than the standard Magan design. Essentially, the iron-ring chulo is a traditional mud chulo with concentric iron rings inserted over the cooking holes. By varying the number of rings the size of the cooking hole can be made larger or smaller, thereby providing a tighter fit for pots. This ability to provide a tighter fit means that the fuel efficiency of the iron-ring chulo with chimney is about the same as the Magan design. A six-ring set costs Rs. 360 in Kathmandu, and Rs. 160 is the average cost of transporting it from Pokhara up to Mustang. This level of cost means that the investment required in Mustang (Rs. 520 for iron rings plus the cost of constructing a mud chulo and the chimney) is much higher than that required for Gorkha (Rs. 80 for the stove and chimney in Kathmandu plus Rs. 28 for transportation to Gorkha) to achieve roughly the same reduction in fuelwood consumption.

As is evident from this discussion of differences in transportation costs and environmental characteristics, the chosen solutions for stove design and even location of the manufacturing facility have varied across districts. The extent to which these choices have been efficient ones will be revealed by the comparison of estimated benefits and costs.

b) Costs

Four categories of costs will be estimated and analyzed: production of the stove assemblies; transportation, first to the District Centers, then onward to the recipient households; installation; and administration/extension.

(1) Production of the Stove Assemblies

A different solution has evolved in each District, as discussed in Section C.2.a. The improved stoves being promoted in Gorkha are purchased as a prefabricated unit in Kathmandu. A negligible amount of foreign exchange is involved in the manufacturing process.[1/] Local clay is the main raw material, local potters provide the skilled labor, and fuelwood is used to fire the kilns. Only transportation of the clay, representing about 2% of total cost, contains any imported inputs. Currently, the retail price of the complete stove assembly, including chimney, is Rs. 80, and the wholesale price is Rs. 48.

Since the stoves being distributed in Myagdi are now being made nearby, they would have essentially zero foreign exchange component in their manufacturing process. Prior to local manufacture, prefabricated stove assemblies were carried in from Kathmandu. Production cost (or wholesale price) near Myagdi is Rs. 100 per stove assembly,[2/] but of course transportation savings more than make up for the higher production cost compared to Kathmandu.

Mustang District depended on stoves brought from Kathmandu up until FY 83/84. Then the switch was made to promoting iron-rings. The iron-rings are manufactured in Kathmandu at a retail price of Rs. 360 per six-ring set. Approximately one-third[3/] of the total manufacturing cost is comprised of foreign exchange cost, since the iron must be imported.

The quantification of production costs is presented in Appendix 3. These costs are shown to be incurred for the fiscal year in which the installation was completed.

(2) Transportation to District Centers and Households[4/]

Lorry transport of stove assemblies from Kathmandu to Gorkha costs Rs. 856 for an average load of thirty stove assembles, or Rs. 29 each, which is paid for by RCUP. Of that total, approximately 63% or Rs. 18 represents foreign exchange operating costs of the lorry, the remainder being the driver's wages. Porterage costs of moving the stove assembly to the recipient household is borne by that household.

1/ See Community Forestry Development Project, Field Document No. 10, "Introduction of Improved Stoves for Domestic Cooking in Nepal," (July 1984), Chapter I, page 25, for a summary of production cost components.

2/ This price is based on testimony by the RCUP Energy Technician stationed in Myagdi District.

3/ Based on testimony of the RCUP Energy Specialist.

4/ The cost estimates in this section are based on RCUP records kept by the Energy Specialist.

Lorry transport of stove assemblies from Kathmandu to Pokhara (the staging point for porterage to Myagdi and Mustang) costs Rs. 1,329 for an average load of thirty stove assemblies, or Rs. 44 each. Of that total, approximately 61% or Rs. 27 represents foreign exchange operating costs of the lorry, the remainder being the driver's wages. An additional Rs. 200 per stove is the cost of porterage from Pokhara to Beni, the District Center of Myagdi. However, if the stove assemblies are manufactured in nearby Parba District, porterage cost is reduced to Rs. 80 per unit.

Iron rings for Mustang must be transported by lorry from Kathmandu to Pokhara. The average cost per six-ring set is Rs. 2, of which about 60% represents operating costs of the lorry. Porterage costs, Pokhara to Jomson, are an additional Rs. 160 per set.

The foreign exchange component, therefore, is a small fraction (11% for Kathmandu/Myagdi, less than 1% for Kathmandu, and zero for Parba District/Myagdi) of average transportation cost except for the Kathmandu/Gorkha trip (63%). Conversely, the unskilled labor component for porterage service is high (100% for Parba District/Myagdi, 99% for Kathmandu/Jomson, and 82% for Kathmandu/Myagdi). It is important analytically to estimate the fractions of total costs which are foreign exchange and unskilled labor components since, typically, each will have a social opportunity cost which is different from its market price. This point will be considered further in the analysis section.

From District Centers to the stove installation site, the recipient households provide self-help porterage to transport the stove assemblies. Since the timing of this activity is decided by the household, the logical assumption is that the self-help porterage occurs at an off-peak time with respect to household labor requirements. Thus, the social opportunity cost of this activity is probably zero.

(3) Installation in the Household

As indicated in the case study of Section C.1.a, the costs of installing the stove assembly is shared between RCUP and the recipient household. The labor input of the stove technician from RCUP is paid by the project. He actually performs the skilled labor of installing the stove insert and chimney (or the iron rings in the case of Mustang). The household members are consulted in determining the location of the new stove, and one household member assists the stove technician during installation. The raw materials required for constructing the brick frame for the stove (clay, water, about twenty bricks) are provided by the household. As with self-help porterage, it is assumed that the social opportunity costs of these household inputs are zero, except for the bricks.

(4) Administration/Extension

Again, the case study discussion describes the labor inputs of the RCUP Energy Specialist and Energy Technician, the costs of which are paid by the project. Essentially all efforts of the individuals have been concentrated on promoting the adoption and use of the new stoves. Only insignificant efforts have been expended on extension activities in the areas of stove and chimney maintenance and repair.

(5) Other Potential Costs

Various other cost categories are alleged to accompany the use of the improved stoves. One hypothesis is that the reduction in smoke causes an increase of termite infestation in beams and other construction materials made from wood. One counter claim is that termites only damage green wood; dried wood or wood in older houses should not be affected.[1/] Others assert that sufficient smoke is released during the colder months, when an open fire is used for warmth, to keep termites away even if the smokeless chulos are adopted. It seems, therefore, that insufficient evidence exists to claim that an increase in house maintenance costs will follow a decision to install and use a smokeless chulo.

Increased labor for wood splitting is another hypothesis. The improved chulos require smaller pieces of wood, so more time will be required to reduce large pieces to the appropriate size. A counter argument is that this potential increase in wood splitting effort is probably more than offset by the one-third or more savings in fuelwood consumption which results in decreased demand for splitting wood.

Finally, increased cooking time of the new stoves is alleged to require more labor by the women of the household. This argument can be rejected easily, since many other activities can be undertaken during the longer time the food is cooking.

None of these potential cost categories appear to have sufficient empirical evidence to support their inclusion as legitimate incremental costs. As a result, this analysis will be concerned only with the four major cost categories described above.

c) Benefits

There are two main categories of benefits generated by the improved stoves: decreased consumption of fuelwood and decreased smoke inhalation and irritation. The former is more easily measured than the latter. Yet the smokeless characteristic of the improved stoves is more frequently cited by households as a benefit.

1/ See Roesing (1983), p. 6.

(1) Decreased Consumption of Fuelwood

The most recent and most authoritative estimates of savings in fuelwood consumption are contained in the July 1984 report of the World Bank's Community Forestry Development Project (CFDP).1/ That project is promoting and installing a stove design similar to the improved stove being distributed by RCUP. Its fuelwood savings estimates, because of this technical similarity, would seem to be applicable to the households using new stoves distributed by RCUP.

The CFDP report2/ estimates that fuelwood savings per installed new stove range from 462 to 1,088 kg annually. The mean savings estimate is 735 kg per year per installed stove. This average includes households which do not use the new stoves at all as well as those which use them exclusively. The incidence of households which do not use the new stoves at all is 30%.

The fuelwood savings estimate in the July 1984 report is 20% higher than the average savings of 609 kg per household per year reported by CFDP one year earlier. No explanation is offered in this year's report regarding the increased savings. This discrepancy suggests that our estimates of net benefits should be tested for their sensitivity to large differences in estimated fuelwood savings.

Within the RCUP geographic area, Roesing's3/ survey reports fuelwood savings percentages which are roughly the same as the 30% recorded by the CFDP report. Roesing's 1983 survey also estimates average fuelwood savings at 589 kg per household per year. This estimate is only 3% below that reported by CFDP for 1983. The difference, 1984 vs. 1983, could reflect movement along a learning curve, but there is always the alternative explanation of errors in measurement or sampling.

No estimates have been made of the fuel efficiency of iron-ring stoves. The testimony of users in the Mustang District is that the iron rings generate the same quantity of fuelwood savings as Magan stoves due to the tighter fit around cooking pots. Studies need to be carried out to test this assertion.

Regarding the economic value of fuelwood savings, the study by Campbell and Bhattarai (1983) reports an average market value of Rs. 11.25/Bhari (25 kg = 1 Bhari).4/ That estimate would apply to Gorkha District. RCUP field checks in 1984 confirmed the validity of that valuation.

1/ See Community Forestry Development Project, Field Document No. 10, op. cit., Chapter IV, p. 65.
2/ Ibid.
3/ See Roesing (1983), p. 8, Figure 1.
4/ See Campbell and Bhattarai (1983), p. V-17.

In Myagdi the average price of fuelwood is estimated to be Rs. 18/Bhari based on RCUP field checks in 1984 and field reports in 1983. The prices range from Rs. 45/Bhari in Beni during the monsoon (July-September) to Rs. 12/Bhari in Pakhopani. In both the eastern and western regions of Myagdi District, fuelwood is abundant and there is no market price.

In Mustang the average price of fuelwood is estimated to be Rs. 29/Bhari, according to an RCUP field check in 1984. This average spans low estimates of Rs. 25/Bhari in the south near pine forests in Ghasa and Lete to Rs. 50/Bhari in the north near Jarkot where a four-day trip might be required to collect a Bhari of fuelwood.

(2) Decreased Smoke Inhalation and Irritation

All studies of users' perceptions about the improved stoves report decreased smoke in the household as the most beneficial characteristic. Quantification of benefits from smokelessness depends upon two types of data: measures of the quantity of smoke and of the decreased incidence of morbidity and mortality. Neither type of data exist for Nepal.

Measures of smoke intensity are being carried out during August-December 1984.1/ These measures will be included in our final report. An attempt will be made to estimate changes in morbidity, and in the accompanying time away from work, based on estimates from similar studies on other countries. At minimum the smoke intensity measures, in households using the traditional mud chulos compared to those using improved stoves, will provide the first quantification of the extent to which the new smokeless chulos can really make a difference in air quality within the household.

d) Analysis

Previous benefit-cost analyses of improved stoves in Nepal have focused on the pay-back period -- how rapidly the cost of the stove can be repaid by fuelwood savings -- and on their cost-effectiveness compared to the alternative of supplying additional fuelwood by establishing fuelwood plantations. Campbell and Bhattarai (1983) conclude that "the cost of the stove (Rs. 70-Rs. 75 with installation and transportation) is repaid within three months of average use."2/ They go on to compare the costs of establishing and protecting a fuelwood plantation (estimated to be Rs. 37.50/ton of fuelwood produced over a 20-year lifespan) with that of saving a ton of fuelwood by distributing improved stoves (estimated to be Rs. 24.00/ton assuming a five-year lifespan).

1/ At the time this study was typed, Holly Reid's data on smoke pollution in Nepal's households had not been analyzed.

2/ Campbell and Bhattarai (1983), p. V-17.

Their final observation is "If the lifespan of the stove can be increased, or the degree of average use per household increased, this figure could be further improved.[1]

There are three major problems with the Campbell and Bhattarai analysis. First, the costs of designing and administering the stove program have not been included, thereby understating the length of the payback period. Second, their study does not indicate whether the cost comparison is based on the present value of comparative costs (discounted over the indicated lifespans at an appropriate discount rate). If not, other biases are introduced, the direction of which is impossible to determine without examination of annual cost estimates for both the plantation and the stoves program. Third, they do not perform tests of the sensitivity of their conclusions to significant variations in their assumptions with respect to fuelwood savings, fuelwood price, and other key variables.

Some of these shortcomings are addressed in the CFDP Field Report No. 10. In that report Figure 13 provides the basis for sensitivity tests by showing low, mean, and high estimates of fuelwood savings. The analysis of the range of estimates also considers the impact of substantial variation in the price of fuelwood. They conclude that "the stove has paid for itself within the year unless the real cost of fuelwood drops below Rs. 0.33. Using the more realistic cost of Rs. 0.50 per kilogram of fuelwood, the stove pays for itself in one year even if we include an almost 100% overhead cost for running the programme and take the lowest estimates."[2]

Nevertheless, their analysis does not offer any evidence that the inclusion of "100% overhead cost for running the programme" provides an acceptable measure of that cost component. The implication of their statement is that they are estimating overhead as 100% of the cost of purchasing, transporting, and installing the stove. If so, their estimates of overhead cost is too low. As will be demonstrated below, the overhead cost of the RCUP program is much higher than fuelwood savings in the initial years of the RCUP improved stoves program. Since the CFDP has an overhead structure which is roughly similar to that of RCUP, the true overhead cost of CFDP is probably much higher than that asserted in their Field Report No. 10. In cases where the costs are higher than the benefits in the initial years (which is the typical case for development projects), the payback period will usually be several years. That situation requires that the present values of the streams of benefits and costs be calculated (using an appropriate discount rate) over the lifespan of the improved stoves.

1/ Ibid.

2/ Community Forestry Development Project, Field Report No. 10 (July 1984), p. 64.

Another problem with the Campbell and Bhattarai study and the CFDP Field Report No. 10 is that they do not analyze the estimated net benefits from initiating a stove repair program. In CFDP Field Report No. 10, they recognize the potential value of a repair program by stating that "consideration should be given to arranging that the replacement of broken parts and their correct installation will be the responsibility of the recipient household. To facilitate this, the stove installer should have easy access, on a commercial basis, to stove components for replacement. Against payment, he could then assist all recipient households with repairs and maintenance."[1/] However, they do not go on to appraise the benefits and costs of a repair and maintenance program.

This analysis attempts to take account of all these factors. The first section analyzes the costs of operating the RCUP improved stoves program during FY 80/81-FY 84/85 and the benefits attributable to fuelwood savings over the lifespan of the stoves actually installed through FY 83/84 and targeted to be installed during FY 84/85. The second section assesses the net benefits to be yielded by a stove maintenance and repair program. The third section evaluates health benefits, and the final section presents our recommendations for adjusting targets in this RCUP activity.

(1) Benefit/Cost Analysis of Fuelwood Savings in the Existing RCUP Improved Stoves Program

Detailed estimates of benefits and costs by HMG fiscal years, FY 80/81 through the lifespan of the stoves, are presented in Appendix 3. Important assumptions used as the basis for quantifying benefits and costs are summarized below:

(a) fuelwood savings per installed stove are estimated to average 735 kg/year;

(b) the average price of fuelwood is estimated to be Rs. 0.44/kg in Gorkha, Rs. 0.72/kg in Myagdi, and Rs. 1.16/kg in Mustang;

(c) the price of the stove assembly (including the stove insert, the chimney, and other small parts) is Rs. 80 for stoves installed in Gorkha (manufactured in Kathmandu) and Rs. 100 for stoves installed in Myagdi (manufactured in Parba District, southeast of Beni); the price of a set of six iron rings (manufactured in Kathmandu) for installation on traditional mud chulos is Rs. 360;

(d) the lifespan of improved stoves and iron rings is estimated to be 5 years and 15 years respectively;

1/ CFDP Field Report No. 10, p. 34.

(e) transportation of stove assemblies to District Centers is via lorry from Kathmandu to Gorkha, via porter from Parbe District to Beni (Myagdi), and via lorry from Kathmandu to Pokhara with onward porterage to Jomson (Mustang);

(f) transportation of stove assemblies and iron-ring sets from District Centers to the installation site is via porterage arranged or performed by the recipient household;

(g) installation is accomplished by RCUP technicians with some labor and materials being provided by the recipient households.

RCUP pays for the stove assembly (or iron rings), transportation to District Centers, and the time required by stove technicians to install the new stoves or iron rings. Recipient households contribute installation materials (clay, water, bricks) and assist the stove technician during installation.

These assumptions, and others described in the footnotes to Appendix 3, are the foundation of our estimates of benefits and costs. Panel I of Appendix 3 presents estimates of benefits -- the value of fuelwood savings -- for each district by groups of stoves installed in a particular HMG fiscal year. An estimate of benefits is made for each year in the assumed five-year lifespan of each group of stoves. Summing across all groups gives total benefits estimated for that district in each fiscal year.

Costs are summarized in Panel II of Appendix 3. Consistent with the organization of the estimates for benefits, costs are presented for each district by HMG fiscal year. This procedure facilitates comparisons of economic efficiency not only across districts, but also by year in which the stoves were installed. The ability to compare performance across districts is important since different sources are used to supply stove parts for each district, and since fuelwood prices are different in Gorkha, Myagdi, and Mustang. It is also useful to compare performance by installation year since different numbers of stoves were installed in each fiscal year.

Panel III of Appendix 3 translates the Panel I and II estimates of benefits and costs into present values with respect to FY 80/81, the beginning year of RCUP. Discount factors are based on an assumed 10% per year social opportunity cost of capital. This rate of interest is used by the World Bank in its economic analyses of Nepal projects. Calculations of present values permits the summary of benefits or costs across years to arrive at an estimate of net

benefits, i.e., benefits/costs, which is the theoretically superior measure of economic efficiency.[1/] Panel III also presents estimates of benefit/cost ratios for each district.

Panel IV performs several sensitivity tests to determine the extent to which the efficiency measures are affected by changes in the values of key variables. Changes in assumptions about fuelwood savings, fuelwood prices, and the lifespan of improved stoves are examined. Also tested is the extent to which "shadow prices" of unskilled labor and foreign exchange affect the economic efficiency measures.

A graphical illustration of the time paths of present values for net benefits (B/C), based on Panel III in Appendix 3, is presented in Figure III-1.

Although Figure III-1 shows negative net benefits for the initial years of the RCUP, the positive net benefits in subsequent years are sufficiently large to result in overall positive net benefits, and B/C ratios which exceed 1.0, in all districts under the original set of assumptions. This result is presented as the "Base Case" in Table III-2.

From these positive values of benefits/minus costs the conclusion follows that the RCUP improved stoves program represents an efficient allocation of resources in all three districts. Furthermore, this conclusion is generally robust even when confronted by significant and adverse changes in estimates of benefits:

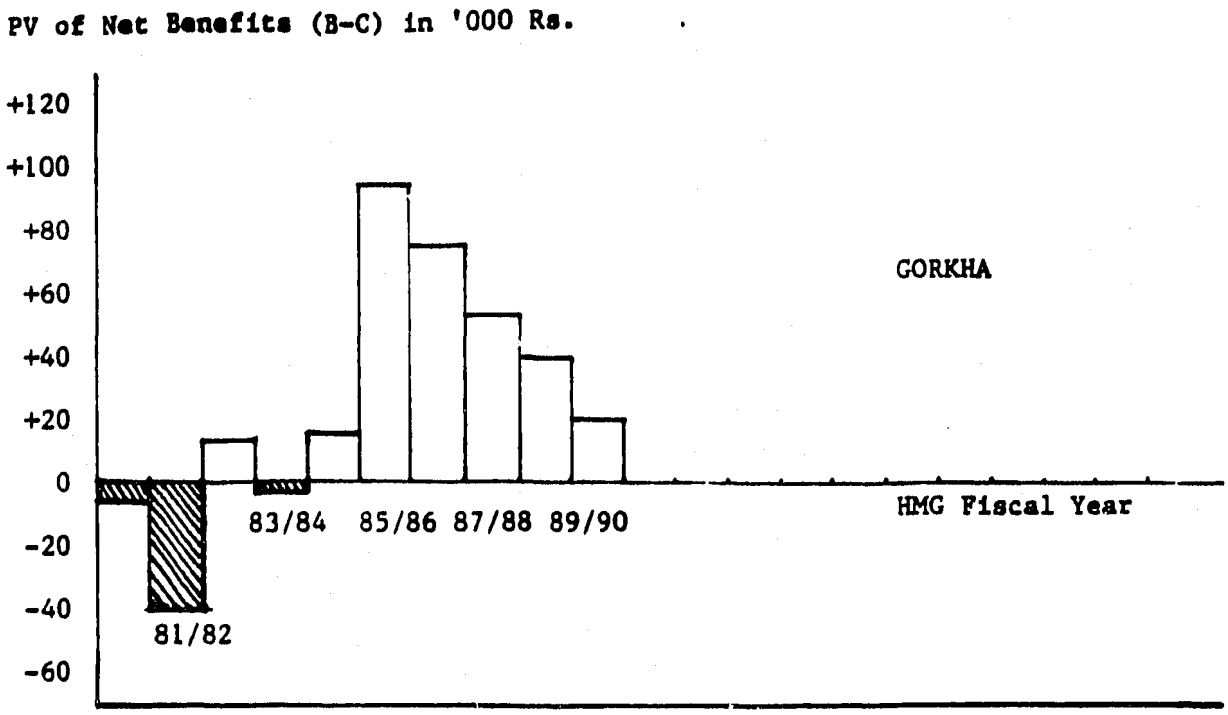
** if fuelwood savings decline to 462[2/] kg/installed stove/year, a decrease of 37% vs. the 735 kg assumed in the Base Case, net benefits are still positive and B/C ratios still exceed 1.0 in all districts;

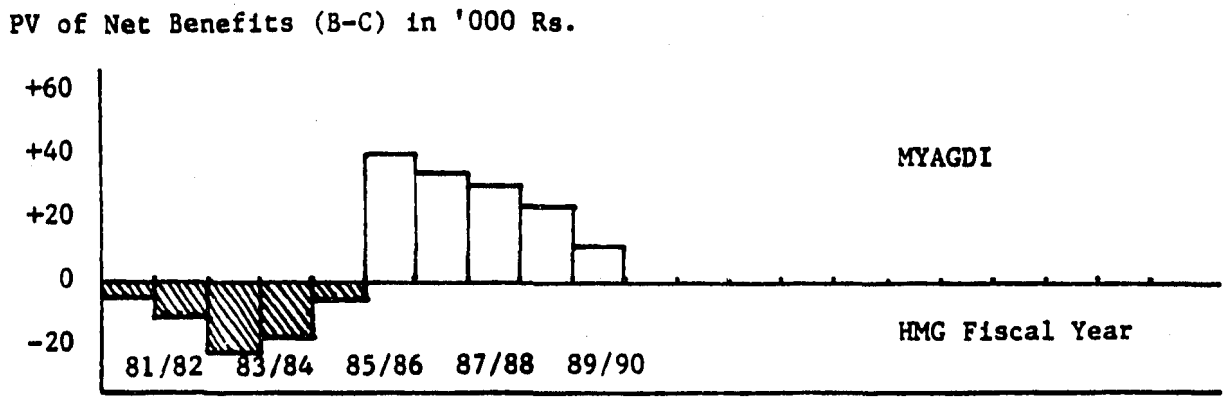
** if fuelwood prices are 25% lower[3/] than in the Base Case and fuelwood savings decline to 462 kg/installed stove/year, net benefits remain positive in Gorkha and Mustang but become slightly negative in Myagdi.

1/ A discussion of alternative measures of economic efficiency appears in Chapter I.

2/ The significance of the 462 kg estimate is that it is the lowest fuelwood savings estimate in CFDP Field Report No. 10, Figure 13.

3/ A 25% drop would change the fuelwood price in Gorkha from Rs. 0.44/kg in the Base Case to Rs. 0.33/kg, which is the lowest price examined in the CFDP Field Report No. 10, p. 64.





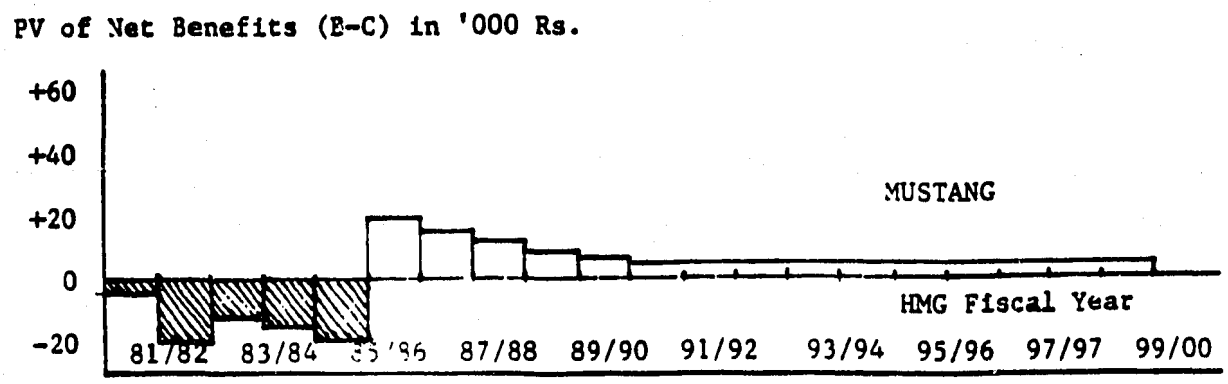


FIGURE III-I

PRESENT VALUES OF NET BENEFITS FROM FUELWOOD SAVINGS: RCUP IMPROVED STOVES PROGRAM IN GORKHA, MYAGDI, AND MUSTANG

TABLE III-2

ECONOMIC EFFICIENCY OF RCUP IMPROVED STOVES
PROGRAM BASED ON FUELWOOD SAVINGS

EFFICIENCY MEASURES	FOR STOVES INSTALLED IN		
	GORKHA	MYAGDI	MUSTANG
	(All figures are in Nepalese Rs.)		
I. Base Case			
A. Present Values @ i=10% Year:			
1. Benefits	526,195	218,372	189,075
2. Costs	221,559	129,161	87,802
3. Benefits-Costs	304,636	89,211	101,273
B. Ratio, B/C	2.37	1.69	2.15
II. If Fuelwood Savings are 462 kg/Year			
A. Present Values @ i=10%/Year:			
1. Benefits	330,766	137,269	118,853
2. Costs	221,559	129,161	87,802
3. Benefits-Costs	109,207	8,108	31,051
B. Ratio, B/C	1.49	1.06	1.35
III. If Fuelwood Savings are 462 kg and Fuelwood Prices are 25% Lower			
A. Present Values @ i=10% Year:			
1. Benefits	248,232	102,952	89,140
2. Costs	221,559	129,161	87,802
3. Benefits-Costs	26,673	(26,209)	1,332
B. Ratio, B/C	1.12	0.80	1.02
IV. If Lifespan of Stoves is 3 Years			
A. Present Values @ i=10%/Year:			
1. Benefits	398,688	165,461	*
2. Costs	221,559	129,161	*
3. Benefits-Costs	177,129	36,300	*
B. Ratio, B/C	1.80	1.28	*

* Indicates not applicable since iron rings are used in Mustang.

** if the lifespan of the improved stoves is reduced to three years, compared to five years in the Base Case, net benefits are still positive in Gorkha and Myagdi (Mustang is excluded because iron rings are being installed there instead of improved stoves.

The payback period was the economic efficiency measure used in the CFDP Field Report No. 10. That study reported payback period of less than one year for improved stoves which are almost identical to those being distributed by RCUP. Problems with the CFDP analytical approach were discussed earlier. Presented in Table III-3 are estimates of payback periods for the RCUP program.

Only one of the payback periods (targeted FY 84/85 stove installations in Gorkha District) is below one year. In view of the RCUP history of failing to achieve the targeted number of stove installations, the actual payback period for Gorkha in FY 84/85 might turn out to exceed one year. The clear message from this analysis, therefore, is that payback periods of less than one year are probably incorrect. A more realistic estimate would be 1.5-2.0 years or higher. The outcome is mainly a function of two variables: the amount of fixed installation and administrative costs allocated to the stoves program, and the number of stoves installed.

The high payback periods for FY 81/82 and FY 82/83 in Myagdi and for all fiscal years except FY 84/85 targets in Mustang suggest that considerable inefficiencies in management or resource allocation are present in those districts. In Myagdi only seven stoves were installed in FY 81/82 and 20 in FY 82/83; in Mustang comparable figures were seven stoves in FY 81/82, three stoves in FY 82/83, and nine sets of iron rings in FY 83/84. Clearly the level of activity in FY 81/82 in both districts and FY 82/83 in Mustang is economically inefficient from the perspective of fuelwood savings: the payback periods are infinite, i.e., there are insufficient benefits being generated to pay for the costs involved. New targets should be set at more economically efficient levels, at least 20 or more stoves or iron rings installed per year.

The results reported in Table III-2 were tested for the sensitivity of the measures of benefits and costs to converting the market prices to "shadow prices" for foreign exchange and unskilled labor inputs. A negligible impact is reported for shadow pricing of foreign exchange, since it represents such a small percentage of total costs.[1/] Although unskilled labor represents a high percentage of some cost components (porterage and household labor to

1/ The most significant foreign exchange cost would be manufacturing costs for iron rings, estimated to contain one-third foreign exchange costs; but that is less than 10% of total costs of installing iron rings.

TABLE III-3

NET BENEFITS STREAM AND PAYBACK PERIOD BY INSTALLATION YEAR

INSTALLATION YEAR	PV OF NET COSTS IN INSTALLATION YEAR	PV OF BENEFITS OVER STOVE LIFESPAN	NET PV, B-C	RATIO, B/C	PAYBACK IN YEARS
A. Gorkha					
1. FY 81/82	(64,619)	136,399	71,780	2.1	1.6
2. FY 82/83	(30,826)	65,545	34,719	2.1	1.5
3. FY 83/84	(59,307)	104,673	45,366	1.8	2.0
4. FY 84/85	(66,807)	219,578	152,771	3.3	0.8
B. Myagdi					
1. FY 81/82	(17,459)	11,159	(6,300)	0.6	∞
2. FY 82/83	(27,385)	28,988	1,603	1.1	4.4
3. FY 83/84	(38,642)	89,597	50,955	2.3	1.4
4. FY 84/85	(45,675)	88,628	42,953	1.9	1.7
C. Mustang					
1. FY 81/82	(26,906)	17,980	(8,926)	0.7	∞
2. FY 82/83	(13,832)	7,006	(6,826)	0.5	∞
3. FY 83/84	(19,838)	45,253	25,415	2.3	4.0
4. FY 84/85	(27,226)	118,836	91,610	4.4	1.8

assist installation), it too comprises a low percentage of total installation costs. Consequently, shadow pricing of unskilled labor also has a negligible effect on estimates of costs.

(2) Net Benefits from a Stove Maintenance and Repair Program

None of the stove improvement programs in Nepal has a formal program for maintenance and repair after the stoves have been installed.[1/] Yet the consistent testimony from surveys of users of the improved stoves is that 9% or more of the new stoves are not being used because they have been cracked or broken.[2/] Further, 60% or more of installed stoves seem to have some sort of break or crack after one year of use, even though most of those stoves are still being used.[3/]

The potential net benefits from a stove maintenance and repair program, therefore, are likely to be large. A rough estimate of the benefits and costs of such a program is presented in Panel IV of Appendix 3. These estimates are derived from the following assumptions:

(a) the program would be introduced in FY 84/85;

(b) stove technicians could service the needs of two stoves per working day, or an average of 360 stoves annually based on 180 working days per year;[4/]

(c) an average of two visits per stove per year will probably be required for both stove repair and chimney cleaning;[4/]

1/ The stove technicians associated with the RCUP program have done small repairs and cleaning of chimneys in the context of helping take surveys about stove use. The CFDP and the Appropriate Technology Unit of ADB/Nepal have concentrated, like RCUP, on promotion and installation.

2/ See CFDP Field Report No. 10, Tables 7 and 8, for the most recent (July 1984) evidence about damaged stoves. Table 7 reports an average of 31% of improved stoves not used after having been installed for one year. Table 8 reports an average of 29% of respondants who were not using their new stoves who said the reason for non-use was that the stove was broken or cracked. Therefore, 9% of new stoves installed were not being used due to being broken or cracked.

3/ The study by Campbell and Bhattarai (1983) reported 60% of installed stoves were cracked or broken (Table 3); Roesing (1983) reported two thirds of installed stoves with some type of break (Figure 3).

4/ Estimates by RCUP energy specialist.

(d) benefits would be (a) for stoves which are currently in use, extending the average lifespan by three years as well as eliminating half of the 10% per year annual depreciation of benefits assumed in the Base Case, and (b) for stoves which were installed but are not now being used because of damage to chimneys or inserts, putting these stoves back into service.

Based on the 344 stoves installed in Gorkha through FY 83/84, and assuming 10% breakage, the number of stove technicians would be 1.7 to inspect the already installed stoves during FY 84/85. The targeted 300 new stoves for FY 84/85 will require an additional 1.7 stove technicians for Gorkha by FY 85/86. The total personnel required, therefore, would be approximately 3.5 stove technicians and a half-time energy technician as a supervisor to operate a stove maintenance and repair program in Gorkha District.

Similar calculations yield estimates for one stove technician and a half-time energy technician/supervisor to operate a stove maintenance and repair program in Myagdi for the 169 new stoves which will have been installed by the end of FY 84/85. The half-time energy technician/supervisor required for both Myagdi and Gorkha could be satisfied by one individual who would commute between the two districts. No personnel are required for Mustang, since iron rings installed on traditional mud chulos are being distributed there.

Operating costs are assumed equivalent to salaries and travel costs for FY 84/85 in the Base Case, but enlarged proportionate to the larger size staff. Cost estimates are not reduced in later years, even though some depreciation will certainly occur in number of stoves being used, since any reduction in staff size (due to fewer stoves) is assumed to be offset by increasing expenditures on replacement parts.

The economic efficiency measures estimated for the stove maintenance and repair program are summarized in Table III-4.

Although the stove maintenance and repair program would be an efficient allocation of resources under the assumption of the Base Case, the opposite conclusion would follow if fuelwood savings drop down to 462 kg/year per installed stove. The program becomes even more inefficient if fuelwood prices were to drop 25% below the Base Case, as shown in Case II.

Of course the results presented in this section consider fuelwood savings as the only source of benefits. The other main source -- health improvement due to decreased smoke -- will be analyzed in the next section. Further, the stove maintenance and repair program may have a more significant impact on fuelwood savings than

TABLE III-4

ECONOMIC EFFICIENCY OF STOVE MAINTENANCE AND REPAIR PROGRAM BASED ON FUELWOOD SAVINGS

EFFICIENCY MEASURES	FOR STOVES INSTALLED IN: GORKHA	MYAGDI
I. Base Case		
A. Present Values @ i=10% Year:		
1. Benefits	240,396	98,862
2. Costs	192,881	70,636
3. Benefits-Costs	47,515	28,226
B. Ratio, B/C	1.25	1.40
II. If Fuelwood Savings are 462 kg/Year and Fuelwood Prices are 25% Lower		
A. Present Values @ i=10% Year:		
1. Benefits	113,407	46,638
2. Costs	192,881	70,636
3. Benefits-Costs	(79,474)	(23,998)
B. Ratio, B/C	0.59	0.66
III. Same As Case II With Visits To Households Reduced to Once Annually		
A. Present Values @ i=10%/Year:		
1. Benefits	113,407	46,638
2. Costs	96,446	35,318
3. Benefits-Costs	16,967	11,320
B. Ratio, B/C	1.18	1.32

the assumptions made herein would suggest. More likely is the prospect of reducing household visits to an average of once annually. This result might be achieved through adult education programs designed to induce households to perform at least half the repairs (especially chimney cleaning) themselves. If this could be accomplished, the program would yield positive net benefits again, as shown in Case III of Table III-4.

(3) Quantification of Health Benefits

As already noted, significant reduction in the amount of smoke is the most attractive aspect of improved stoves from the viewpoint of users. Until recently, there have been no data which might be used to quantify the benefits from reduced smoke pollution inside Nepali households. SECID's Center for Women in Development sponsored a fellowship for Ms. Holly Reid to collect data on smoke exposure in Nepali households during July-December 1984. Ms. Reid is now analyzing the data she collected. Her results are expected to be available in the spring of 1985.

Her preliminary findings hold out the promise of significant benefits being realized from reduced smoke pollution inside Nepali houses:

> "Carbon monoxide results were immediately available upon the completion of each household test. Preliminary averaging indicates that the new stove results only slightly exceed the World Health Organization (WHO) standard for allowable exposure to CO for a one hour period of 35 parts per million (ppm.) CO results from old stove tests greatly exceed, on order of magnitude, even the highest allowable occupational health standard (United States) of 50 ppm for an eight hour working day. These results alone signify that the new stove chimney functions to help rid the indoor cooking environment of very large quantities carbon monoxide, just one harmful constituent of smoke produced throug the burning of biomass fuels."1/

Reid's preliminary findings also add evidence that health benefits from reduced smoke exposure are perceived as being the highest priority benefit from RCUP's improved stoves:

1/ From Holly F. Reid, "An Evaluation of RCUP's Improved Stove Program with Special Emphasis on Smoke Exposure and Its Health Implications", Preliminary Summary of Observations and Recommendations, July-December, 1984, p. 4. Analyzed data results will be available through RCUP in early 1985. Initial results measured carbon monoxide at an average of 60 ppm for the improved magan stoves being distributed by RCUP compared to 1,000 ppm for traditional chulos! (Obtained from Holly Reid in personal communications.)

"All new stove households claimed there was a very significant decrease in the amount of smoke in the cooking area due to the installation of the chimney. More than half of both new and old stove owners also stated that their first priority for wanting the new stove was for smoke savings. (Fuel savings was most often declared as their second priority.) Health problems associated to exposure to too much smoke included: asthma, weak eyes, dizziness, headaches, "chest paints", inflamed eyes, runny nose and coughing. Many households did not make a direct correlation between smoke and health problems, however. Only a few respondents directly attributed a particular ill to the smoke, such as: coughing up black mucous, mucous formation around edge of eyelids, and chronic coughing, tearing and headaches during the cooking hours.1/

The likelihood appears to be large, therefore, that the improved stoves will be able to claim benefits due to decreased morbidity and consequent savings in productive time. Quantification of these health benefits will be included in the final version of this study.

(4) Implications for Adjusting Targets in RCUP

The results of our benefit-cost analysis as summarized in Table III-2, generally confirm the positive findings from the Community Forestry Development Program with respect to the economic efficiency of distributing improved stoves in Nepal. Our recommendation, therefore, is that these targets should be increased. The distribution of the improved stoves by RCUP exhibits such high B/C ratios that even a doubling or tripling of the volume of stoves being distributed would be unlikely to bring RCUP into the area where costs would start to exceed benefits.

There are several important caveats, however:

(a) An implication of Table III-3 is that RCUP seems to have used inefficient ways to distribute improved stoves in FY 81/82 for Myagdi and in FY 81/82 and FY 82/83 for Mustang. The estimated net present value of benefits minus costs is negative for each of those situations. This result suggests that there are economies of scale in stove distribution programs. Although positive net benefits and B/C ratios which exceed 1.0 characterize the most recent time periods, attention to improved distribution techniques could improve the economic efficiency of the program even further. Thus, the suggestion made by USAID/Nepal to have RCUP's stoves distributed by the Appropriate Technology

1/ Ibid, p.5.

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Unit of the ADB may result in additional economies of scale. Of course ATU's distribution costs should be compared to RCUP's before taking action on this suggestion.

(b) The technical efficiency of the iron rings being distributed in Mustang needs to be tested. At the present our assumption, that the installation of iron rings in traditional chulos makes the resultant combination as energy-efficient as the improved Magan design, is based on the observation that traditional chulos used in Mustang are constructed similarly to the new designs being promoted by RCUP. The main performance differences are that the iron ring stoves do not have a damper (which are not used often on the improved Magan stoves, according to field observations by RCUP staff), and the iron ring conducts more heat into the house.

(c) Some experiments should be made in pricing policy to identify the extent to which Nepali rural residents are willing to absorb some of the costs of stove parts. The most obvious component to be paid for by recipient households would be the chimney. As pointed out earlier, the health benefits from reduced smoke are captured entirely by the individuals residing in that household. Sound public finance would require those households to pay for the costs associated with those benefits, other things equal.

One thing which may not be equal, however, is the discount rate to individual households compared to RCUP.[1/] From the viewpoint of RCUP and HMG, a 10%/year discount rate probably represents a valid approximation of the opportunity cost of capital. It is legitimate, therefore, to use the 10% rate to represent the viewpoint of whether the present value of the world-wide commitment of resources to RCUP activities is justified by the present value of benefits realized. But if the farmer is confronted by much higher costs of capital, the present value of his perceived stream of benefits may not be sufficient to equal or exceed his perceived costs. If so the result would be a sub-optimal number of improved chulos being adopted by farmers' households.

This problem is a familiar one in project appraisal work in developing countries. It deserves further analysis and experimentation before any changes are made in the current heavily subsidized stove improvement programs being financed by RCUP and other donor projects.

1/ This observation was made to Jennifer Wood by Kenneth Darrow of RECAST/ Tribuvan University. He advised that the rate for farmers is more like 50%.

(d) The other caveat concerns the desirability of a stove maintenance and repair program. As mentioned earlier, there seems to be general agreement regarding the desirability of doing something to induce the recipients of improved stoves to clean their chimneys and repair damaged parts of stoves. Neither RCUP nor any other donor program sponsors systematic repair and maintenance activities for previously installed stoves. The economic analysis summarized in Table III-4 indicates that such a program will probably yield positive net benefits.

Although much more precise analysis should be done prior to implementing a stove maintenance and repair program on a large scale, its potential seems promising enough to justify at least an experimental effort in, say, Gorkha. A pilot project could be undertaken at fairly low cost and would yield valuable data for analyzing the viability of such a program. We recommend that RCUP's targets be adjusted to include this experiment.

D. Solar Water Heaters

1. Overview

Nineteen solar water heaters have been installed in the RCUP project area. The cost (about Rs. 9,000 for a 90-liter system fully installed) of each system makes it impractical to disseminate solar water heaters to rural households using the same procedures followed for improved stoves. Also, there is no fair way to distribute a few systems to individual households. Therefore, they are being installed in appropriate government offices in the three districts for the purposes of disseminating the idea and demonstrating the use of the actual technology. For this reason, it is appropriate in defining benefits to consider instances where solar ideas are adopted as a result of RCUP's installations, as well as the direct benefits of the solar water heaters themselves.

In RCUP's 1982 cost/benefit study, Leuschner described the benefits in terms of the fuelwood that would have otherwise been used to heat water. This is an assumption which is unrealistic. Most of the Health Posts and Livestock Sub-centers are less than four years old, and none of them used a significant amount of fuelwood prior to the installation of the RCUP solar water heater. It is more accurate to discuss the potential benefits of the individual units, as well as any resultant adoptions of the technology.

The distribution of solar water heaters within Gorkha, Myagdi, and Mustang is summarized in Table III-5. The technology has been the most successful in Mustang because the people are quick to employ new ideas, and because trekkers are a ready market for hot showers along this main trade route, making private solar water heaters profitable (see Section D.3.). The colder climate is also a factor affecting demand for heated water.

TABLE III-5

DISTRIBUTION OF SOLAR WATER HEATERS BY DISTRICTS

A. Gorkha

FY 81/82 - 1, 90 liter, Balmandir Preschool, Gorkha Bazaar
- 1, 90 liter, Gorkha Hospital (indoor)

FY 82/83 - 1, 120 liter, with storage capacity, Gorkha Hospital (indoors)
- 1, 120 liter, Livestock District Office, Gorkha Bazaar

FY 83/84 - 1, 60 liter, Health Post, Bunkot

B. Myagdi

FY 81/82 - 1, 60 liter, Livestock District Office, Beni
- 1, 60 liter, Livestock Subcenter, Pakhopani (out of commission)

FY 82/83 - 1, 60 liter, Health Post, Beni
- 1, 60 liter, Health Post, Rakhu
- 1, 90 liter, Health Post, Tatopani
- 1, 90 liter, Health Post, Sikha

FY 83/84 - 1, 60 liter, Livestock Sub-center, Dana
- 1, 60 liter, Livestock Sub-center, Chinikhola

C. Mustang

FY 81/82 - 1, 60 liter, Health Post, Jarkot (out of commission)

FY 82/83 - 1, 60 liter, Health Post, Tukche
- 1, 60 liter, Marpha Farm, Marpha
- 1, 60 liter, Health Post, Lete
- 1, 60 liter, School Hostel, Lete

FY 83/84 - 1, 60 liter, Health Post, Marpha

2. A Case Study: Tatopani Health Post

a) Rationale for Site Selection

The Health Post at Tatopani was built in 1972.[1/] Health Posts and Livestock Sub-centers, in general, are targeted for the reasons already stated -- visibility as well as the more obvious benefits of cleanliness or health. The Tatopani Health Post is a large one, serving the surrounding four Panchayats, and is located on the main trail up the Kaligandaki Valley. Therefore the site was chosen, and the water heater was installed in July 1982.

All of the systems to be installed in a year are transported from Kathmandu to Pokhara in a lorry. From Pokhara the solar water heaters designated for Myagdi are carried up from Naudauda through Kushma for approximately Rs. 250 per porter. One porter carries the tank and all the fittings, the second carries the solar water heater and pipe, and the third carries the glass.

Total installation time takes 1.5 days -- a half day for the health post employee to gather the materials necessary for positioning the solar panel (wood, rock) and one day for the plumber, RCUP Energy Technician, and health post supervisor to install the system. At Tatopani, and at all of the sites except the Livestock Subcenter in Dana, the systems are connected to a constant water source.[2/]

The Health Post's solar panel is located to the east of the post, directly in view of the main trail. An illustration of the installation is presented in Figure III-2. The site was chosen with the understanding that two small trees standing right in front of it would be cut down. With this agreed upon, RCUP technicians completed the installation. The solar water heater is still in place and so are the banana trees. The extent to which the banana leaves are detracting from the effectiveness of the water heater is uncertain, but this situation represents some of the problems encountered in the course of installation and operation, and extension in general.

To date, there has been no organized means of maintenance. In the relatively visible high profile case of the Gorkha Hospital, a broken glass pane was replaced one year after installation. Aside from this example in Gorkha, the general policy is that, after installation, the system is the responsibility of the recipient. Twenty percent of the solar water heaters installed are not being used. Out of these four

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1/ Information obtained from the Catchment Conservation Officer/Myagdi.
2/ This means that water is tapped directly into the water storage tank for the system. Dana's system will be connected to a water supply in 1984-85 when the Livestock Sub-center is moved into the new RCUP buildings.

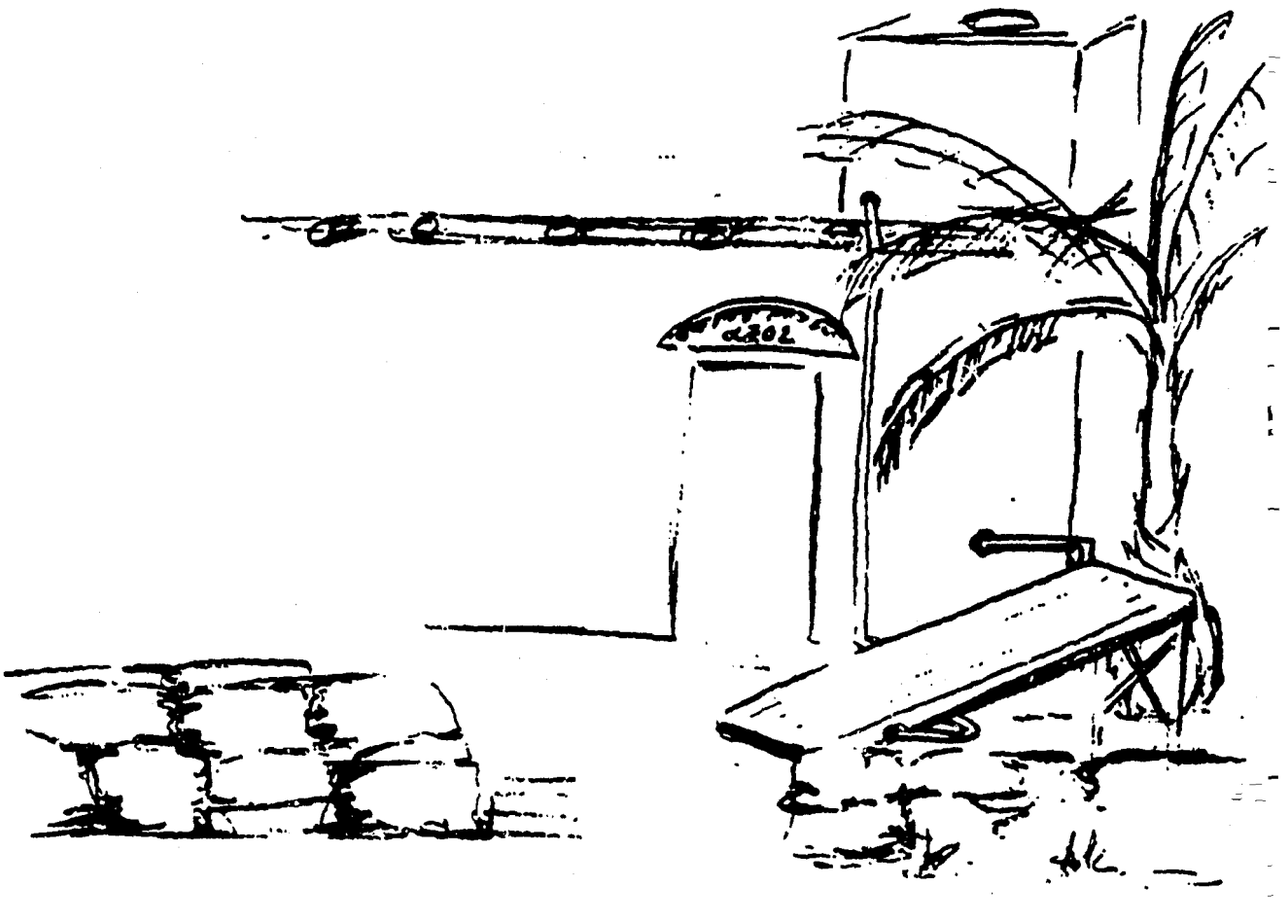

FIGURE III-2.

TATOPANI SOLAR WATER HEATER
HEALTHPOST
RCUP

heaters not in use, three have not been properly installed and the fourth (in Pakhopani, Myagdi) has blown off the roof three times. Each time it has been put back in place by the post employees.

b) Costs

The complete solar water heater assembly is purchased from Balaju Yantrashala in Kathmandu. RCUP's costs break down as follows for the heater in Tatopani:

Rs. 3,300	solar water heater (90 liter system)
800	water tank
1,500	pipe and pipe fittings
500	vehicle[1/]
750	porter[2/]
800	installation (plumber)
1,000	administrative
300	repairs (glass replacement and paint)
8,950	

Of RCUP's 19 solar water heaters, 2 are 120 liter systems (Rs. 7,000), 4 are 90 liter systems (Rs. 3,300) and 13 are 60 liter systems (Rs. 1,650). Costs of the water tank, pipe and fittings, and transportation/installation/other are the same for each unit. The recipient government post pays for the 1.5 days of gathering materials for the positioning of the panel, assisting with the installation, and any repair time, as in the case of Pakhopani.

c) Benefits

Records of attendance at Health Posts and Livestock Sub-centers are scarce and sporadic at best, so this discussion will cover potential benefits of solar heated water. Water is clearly beneficial in preventative medicine by increasing cleanliness. Since hot water can cut grease more effectively than cold, it can clean more effectively. This is especially true in climates like that of Mustang where many prefer to remain unscrubbed rather than to wash in freezing water.

In several cases there was not a water source in the post prior to the installation of the water heater. It is probable that the availability of water will greatly improve the standards of sanitation at Health Posts and Livestock Sub-centers.

With no records, it is difficult to make precise conclusions regarding the benefits of solar heated water to RCUP's three districts. It

1/ Total cost of transportation by lorry from Kathmandu to Pokhara, assuming a load of five solar water heaters.

2/ Total cost of porterage, Pokhara to Tatopani.

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may be, as with drinking water projects, that the full benefits of the technology cannot be realized without simultaneously teaching basic health and sanitation to the community.

The direct benefits of solar heated water with respect to health or fuelwood conservation are not clear and do not appear to be as significant as benefits from other parts of the energy project, such as improved stoves. While hot showers can easily be sold to trekkers for a profit, that market for solar water heating is not a priority in the context of RCUP's objectives.

One way to measure the effects of the availability of solar water could be to measure its impact on health, and therefore on working days lost to illness. Assuming the solar water heater life to be ten years[1/] and the initial costs to be Rs. 9,010,[2/] the solar water heater would have to contribute 83 person/days annually, due to better health, to pay for itself.[3/]

3. Implications for Adjusting Targets in RCUP

Having already completed installing solar water heaters at several health facilities for demonstration effects, continuation of this part of the RCUP energy program would not seem to merit a high priority. This conclusion is particularly true with respect to using solar heated water for showers in hotels and other private establishments. If those private installations are profitable (and they appear to be, based on the fact that many are being purchased through private means), this aspect of the market can be left to private enterprise. In sum, after the completion of FY 84/85 targets, the solar water heater program should probably be discontinued.

E. Solar Dryers

1. Descriptions of Installations in Each District

Since FY 1981-82, RCUP has installed 21 solar dryers in the three districts: 2 in Gorkha, 3 in Myagdi and 16 in Mustang. A list of the specific sites is presented in Table III-6. Myagdi's three dryers are all located in District Offices. One dryer is in the Catchment Conservation Office (CCO) in Beni, the second is in Beni's Department of Agriculture Office and the

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1/ RCUP Energy Specialist.

2/ See D.2.b), Costs, for more details with respect to the RCUP inputs which cost RS. 8,950. In addition, local inputs valued at Rs. 60 must be included to obtain the total installed cost of Rs. 9,010.

3/ This calculation is based on equal annual returns of Rs. 1,334 over a ten-year period (Years 0 through 9) using a discount rate of 10%/year. At, Rs. 16/day, which is the average payment for unskilled labor in the Tatopani area, this required annual return is equivalent to approximately 83 workdays saved.

TABLE III-6

DISTRIBUTION OF SOLAR DRYERS BY DISTRICT

A.	Gorkha	
	FY 81/82 - 1	Current locations are not known
	FY 82/83 - 1	
B.	Myagdi	
	FY 81/82 - 1,	Agriculture District Office Beni
	FY 82/83 - 1,	Catchment Conservation Office, Beni
	- 1,	District Forest Office, Dana
C.	Mustang	
	FY 81/82 - 1,	Marpha Farm, Marpha
	FY 82/83 - 1,	Lete
	- 2,	Tukche
	- 2,	Kobang
	- 2,	Pradan Panch and Private, Taglung
	FY 83/84 - 3,	(2) Om's Home; (1) Pradan Panch, Marpha
	- 1,	Former Pradan Pauch (600-tree apple orchard), Tukche
	- 1,	Pradan Pauch, Lete
	- 1,	Private, Kobang
	- 1,	Kalopani Guest House, Kalopani

third is in the Dana Forest Office. Demonstration is their most important function, but Mustang is the only district where the introduction of solar dryers has truly been successful. We will use the solar dryer installed at Marpha Farm in Mustang, to illustrate the potential for the process.

2. A Case Study: Marpha Farm

Solar drying is not a new idea in Nepal. People have dried their grains and peppers on grass mats spread out in the sun for centuries. This technique, judging from the lack of interest in solar dryers in Gorkha and Myagdi, continues to meet peoples' needs in those districts. Mustang, however, has different needs.

Over the last 15 years horticulture has increased significantly in the Mustang District. The area's limited water supply is being used to support orchards in what is otherwise a desert. The valley is widely known for its red and golden delicious apples and apricots. The harvest season runs approximately from June through November, as illustrated in Figure III-3.

Of all the products, only apples can be stored over a long period of time (until the following May). Also, apples can survive being transported better than apricots, peaches or grapes. Even they, however, are fairly bruised after seven days of bumping around in a porter's Dhoka basket to reach the Pokhara Market. One method used to overcome this problem of transportation is to bottle the produce either as jam or as brandy for sale on the local market as well as in Pokhara. Still, much produce goes to waste.

Solar dryers are built in Jomson and transported to their designated installation for Rs. 1,000. This cost covers the price of materials, labor and transportation. In July, 1982 the first solar dryer was installed at Marpha Farm. They have since copied the design and built three more, an indication of the dryers desireability. This year, using four solar dryers, they have dried 100 kg of fresh produce. Most of the other solar dryers in the north of Mustang dry tomatoes and peppers for household use in addition to the fruits mentioned above. In the southern part of the district, mushrooms are being dried for selling. The profitability of solar dryers in Jomson is evident by the surge of demand that has appeared after the installation of just a few dryers. The comparative selling prices are shown in Table III-7.

In the initial season of use, Marpha Farm was able to produce 100 kg of dried fruit (from approximately 500 kg of fresh fruit). The fruit was worth Rs. 2,000 fresh and is now worth Rs. 3,500 dried. Marpha Farm has requested an additional 50 dryers from RCUP, and there have been many other requests from people impressed with the potential of solar dryers.

3. Implication for Adjusting Targets in RCUP

This level of demand seems to indicate that solar dryers are profitable enough to do extremely well on the open market in Mustang. Over 100 solar

FIGURE III-3

MARPHA FARM
Calendar of Harvest

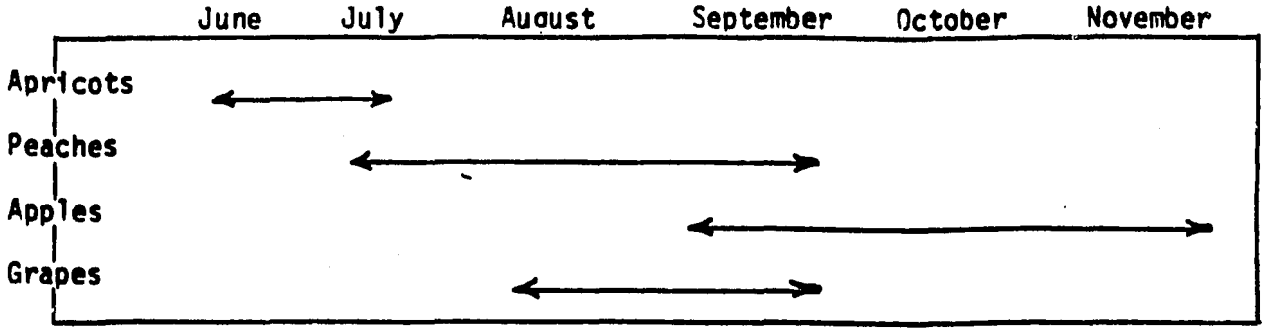

TABLE III-7

MUSTANG PRODUCE
'FARM-GATE' PRICES[1/]

	FARMGATE PRICES, Rs./Kg		MARKET PRICES TO FARMERS Rs./Kg	RETURNS TO DRYING ACTIVITY Rs./Kg
	FRESH	DRIED		
Apples	4.0	6.4[2/]	35.0	28.6
Apricots	4.0	8.0[3/]	35.0	27.0
Mushrooms	5.0	-[4/]	45.0	-[4/]

1/ Information collected from the managers of Marpha Farm, October 1984.
2/ 2 kg. of fresh apples becomes 400 grams of dried apples.
3/ 2 kg. of fresh apricots becomes 500 grams of dried apricots.
4/ Information not available at the time of this study.

dryers have been requested in the last year in Mustang.[1/] It seems to be appropriate, therefore, for RCUP to withdraw and leave the proliferation of solar dryers to the open market. RCUP perhaps should remain involved by assisting with materials and technical advice on construction and through extension work including adult education. But there appears to be no further need for distributing solar dryers through RCUP.

F. Water Mills

1. Description of Installation in Each District

Only two improved water mills have actually been completed by RCUP, one in Gorkha and the other in Mustang. A summary of their locations, capacity, and type of equipment installed is presented below:

Gorkha - Jaubari mill
- Installed: May '83
- Capacity: 10 HP
- Function: hulling (No. 4)
  - grinding (No. 16)
  - oil extractor - new, not installed yet (6 bolt)
  - churra

Mustang - Kunjo
- Installed: July '84
- Capacity: 10 HP
- Function: grinding (No. 16)
  - flour separator

When rice is hulled the waste can be used as fodder, whereas the waste after husking does not have much nutritional value. A churra is a rice beater or flattener. People bring enough wood to cook their rice slightly. Then it is put into a centrifuge attached to the mill, and this process flattens the rice so it can be stored and eaten anytime.

2. A Case Study: Jaubari Water Mill, Gorkha District

The Water Mill at Jaubari has been operating since its installation in May 1983. By December, the income from the mill covered the operating expenditures (See Table III-8). Jaubari's Mill is a particularly good example for this study because of the quality of the data. Most mill studies have been conducted using recall on the part of both users and mill owners. Or else the mill owners were reluctant to divulge any records they may have had.[2/]

The accounts at Jaubari have been handled by the local school. The profits, as well, go to the school. For these reasons the records are more accurate than those available for most private mills.

1/ Personal conversation with Energy Specialist and Energy Technician/Mustang.
2/ This is an indirect indication of how profitable they might be.

TABLE III-8
INCOME STATEMENT FOR JAUBARI WATER MILL (GORKHA)

	FY82/83	FY83/84	FY84/85	FY85/86	FY86/87	FY87/88	FY88/89	FY89/90	FY90/91	FY91/92	TOTAL
Costs											
A. Physical Facilities[1/]											
1. Equipment and Materials;											
a. Multi-Purpose Power Unit System	32,756										
b. Appliances: Grinder, Rice Huller, Oil Expeller, Rice Flattener	28,144										
c. Cement	2,000										
d. G.I. Sheet	4,000										
e. Contingency @ 10%	6,690										
2. Survey, Installation and Training	10,000										
3. Subtotal, including Mill House	83,590	-	-	-	-	-	-	-	-	-	-
B. Operating Costs											
1. Salaries[2/]	2,160	8,640	7,170	5,700							
2. Repair and Maintenance[3/]	179	899	1,000	1,400							
3. Subtotal	2,339	9,539	8,170	7,100	7,100	7,100	7,100	7,100	7,100	7,100	
C. Total Costs	85,929	9,539	8,170	7,100	7,100	7,100	7,100	7,100	7,100	7,100	
Benefits[4/]											
A. Grinding	305	2,020	4,353	3,000							
B. Hulling	943	5,157	2,841	4,000							
C. Flattening	644	4,102	7,168	5,600							
D. Oil Expelling	-	-	-	5,000							
E. Total Benefits	1,892	11,279	14,362	17,600	17,600	17,600	17,600	17,600	17,600	17,600	
I. Benefits-Costs (II.E - I.C)	(84,037)	1,740	6,192	10,500	10,500	10,500	10,500	10,500	10,500	10,500	
Present Value @ 10% Discount Factor											
A. Benefits	1,892	10,253	11,863	13,218	12,021	10,929	9,926	9,029	8,202	7,462	94,795
C. Costs	85,929	8,671	6,748	5,332	4,409	4,004	4,004	3,642	3,309	3,010	129,903
C. Benefits - Costs	(84,037)	1,582	5,115	7,886	7,172	6,520	5,922	5,387	4,893	4,452	(35,108)
D. Ratio, B/C											0.73

Based on estimates provided by G. Shakya and G. Richard.

Rs. 720 covers the monthly salary of two mill operators and one accountant who is also a teacher at the school. The operators prepare the accounts for the teacher anyway, so RCUP plans to only hire the two operators after December 1984, to cut back on costs.

Derived from "Income and Expenditure Statement of the Poropkar Bahuudyesha Mill, Jaubari, April/May 1983 - Sept./Oct., 1984.

Same source as 3/. Estimates for FY 84/85 are based on ratios of July-Sept. 1984 to July-Sept. 1983.

Three attachments were installed with the mill: a huller, grinder and ric flattener. An oil expeller will be added in FY 84/85. Approximately 70% of mill's income comes from the rice flattener, or chyura maker. It is interest that even with the apparent popularity of this attachment, it is rarely found Nepal. Approximately 10% of total income comes from the grinder and 15% from huller. After installation the oil expeller will bring in a large part of the come. Farmers will come from twice the distance (7-10 km) to have oil made f their seeds. One reason is that to squeeze oil in the home involves a multi of 4-5 of the time it would take to grind or hull a similar amount of corn, wh or rice.[1] Yet another reason is that a mechanical oil expeller is m efficient, and can produce 25% more oil than when it is done by hand.[2]

TABLE III-9
Comparison of Milling Fees

	JAUBARI WATER MILL[3]	BENI DIESEL MILL[4]	CHOR-KATEE TAR BIOGAS MILL[5]
Grinding	Rs. 10	Rs. 20-25	Rs. 30
Hulling	Rs. 5	Rs. 13	Rs. 7
Oil Extraction	Rs. 50	- -	Rs. 70
Chyura	Rs. 30	- -	- -

(Milling Fees for 1984 shown in Rs/Muri)[6]

Comparing in Table III-9 the current milling fees at the Jaubari water m with the diesel mill in Beni (Myagdi) and the biogas mill at Chor-katee (Choprak Panchayat, Gorkha) helps to illustrate the relative cheapness of wa power. The fees quoted for Jaubari are the average milling rates in Gor District (water power).

The implied profitability of water mills, however, is not borne based on the data which are available for Jaubari. As can be observed from Ta III-8, the net present value of benefits - costs is estimated to be negative, our assumptions of a ten-year economic life and a 10%/year opportunity cost capital are correct. Of course the mill just began operating in May 1983 so actual net income for FY 84/85 and beyond may be higher than our estiamtes.

One potentially important source of social benefits, which could not be flected in the mill's income statement, is labor savings and travel time savi for customers. Data required to estimate such benefits were not available. final version of this study will attempt to include estimates of these elements consumer savings.

1/ United Mission to Nepal, "Socio-Economic Evaluation Study of Small Turbines Mill Installations". Vol. I. Final report. May 1982, p. 19.
2/ Ibid.
3/ Uttan Shresta - RCUP expediter.
4/ RCUP energy specialist.
5/ RCUP energy technician, Gorkha district.
6/ 1 Muri = 24 U.S. gallons, volume.

3. Implications for Adjusting Targets in RCUP

Despite the preliminary results reported in Table III-8, it is evident from the demand in RCUP's areas[1/] as well as the general popularity of improved water mills in Nepal that some water mills are probably profitable. Given the demand, it is time to let the distribution of water mills be taken over the market. Loans are readily available from the ADB. It has even been shown that mills that began with larger loans from the ADB, show larger profits.[2/]

Using water power to process grains and seeds in an efficient use of Nepal's resources as well as income generating. If the Appropriate Technology Unit (ATU) is instituted in the RCUP districts, it will facilitate the private sector's installation of improved mills.

It was noted in the United Mission to Nepal Socio-Economic Study[3/] that whether you have a community or school operated milling system or a privately operated system, there is a certain re-distribution of income of similar proportions in each case. It is therefore preferable in terms of both efficiency and distribution to turn water mills in Gorkha, Myagdi and Mustang in the private sector.

G. Biogas Plant

1. Description of Installation

Only one biogas plant has been installed by RCUP. For five months RCUP consultants worked with the Khumal villages in Chor-katee Tar, Gorkha District to plan an energy project for the area. Using technical advice from RCUP and guidance in business from the Agricultural Development Bank (ADB) the people chose to construct a community operated biogas mill. RCUP would fund the machinery[4/] (Rs. 55,000) and the people of Chor-katee Tar would pay for the Biogas Digester (Rs. 45,084) with a loan from the ADB. This loan was to be paid off in installments of Rs. 500/month.[5/] After further consultation, it was agreed that two wealthier people of the community would put their land up as collateral on the bank loan, because they should better afford to do so than anyone else.

A supply of gobar, or manure, was arranged with the two largest livestock owners in the area. This method was simpler, and therefore more effective, than rotating the responsibility of providing the necessary manure throughout the community. The mill was to be powered on 20% diesel and 80% gobar gas. The two biogas digesters provide enough gas to run the mill for approximately four hours.[6/] Construction of the mill and biogas plant was completed and the mill operation began in June 1982.

1/ Requests for mills were received in Gorkha District (by the CCO) this year.
2/ Socio-Economic Evaluation, p. 28.
3/ Ibid.
4/ Machinery includes a huller, grinder, and oil expeller.
5/ Hira Man Shresta's report (Gorkha Energy Technician)
6/ RCUP Energy Specialist and USAID Consultant, Dan Jantzen

2. Operating Experience

The biogas mill at Chor-katee Tar has fallen short of its goals for several reasons. The mill, as a community operated project, has been managed poorly. Thus, the efficiency of the mill is less than it could be -- consuming more fuel and requiring large repair bills. Instead of operating on 80% Gobar Gas and 20% diesel, the mill operates, on the average, on 80% diesel and 20% Gobar Gas.1/ Operating using a higher percentage of diesel is preferable to the community for several reasons. Since the agreements that secured a future supply of gobar for the plant, the two livestock owners have done some reconsidering and more recently have been grudgingly supplying a percentage of the needed gobar. Also, if the mill is run on the planned 80% gobar/20% diesel it can only be in operation for 4 hours a day (2 hours for each biogas digester). The short operation schedule makes inefficient use of the mill machinery. For these reasons the community has been unable to regularly meet the payments on the ADB loan.2/

It is possible for 'appropriate technology' to be rendered inappropriate, and that maybe the case with the community biogas mill at Chor-katee Tar. Biogas plants require a level of close management that can rarely be attained on a community basis. The community's general district of banks and loans are being re-affirmed as a result of mis-management of the mill, itself. Out of the 27 months since the mill's completion it has been in operation for 16 months.

Technical difficulties with Biogas plants are not limited to Chor-katee Tar or to community management projects. The Gobar Gas Company, itself, has been operating in the red for approximately the last five years.3/ They have been selling many biogas systems. Each is sold with a seven year warranty. This is the problem for the company. This type of guarantee could work in an area where the problems with transportation and communication were not so formidable, but in Nepal, it poses an immense problem. Maintaining the warranty required many field visits, for big and small problems alike, and this is where the Gobar Gas Company is losing.

For these reasons tight management at the village level is crucial for maintaining operation of a Biogas plant. John Ashworth, an energy consultant with UASID/Nepal, was pursuing this idea on his recent visit in November, 1984. He looked at over a dozen plants, both privately owned and community operated to try to support his hypothesis that Biogas plants require closer management than can be provided by a community working in conjunction with a doner agency. The experiences with biogas in Nepal to date support the idea that biogas can be significantly more cost-effective when privately managed.

In the case of Chor-katee Tar, the costs already total more than Rs. 140,000 (approximately U.S. $8,000). The whole system was overhauled between September 1983 and June 1984. The most important thing now is to tighten management with the goal of paying off the bank loan.

1/ RCUP Energy Specialist.

2/ As of October, 1984 only Rs. 3,607 has been paid towards the ADB loan.

3/ Dan Jantzen, Private Energy Consultant.

3. Implications for Adusting Targets in RCUP

Clearly RCUP's experience with biogas does not justify additional installations. The only effort which should be expended at this time would be an analysis of how practices at the existing plant might be modified so that enough operating surpluses might be generated to repay the ADB loan. This effort ought to be made to protect the villagers from major financial problems.

January 25, 1985

APPENDIX 1 - REFERENCES

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APPENDIX II

APPENDIX 3 - SUMMARY OF BENEFITS AND COSTS: IMPROVED STOVES

Categories of Costs or Benefits	FY80/81	FY81/82	FY82/83	FY83/84	FY84/85	FY85/86	FY86/87	FY87/88	FY88/89	FY 89/90	FY90/91 to FY98/
I. Costs		(all figures are in Rupees)									
A. Gorkha:											
1. Stove Unit 1/	-	11,200	5,920	10,400	24,000						
2. Transportation 2/	-										
a. To District Center 2/	-	4,060	2,146	3,770	8,700						
b. To Household 3/		2,100	1,110	1,950	4,500						
3. Installation											
a. RCUP inputs 4/	-	23,774	12,566	23,925	25,397						
b. Household inputs 5/	-	840	444	780	1,800						
4. Administration/Extension 6/	7,967	20,339	15,134	38,146	33,417						
5. Subtotal	7,967	62,313	37,320	78,971	97,814	-	-	-	-	-	-
B. Myagdi:											
1. Stove Unit 1/	-	700	2,000	6,800	7,400						
2. Transportation											
a. To District Center 7/	-	350	1,000	3,400	3,700						
b. To Household 3/	-	105	300	1,020	1,110						
3. Installation											
a. RCUP inputs 4/	-	5,348	15,281	22,736	28,080						
b. Household inputs 5/	-	56	160	544	592						
4. Administration/Extension	5,317	6,798	14,413	16,954	25,992						
5. Subtotal	5,317	13,357	33,154	51,454	66,874	-	-	-	-	-	-
C. Mustang:											
1. Stove Unit 1/	-	560	240	3,240	9,360						
2. Transportation											
a. To District Center 8/	-	1,708	732	1,459	4,212						
b. To Household 3/	-	119	51	153	442						
3. Installation											
a. RCUP inputs 4/	-	14,191	6,082	7,336	10,092						
b. Household inputs 5/	-	77	33	99	286						
4. Administration/Extension	4,431	8,070	9,608	14,128	15,471						
5. Subtotal	4,431	24,725	16,746	26,415	39,863	-	-	-	-	-	-
D. Total RCUP	17,724	100,395	87,220	156,840	204,551	-	-	-	-	-	-

	FY 80/81	FY 81/82	FY 82/83	FY 83/84	FY 84/85	FY 85/86	FY 86/87	FY 87/88	FY 88/89	FY 89/90	FY 90/91 to 98/99	FY 99/00	TOTAL
II. Benefits													
(all Figures are in Rupees)													
A. Gorkha:													
1. FY 81/82	-	11,319	45,276	40,748	36,673	33,006	22,279	-	-	-			
2. FY 82/83	-	-	5,983	23,932	21,539	19,385	17,446	11,776	-	-			
3. FY 83/84	-	-	-	10,510	42,042	37,838	34,054	30,648	20,688	-			
4. FY 84/85	-	-	-	-	24,255	97,020	87,318	78,586	70,727	47,741			
5. Subtotal	-	11,319	51,259	75,190	124,509	187,249	161,097	121,010	91,415	47,741			
B. Myagdi:													
1. FY 81/82	-	926	3,704	3,334	3,000	2,700	1,822	-	-	-			
2. FY 82/83	-	-	2,646	10,584	9,525	8,573	7,716	5,028	-	-			
3. FY 83/84	-	-	-	8,996	35,987	32,388	29,149	26,234	17,708	-			
4. FY 84/85	-	-	-	-	9,790	39,161	35,245	31,720	28,548	19,270			
5. Subtotal	-	926	6,350	22,914	58,302	82,822	73,932	63,162	46,256	19,270			
C. Mustang:													
1. FY 81/82	-	1,492	5,968	5,371	4,834	4,351	2,937	-	-	-			
2. FY 82/83	-	-	639	2,558	2,302	2,072	1,865	1,259	-	-			
3. FY 83/84	-	-	-	1,918	7,673	7,673	7,673	7,673	7,673	7,673	7,673		
4. FY 84/85	-	-	-	-	5,542	22,168	22,168	22,168	22,168	22,168	22,168	22,168	
5. Subtotal	-	1,492	6,607	9,847	20,351	36,264	34,643	31,100	29,841	29,841	29,841	22,168	
D. Total BCUP	-	13,737	64,216	107,951	203,162	306,335	269,672	215,272	167,512	96,852	29,841	22,168	
III. Summary (10% Discount Factors)													
A. Gorkha:													
1. Present Value													
a. Benefits	-	10,288	42,340	56,467	85,040	116,282	90,859	62,078	42,599	20,242	-	-	526,195
b. Costs	7,976	56,643	30,826	59,307	66,807	-	-	-	-	-	-	-	221,559
c. B-C	(7,976)	(46,355)	11,514	(2,840)	18,233	116,282	90,859	62,078	42,599	20,242	-	-	304,636
2. B/C Ratio													2.37
B. Myagdi:													
1. Present Value													
a. Benefits	-	842	5,245	17,208	39,820	51,432	41,698	32,402	21,555	8,170	-	-	218,372
b. Costs	5,317	12,142	27,385	38,642	45,675	-	-	-	-	-	-	-	129,161
c. B-C	(5,317)	(11,300)	(22,140)	(21,434)	(5,855)	51,432	41,698	32,402	21,555	8,170	-		89,211
2. B/C Ratio													1.69
C. Mustang:													
1. Present Value													
a. Benefits	-	1,356	5,457	7,395	13,900	22,520	19,539	15,954	13,906	12,653	72,782	3,613	189,075
b. Costs	4,431	22,475	13,832	19,838	27,226	-	-	-	-	-	-		

	FY 84/85	FY 85/86	FY 86/87	FY 87/88	FY 88/89	FY 89/90	FY 90/91	FY 91/92	TOTAL
IV. Incremental Benefits and Costs if a Stove Maintenance and Repair Program is Introduced				(all Figures are in Rupees)					
A. Gorkha:									
1. Undiscounted Changes In:									
a. Benefits - Increased Fuel Savings for Stoves in Use	3,234	8,246	16,229	58,728	83,248	78,486	139,062	97,020	
- Rehabilitation of Inoperative Stoves	13,394	6,767	10,253	10,253	10,253	10,253	10,253	10,253	
- Total Benefits	6,618	15,013	26,482	69,001	93,501	88,739	149,315	107,273	
b. Costs	12,249	55,531	55,531	55,531	55,531	55,531	55,531	55,531	
c. Benefits Minus Costs	(5,631)	(40,518)	(29,049)	13,470	37,970	33,208	93,784	51,742	
2. Present Values of Changes In:									
a. Benefits	4,513	9,323	14,935	35,397	45,571	37,625	57,486	37,546	240,396
b. Costs	8,353	34,485	31,319	28,487	25,877	23,545	21,379	19,436	192,881
c. Benefits Minus Costs	(3,840)	(25,162)	(16,384)	6,910	17,694	14,080	36,107	18,110	47,515
d. Ratio, B/C									1.25
B. Myadni:									
1. Undiscounted Changes In:									
a. Benefits - Increased Fuel Savings for Stoves in Use	696	3,122	7,150	13,296	23,866	51,622	75,184	39,161	
- Rehabilitation of Inoperative Stoves	982	1,965	2,977	2,977	2,977	2,977	2,977	2,977	
- Total Benefits	1,678	5,087	10,127	16,273	26,843	54,599	78,161	42,138	
b. Costs	6,124	20,000	20,000	20,000	20,000	20,000	20,000	20,000	
c. Benefits Minus Costs	(4,446)	(14,913)	(9,873)	(3,727)	6,843	34,599	58,161	22,138	
2. Present Values of Changes In:									
a. Benefits	1,144	3,159	5,712	8,348	12,509	23,150	30,092	14,748	98,862
b. Costs	4,176	12,420	11,280	10,260	9,320	8,480	7,700	7,000	70,636
c. Benefits Minus Costs	(3,032)	(9,261)	(5,568)	(1,912)	3,189	14,670	22,392	7,748	28,226
d. Ratio, B/C									1.40

Notes: 1/ Assumes repair program reduces to 5%/year the annual depreciation in fuelwood savings and extends average stove life by 3 years.
2/ Assumes 9% of total improved stoves installed by FY 83/84 were not being used due to damage (see Footnote 9, Appendix 3, for basis of this estimate). The stove maintenance and repair program is assumed to place all of these currently inoperative units back into service over a 3-year period.
3/ Assumes 3 stove technicians and 1.0 energy technician are required from FY 85/86 onward. Costs are based on Attachment 1.
4/ Assumes a 10%/year discount rate, with FY 80/81 as year zero.
5/ Assumes 1 stove technician and 0.5 energy technician are required from FY 85/86 onward. Costs are based on Attachment 1.

APPENDIX 3 - FOOTNOTES

I. Costs

1/ The stoves installed in Gorkha District are made in Kathmandu (Rs. 80/stove). Myagdi's stoves are made in Phanga Panchayat, Parba District, southeast of Beni (Rs. 100/stove). The iron ring stoves installed in Mustang in FY 83/84 and FY 84/85 are cast at Cast Iron Stove Parts, Nagal, Kathmandu. A set of six rings cost Rs. 360, one third of which is foreign exchange.

2/ The transportation cost to Gorkha includes operating costs and the driver's wage, since the stoves are brought to Gorkha Bazaar in a lorry. The costs of delivering 30 stoves (one truckload) to the district center are as follows:

Rs. 540	Operating Costs
Rs. 316	Driver's Wage
Rs. 856	Total/30 Stoves and Chimmeys

Approximately Rs. 29/stove assembly, therefore, is the average cost of transportation from the manufacturing site in Kathmandu to the Gorkha District Center.

3/ The distance from the district centers out to the surrounding areas that either have RCUP stoves or are targeted for the near future, averages a one-day trek, both coming and going. This will be included as a cost at one half the local porter wage rates (because one stove is approximately half a load) which are estimated as follows:

Gorkha 1/2 (Rs. 30) = Rs. 15
Myagdi 1/2 (Rs. 30) = Rs. 15
Mustang 1/2 (Rs. 35) = Rs. 17

4/ RCUP's inputs include the stove technician's salary for each district and his travel costs. See Attachment 1 for estimates of these costs.

5/ Household inputs involve the time it takes the householder to procure the necessary water, clay, and bricks or stones and to assist and supervise the stove placement and installation. The actual installation takes two to three hours. We equate this cost with one half the local daily wage for an unskilled laborer, as follows:

Gorkha 1/2 (Rs. 12) = Rs. 6
Myagdi 1/2 (Rs. 16) = Rs. 8
Mustang 1/2 (Rs. 22) = Rs. 11

These wages are weighted averages from the followng sources; National Farm Management Study, HMG reports 1983, R. Sharma (RCUP), G. Shirakoti (Triburan University, Rampur). The "on season" rate is used (monsoon rice crop season) since that is when most stoves are installed due to the HMG budget procedures.

APPENDIX 3 - FOOTNOTES (cont'd)

6/ Administration and extension costs cover the Energy Consultant's salary and travel (FY 80/81 and FY 81/82), the Energy Specialist's salary and travel (FY 82/83 - FY 84/85), and the Energy Technician's salary and travel for each district. (See Attachment 1 of Appendix 3 for the breakdown of costs by district and by component.)

7/ Transportation for Myagdi is included in the initial Rs. 150 price of the stove. The potter from Parba District is responsible for bringing them to Beni, the district center, and the estimated porterage cost is Rs. 50/stove assembly.

8/ Transportation to Mustang covers the vehicle transport to Pokhara. Approximately 660 sets of iron ring stoves can be carried in one truck-load. The current numbers of ring sets are well under that maximum. The costs to Pokhara are as follows:

Rs. 810	Operating Costs
Rs. 519	Driver's Wage
Rs. 1329	Total/660 Iron-Ring Sets or 30 Stove Assemblies

Thus, average cost from Kathmandu to Pokhara is approximately Rs. 2/set. Each set weighs 11 kg., and a porter usually carries three sets to Jomsom for Rs. 480, or Rs. 160/set. Total cost, Kathmandu to Jomsom, averages Rs. 162/set.

During FY 81/82 and FY 82/83, Magan stoves were transported via lorry from Kathmandu at an average cost of Rs. 44/stove assembly, based on the lorry cost estimates above. Porterage from Pokhara to Jomsom costs an average of Rs. 200/stove assembly. Total cost, Kathmandu to Jomson, averaged Rs. 244/stove assembly.

II. Benefits

9/ In Gorkha, 140 improved chulos were installed in FY 81/82, 74 in FY 82/83, 130 in FY 83/84, and 300 are planned for FY 84/85. Based on the August 1983 CFDP Report (Campbell and Bhattarai, 1983) 79% of installed stoves are used to some extent (p. V-5, Table 2). The 1984 edition of that study (p. 65, Figure 13) estimates average savings per household of 735 kg. of fuelwood per distributed stove ("not used" stoves being included in the average). This rate of savings is based on households in the Kathmandu Valley where the traditional mud stoves were compared to the improved insert stove, which is very similar to RCUP's improved Magan stove (see illustrations, Appendix 2). The annual estimates of fuelwood savings after the first full year of operation have been depreciated at the rate of 10% per year to represent the effects of breakage or cracks on burning efficiency. The basis for the 10% estimate is the July 1984 CFDP study, in which Table 8, p. 57, reports 29% of installed

stoves as broken or cracked and Table 7, p. 55, which reports 31% of damaged stoves not being used.

An average price of Rs. 11.25/Bhari (25 kg.) is used to calculate the value of fuelwood savings (Campbell and Bhattarai, 1983, p. V-17, Central Hills mean market value). Since installation typically occurs during April-June, it is assumed that the initial year of operating achieves only 25% of potential savings. The last year's calculation, therefore, only spans 75% of the year. The lifetime of the improved stove is estimated at five years for Gorkha's improved Magan stoves (Campbell and Bhattarai, 1983, p. V.17).

10/ In Myagdi, 7 improved chulo's were installed in FY 81/82, 20 in FY 82/83, 68 in FY 83/84, and 74 are planned for FY 84/85. The assumed rate of fuelwood savings is, again, 735 kg./new stove/year. The price of fuelwood in Myagdi is assumed to be Rs. 180/Bhari (field checks, 1984 and RCUP field reports, 1983). The prices range from Rs. 40-45 during the monsoon in Beni to the mere five minutes it may take to collect it up in Kuinmungle far from the main trail. One reason that not many stoves have been distributed in this district is because many of heaviest fuelwood users are the hotel owners, and the RCUP stove is too small for their needs. As in the case of Gorkha, estimates of annual savings of fuelwood are depreciated at 10% per year, to take account of stove damage, and stove life is estimated to be five years.

11/ In Mustang, 7 improved chulos were installed in FY 81/82, 3 in FY 82/83, and 9 sets of iron rings in FY 83/84. For FY 84/85, 26 sets of iron rings are targeted for installation. The iron rings are cast in Kathmandu and come in a set of six, weighing 11 kg. per set (see illustration, Appendix 2.) They have been given priority in Mustang for several reasons. They are much easier to transport than a ceramic stove because of compactness and no breakage. Unlike the improved Magan stoves, the iron rings radiate heat, which is extremely beneficial in Mustang. Although no efficiency studies have been conducted with the iron rings, they have been reported to have a similar rate of savings to the CFAD insert stoves and the RCUP improved Magan stoves. Taking into consideration the additional benefits of space heating, it is assumed that the benefits derived from fuel savings are 735 kg. per stove annually, as in Myagdi and Gorkha. The price for fuelwood is assumed to be Rs. 29/ Bhari (RCUP field check, September 1984). This is an average from places such as Lete in the south, where pine is abundant, to areas in the north where a four day trip may be rquired to collect a Bhari of fuelwood.

Benefits from the iron rings are assumed to extend for 15 years from the time of installation. No depreciation of initial savings levels is assumed, since the iron rings are very durable.

APPENDIX 3 - ATTACHMENT 1

ENERGY COMPONENT: ALLOCATION OF RCUP STAFF SALARIES AND TRAVEL BY DISTRICTS AND TECHNOLOGY, FY 80/81 - FY 84/85

Cost Components	All Figures in Nepalese Rs. by HMG Fiscal Years				
	FY 80/81	FY 81/82	FY 82/83	FY 83/84	FY 84/85
I. Total RCUP Budget for Energy					
Staff Salaries and Travel 1/					
A. Energy Specialist:					
1. Salary	163,625	174,026	52,600	59,850	65,835
2. Travel	13,617	51,967	43,488	53,175	57,934
3. Total	177,242	225,993	96,088	113,025	123,769
B. Gorkha District:					
1. Energy Tech.					
a. Salary	---	---	10,031	12,840	14,124
b. Travel	---	---	1,255	4,244	4,660
c. Subtotal	---	---	11,286	17,084	18,784
2. Stove Tech.					
a. Salary	---	---	6,558	9,600	10,560
b. Travel	---	---	365	1,512	1,689
c. Subtotal	---	---	6,923	11,112	12,249
3. Total, Gorkha	---	---	18,209	28,196	31,033
C. Myagdi District:					
1. Energy Tech.					
a. Salary	---	---	8,984	13,476	14,824
b. Travel	---	---	540	720	740
c. Subtotal	---	---	9,524	14,196	15,564
2. Stove Tech.					
a. Salary	---	---	8,640	10,080	11,170
b. Travel	---	---	927	5,558	6,015
c. Subtotal	---	---	9,567	15,638	17,186
3. Total, Myagdi	---	---	19,091	29,834	32,750
D. Mustang District:					
1. Energy Tech.					
a. Salary	---	---	13,998	17,640	19,404
b. Travel	---	---	1,207	700	780
c. Subtotal	---	---	15,205	18,340	20,184
2. Stove Tech.	---	---	---	---	---
3. Total, Mustang	---	---	15,205	18,340	20,184
E. Grand Total	177,242	225,993	148,593	189,395	207,737

1/ Source is RCUP actual expenditures from Annual Program and Budget. Includes A. Byers' salary and travel for FY 80/81 and FY 81/82, and G. Shakya's starting late FY 81/82.

APPENDIX 3 - ATTACHMENT 1

ENERGY COMPONENT: ALLOCATION OF RCUP STAFF SALARIES AND TRAVEL
BY DISTRICTS AND TECHNOLOGY, FY 80/81 - FY 84/85

Energy Activities by Districts	FY 80/81			FY 81/82			FY 82/83			FY 83/84			FY 84/85		
	S.T.	E.T.	E.S.2/	S.T.	E.T.	E.S.	S.T.	E.T.	E.S.	S.T.	E.T.	E.S.	S.T.	E.T.	E.S.
II. Time Distribution of Energy							(All Figures are Percentages)								
Staff Across Energy Activities1/															
A. Gorkha															
1. Improved Stoves	—	—	10	—	—	20	100	50	35	100	75	75	100	70	60
2. Solar Water Heaters	—	—	10	—	—	—	—	10	10	—	5	5	—	10	10
3. Solar Dryers	—	—	10	—	—	—	—	10	5	—	—	—	—	—	—
4. Water Mills	—	—	—	—	—	—	—	10	15	—	—	—	—	20	30
5. Biogas Plant	—	—	10	—	—	20	—	10	20	—	20	20	—	—	—
6. Other Technologies	—	—	60	—	—	60	—	10	15	—	—	—	—	—	—
B. Myagdi															
1. Improved Stoves	—	—	10	—	—	10	100	60	50	100	50	50	100	70	70
2. Solar Water Heaters	—	—	10	—	—	10	—	20	25	—	20	20	—	10	10
3. Solar Dryers	—	—	10	—	—	10	—	10	15	—	—	—	—	—	—
4. Water Mills	—	—	—	—	—	—	—	—	—	—	30	30	—	20	20
5. Biogas Plant	—	—	—	—	—	—	—	—	—		—	—	—	—	—
6. Other Technologies	—	—	70	—	—	70	—	10	10		—	—	—	—	—
C. Mustang															
1. Improved Stoves	—	—	10	—	—	10	—	40	40	—	40	50	—	50	50
2. Solar Water Heaters	—	—	10	—	—	10	—	20	20	—	10	5	—	10	10
3. Solar Dryers	—	—	10	—	—	10	—	30	30	—	20	25	—	20	20
4. Water Mills	—	—	—	—	—	—	—	—	—	—	30	20	—	20	20
5. Biogas Plant	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6. Other Technologies	—	—	70	—	—	70	—	10	10	—	—	—	—	—	—

1/ Source is estimates from A. Ayers and G. Shakya, Energy Specialists.

2/ E.S. = Energy Specialist; E.T. = Energy Technician; S.T. = Stove Technician.

APPENDIX 3 - ATTACHMENT 1

ENERGY COMPONENT: ALLOCATION OF RCUP STAFF SALARIES AND TRAVEL BY DISTRICTS AND TECHNOLOGY, FY 80/81 - FY 84/85

ost Components	All Figures in Nepalese Rs. by HMG Fiscal Years				
	FY 80/81	FY 81/82	FY 82/83	FY 83/84	FY 84/85
II. Allocation by Districts and Technology[1/]					
A. Gorkha					
I. Improved Stoves					
a. Installation:					
i. E.T. S&T	---	---	5,643	12,813	13,148
ii. S.T. S&T	---	---	6,923	11,112	12,249
iii. Subtotal	---	23,774[2/]	12,566	23,925	25,397
b. Adm. (E.S. S&T)	7,976	20,339	15,134	38,146	33,417
c. Subtotal	7,976	44,113	27,700	62,071	58,814
2. Solar Water Heaters					
a. Install. (E.T. S&T)	---	---	1,130	854	1,878
b. Adm. (E.S. S&T)	7,976	---	4,324	2,543	5,569
c. Subtotal	7,976	---	5,454	3,397	7,447
3. Solar Dryers					
a. Install. (E.T. S&T)	---	---	1,130	---	---
b. Adm. (E.S. S&T)	7,976	---	2,162	---	---
c. Subtotal	7,976	---	3,292	---	---
4. Water Mills					
a. Install. (E.T. S&T)	---	---	1,130	---	3,759
b. Adm. (E.S. S&T)	---	---	6,486	---	16,709
c. Subtotal	---	---	7,616	---	20,468
5. Biogas Plant					
a. Install. (E.T. S&T)	---	---	1,130	3,416	---
b. Adm. (E.T. S&T)	7,976	20,330	8,648	10,172	---
c. Subtotal	7,976	20,339	9,778	13,508	---
6. Other Technologies[3/]	47,856	37,243	7,614	---	---
7. Grand Total	79,760	101,695	61,454	79,056	86,729

otes:

/ Allocations are based on applying percentage time distributions in Panel II, Page 2, to Total RCUP Budget for Energy Staff Salaries and Travel in in Panel I, page 1.

/ Estimated equal to FY 82/83 costs times 140/74, the ratio of installations, (FY 81/82) + (FY 82/83).

/ Represents the other technologies undertaken by the project such as beehives, windmills, corn shellers, peddle threshers, and training sessions and exhibitions.

APPENDIX 3 - ATTACHMENT 1

ENERGY COMPONENT: ALLOCATION OF RCUP STAFF SALARIES AND TRAVEL BY DISTRICTS AND TECHNOLOGY, FY 80/81 - FY 84/85

Cost Components	All Figures in Nepalese Rs. by HMG Fiscal Years				
	FY 80/81	FY 81/82	FY 82/83	FY 83/84	FY 84
III. Allocation by Districts and Technology[1/] (cont'd)					
B. Myagdi					
I. Improved Stoves					
a. Installation:					
i. E.T. S&T	---	---	5,714	7,098	10,
ii. S.T. S&T	---	---	9,567	15,638	17,
iii. Subtotal	---	5,348[1/]	15,281	22,736	28,
b. Adm. (E.S. S&T)	5,317	6,798	14,413	16,954	25,
c. Subtotal	5,317	12,146	29,694	39,690	54,
2. Solar Water Heaters					
a. Install. (E.T. S&T)	---	---	1,904	2,837	1,
b. Adm. (E.S. S&T)	5,317	6,798	7,206	6,782	3,
c. Subtotal	5,317	6,798	9,100	9,619	5,
3. Solar Dryers					
a. Install. (E.T. S&T)	---	---	952	---	
b. Adm. (E.S. S&T)	5,317	6,798	4,324	---	
c. Subtotal	5,317	6,798	5,176	---	
4. Water Mills					
a. Install. (E.T. S&T)	---	---	---	4,258	3,
b. Adm. (E.S. S&T)	---	---	---	10,172	7,
c. Subtotal	---	---	---	14,430	10,
5. Biogas Plant					
a. Install. (E.T. S&T)	---	---	---	---	
b. Adm. (E.T. S&T)	---	---	---	---	
c. Subtotal	---	---	---	---	
6. Other Technologies[2]	37,222	42,238	3,835	---	
7. Grand Total	53,172	67,980	47,815	63.739	69,

Notes:

1/ Estimated equal to FY 82/83 costs times 7/20, the ratio of installations, (FY 81/82) ÷ (FY 82/83).

2/ See page 2 for a list of other technologies.

APPENDIX 3 - ATTACHMENT 1

ENERGY COMPONENT: ALLOCATION OF RCUP STAFF SALARIES AND TRAVEL BY DISTRICTS AND TECHNOLOGY, FY 80/81 - FY 84/85

ost Components	All Figures in Nepalese Rs. by HMG Fiscal Years				
	FY 80/81	FY 81/82	FY 82/83	FY 83/84	FY 84/85
'I. Allocation by Districts and Technology[1/] (cont'd)					
C. Mustang					
1. Improved Stoves					
a. Installation:					
i. E.T. S&T	---	---	6,082	7,336	10,092
ii. S.T. S&T	---	---	---	---	---
iii. Subtotal	---	14,191/1	6,082	7,336	10,092
b. Adm. (E.S. S&T)	4,431	8,070	9,608	14,128	15,471
c. Subtotal	4,421	22,261	15,690	21,464	25,563
2. Solar Water Heaters					
a. Install. (E.T. S&T)	---	---	3,041	1,834	2,018
b. Adm. (E.S. S&T)	4,431	8,070	4,804	1,412	3,094
c. Subtotal	4,431	8,070	7,845	3,246	5,112
3. Solar Dryers					
a. Install. (E.T. S&T)	---	---	4,561	3,668	4,037
b. Adm. (E.S. S&T)	4,431	8,070	7,206	7,064	6,188
c. Subtotal	4,431	8,070	11,767	10,732	10,225
4. Water Mills					
a. Install. (E.T. S&T)	---	---	---	5,502	4,037
b. Adm. (E.S. S&T)	---	---	---	5,651	6,188
c. Subtotal	---	---	---	11,153	10,225
5. Biogas Plant					
a. Install. (E.T. S&T)	---	---	---	---	---
b. Adm. (E.T. S&T)	---	---	---	---	---
c. Subtotal	---	---	---	---	---
6. Other Technologies[2/]	31,017	18,092	3,923	---	---
7. Grand Total	44,310	56,493	39,225	46,595	51,125

: -

stimated equal to FY 82/83 costs times 7/3, the ratio of installations, FY 81/82) ÷ (FY 82/83)
ee page 2 for a list of other technologies.

IV. IRRIGATION[1/]

A. Introduction

Eighty three percent of the people in Nepal are engaged in agriculture. This dependence on agriculture for both food and income ties nutritional levels and incomes to the uncertainties of weather and agricultural markets. Incomes are low, holdings are small, and most hill farmers do not produce enough food to provide even minimum nutritional requirements. Irrigation increases both nutritional levels and incomes of farmers by increasing arable cropland and allowing more crops to be grown in a given year. Since little arable land exists in the hills that is not already being cropped, this increases the pressure to clear range and forested areas. Nepal's favorable climate would allow two to three crops to be grown a year in most areas except for the lack of water during the extended dry season. Water is the critical factor and provision of irrigation water can add one or two crops per year. If these crops are profitable farmer's incomes will be increased and standards of living improved.

Despite abundant water resources, only 20 to 25% of hill area cropland is irrigated. Much of this is supplementary, irrigation being provided by small streams and springs during the rainy season. After the rainy season most of these sources dry up. Diversion of water from larger streams and rivers is generally beyond the technical and capital resources of the local people.

B. Physical Activity Targets and Completions

As shown in Table IV-1 the RCUP project has undertaken 20 irrigation projects with a total cost of $1.7 million. Six projects have been completed to date while the remaining projects are expected to be completed by the dates shown in Table IV-1.

C. Theoretical Benefits and Costs of Irrigation

There are four direct benefits to development of irrigation systems in Nepal. First, when irrigation water becomes available higher yields can be achieved since the irregularities in rainfall can be smoothed. Farmers have direct control over water application and at least the problem of too little water for crops is solved. Second, more profitable crops that require increased amounts of water can replace less profitable crops. The last two types of benefits are similar -- more land can be brought under cultivation and land that was cultivated prior to provision of irrigation water can be cropped more intensively.

1/This paper represents one component of the Agriculture/Irrigation study. It was prepared by Kerry Livengood based on estimates developed by Ganesh Shirakoti.

TABLE IV-1

RCUP Irrigation Projects

		Projected Completion Date	Construction Cost (Rupees)	Architect and Engineering Cost (Rupees)
	Gorkha			
1.	Ampipal	1983	189,312	100,000
2.	Muchoktar	1985	568,619	34,579
3.	Chhoprak	1986	4,048,340	120,000
4.	Mallatar	1985	3,440,452	140,000
5.	Muchok	1985	809,393	120,000
6.	Jaubari	1986	2,560,000	85,000
7.	Simjung	1986	2,000,000	85,000
8.	Dhuwakot	1984	1,811,109	83,856
	Myagdi			
1.	Begkhola	1984	622,673	115,000
2.	Ghatan	1984	852,433	120,000
3.	Jheen	1986	1,402,792	37,000
	Mustang			
1.	Lamangthang	1984	629,171	107,777
2.	Kagbeni	1985	564,513	26,205
3.	Chhonup	1985	509,160	87,219
4.	Charang	1983	334,101	57,231
5.	Ghami (Ward 8-9)	1986	840,000	34,434
6.	Ghami (Ward 1-4)	1986	166,132	6,988
7.	Tukuche	1985	670,483	37,000
8.	Marpha	1984	385,000	17,470
9.	Kunjo	1985	670,483	37,000

Thus, incremental benefits and costs are due to changes in demands placed on environmental resources. Availability of irrigation water usually results in substitution of paddy for maize. This type of substitution usually reduces the requirements for fertilizer and, indirectly, livestock. However, the increased cropping opportunities resulting from availability of irrigation water may increase the use of farmyard manure. The need for fodder and browse to feed livestock to produce farmyard manure is one of the most serious problems facing forest and range managers. Annual burning of the forest to increase browse greatly increases the time required to regenerate the forest. Erosion on grazing lands from overgrazing can also be attributed to the high demand for livestock feed.

Though profits generally increase after irrigation water becomes available, costs also increase. Higher levels of inputs such as seeds, fertilizers and labor raise costs, and if these inputs are not available, profits will be affected. One of the most important inputs is the provision of increased technical support to farmers. New crops require new techniques that must be learned. Extension workers must be available to help in the transition to more profitable crops.

A case study will be used to illustrate the changes in cropping patterns, yields and returns resulting from construction of a irrigation system. The case study will also clarify the assumptions made in calculating benefits and costs of other irrigation projects that have or will be undertaken.

D. Case Study - Dhuwakot Panchayat

1. Setting

The Dhuwakot irrigation system is located in the Gorkha District at the confluence of the Chukti and Rigdi rivers. The 50 hectare command area is dry flat benchland (tar) and has high potential productivity with irrigation. A baseline survey conducted in February/March 1984 (Wood, 1984) found approxi- mately one hundred families farming the land that will be irrigated by the project. Two castes of people dominate in the community, the Kumal (50%) and higher caste Brahmins (50%).

2. Design - Implementation

The system was designed by a consulting firm located in Kathmandu. The firm estimated that the project would cost about NRs. 1,831,000 or NRs. 36,6[illegible] per irrigated hectare. Construction began in 1982 and work was virtually complete in December 1984 with some floodgates to be installed and only minor maintenance and finishing work remaining. Actual expenditures were NRs. 1,811,109, as reported in Table IV-1.

Few significant problems were encountered during the design or construction phase. A number of houses were moved during the construction phase by the owners, and compensation had to be paid to one homeowner for land used for the offices and main canal. A small mill was also moved due to the diversion of water for the canal.

3. Cropping Patterns

As shown in Figure IV-1, prior to irrigation 25 hectares of the command area was irrigated by individuals able to utilize small springs or streams. This allowed 25 hectares of monsoon paddy to be grown under irrigated conditions. The flow of many of these sources drops off after the monsoon season so that there was considerable risk associated with a post-monsoon crop of wheat. Favorable rains were needed on much of the area to assure an adequte yield. Small potato patches were sometimes grown but the most important crop from year to year in the irrigated area during the post-monsoon season was wheat. Wheat area varied from approximately 18 to 25 ha. During the monsoon season a crop of paddy was grown and the area was mostly fallow during the pre-monsoon season with some maize being grown where irrigation water continued year round. Information on the area in maize is not available but was of relatively minor importance.

FIGURE IV-1

Cropping Patterns for the Dhuwakot Project

	Pre-Monsoon	Monsoon	Post-Monsoon
Before Project Cropping Patterns:			
Irrigated	25 Ha maize/fallow	25 ha paddy	25 ha wheat
Rainfed	25 ha fallow	25 ha rainfed paddy	25 ha fallow
After Project Cropping Patterns			
Irrigated	50 ha early paddy	50 ha paddy	50 ha wheat

4. Transition to Full Utilization

Cropping patterns after the project will require a number of years to settle to the pattern shown in Figure 1, due to the time it takes individual farmers to build the earthworks necessary contain the water. The greatest change in cropping is the addition of 25 hectares of irrigated land and the ability to grow a pre-monsoon crop of paddy. The entire area will eventually be planted to an early rice crop, the monsoon paddy, and a post monsoon wheat crop with some area devoted to minor crops such as vegetables and potatoes.

The conversion of land to irrigated paddy requires labor that is provided by the individual farmer. This conversion period will require approximately three years. On-site discussions with farmers indicate that approximately 50% of the land will be converted to paddy in time for the pre-monsoon season of 1985, 75% by 1986 and all 25 hectares by 1987. The actual area planted to different crops in these years also depends on the individual farmer's experience with the pre-monsoon paddy and post-monsoon wheat crop. Evidence from a similar project (Peabody, 1983) supports the adoption rates given in Table IV-2.

TABLE IV-2

AREA CROPPED IN HECTARES BY YEAR

Crop	83/84	84/85	85/86	86/87	87/88	88/89
Monsoon paddy	39	39	40	44	49	50
Rainfed paddy 1/	9	3	--	--	--	--
Pre-monsoon paddy	0	34	39	44	49	50
Wheat	28	34	39	44	49	50

1/ Less land was planted in rainfed paddy in 83/84 and 84/85 because many terraces were under construction.

5. Yields and Production

Dhuwakot is expected to reach full capacity by 1988/89. Yields will increase due to availability of irrigation water and due to use of improved practices. With project and without project yields are given in Table IV-3.

6. Economic Analysis

Returns to irrigation depend on changes in yields which affect revenues, and inputs which affect costs. Revenue changes are summarized in Table IV-4.

TABLE IV-3

WITH AND WITHOUT PROJECT YIELDS

Crops by Type of Water Source	W/P Yield kg/ha	W/O Yield kg/ha	Change in Yield kg/ha
Paddy			
Partial to full irrigation	2600[1/]	1995[1/]	605
Rainfed to irrigated	2600[1/]	1850[2/]	750
Spring paddy	3100[1/]	--	3100
Wheat			
Partial to full irrigation	1800[1]	1342[3/]	458
Additional[4/]	1800	--	1800

1/ Yields from Peabody, 1983.
2/ Yield from Agricultural Statistics of Nepal, Summer Crop Production and Area, Gorkha District, average for district.
3/ CEMAT, 1982.
4/

TABLE IV-4

NET REVENUES FROM IRRIGATION

Paddy	ha	Change in Yield, kg/ha	Total Yield, '000/kg	Price, Rs/kg	Total Revenue, Rs.
Partial to full irrigation	25	605	15.12	3.66	55,350
Rainfed to irrigated	25	750	18.75	3.66	68,625
Spring paddy	50	3100	155.00	3.66	567,300
Wheat					
Rainfed & partial to full irrigation	25	458	30.00	2.75	31,475
Additional	25	1800	45.00	2.75	123,750
TOTAL REVENUES					846,500

Costs of production are based on the detailed estimates developed in the agricultural section. In the Gorkha district these costs include the addition of chemical fertilizer, manure, less family labor due to less weeding, less bullock labor and the application of some insecticides.

The cost of converting unirrigated area to irrigated is paid by the owner of the land either by hiring laborers or by constructing the dikes with family labor. Some landowners were in a hurry to get the first crop in and therefore hired labor for much of the conversion. Others not fortunate enough to have the wealth to pay for the conversion, or due to fields being on the far end of the command area which received less irrigation water in the first year, were planning to convert over a period of several years. Evidence from other such projects indicates that once the water was shown to be available, conversion often came at a faster rate than expected. The labor cost of converting the land is small relative to total project cost, but it is significant from the viewpoint of individual farmers.

TABLE IV-5

COSTS OF PRODUCTION

	ha	W/P Rs.	W/O Rs.	Change Rs.	Total Rs.
Paddy					
Partial to full	25	5604	4667	937	23,425
Rainfed to full	25	5604	4667	937	23,425
Spring paddy	50	5604	0	5604	280,200
Wheat					
Partial to full	25	3554	2860	694	17,350
Additional	25	3554	0	3554	88,850
TOTAL PRODUCTION COSTS					433,250

The change in net returns with the project equals Rs. 413,250 annually once the final cropping pattern is reached. Table IV-6 shows the steady increase in annual returns over conversion period.

The architect and engineering firm responsible for the design of the Dhuwakot project also designed four other projects with a single payment for all. Design costs attributable to the Dhuwakot project are, therefore, not precisely known but were determined based on the relative size of the project. Total payments to the engineering design firm were Rs. 174,000 for the four projects and Dhuwakot represented 48% of the total construction costs.

Maintenance and operating costs were estimated by the contractor to average 10 percent of construction costs per year (CEMAT, 1982). Construction costs were spread over a two year period, beginning in 1983 through 1984. The expected life of the project is 20 years (CEMAT, 1982).

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TABLE IV-6

RETURNS TO CROP PRODUCTION ON COMMAND AREA OVER CONVERSION PERIOD

		Paddy			Wheat		
		Partial To Full	Rainfed To Full	Additional	Partial To Full	Additional	Total
83/84	ha	25	14	0	25	3	
	benefit	55,350	38,430	0	31,475	14,850	140,105
	cost	23,425	13,118	0	17,350	10,662	64,555
84/85	ha	25	14	34	25	9	
	benefit	55,350	38,430	385,764	31,475	44,550	555,569
	cost	23,425	13,118	190,536	17,350	31,986	276,415
85/86	ha	25	15	39	25	14	
	benefit	55,350	41,175	442,494	31,475	69,300	639,794
	cost	23,425	14,055	218,556	17,350	49,756	323,142
86/87	ha	25	19	44	25	19	
	benefit	55,350	52,155	499,224	31,475	94,050	732,254
	cost	23,425	17,803	246,576	17,350	67,526	372,680
87/88	ha	25	24	49	25	24	
	benefit	55,350	65,880	555,954	31,475	118,800	827,459
	cost	23,425	22,488	274,596	17,350	85,296	423,155

Since construction costs involve use of unskilled labor which is paid a wage above the market rate, some adjustment of construction cost is required. The World Bank (1981) found that approximately 55 percent of construction costs in the hill food production project's buildings and irrigation activities involved unskilled labor. The shadow price of labor in Gorkha was Rs. 7 per day while the wage actually paid was Rs. 15 per day. This differential requires a 53% reduction in the cost of unskilled labor, which reduces total construction costs to Rs. 1,285,887.

Benefits and costs are summarized in Table IV-7 by year. Discounting the above cash flows using 10%/year opportunity cost of capital gives a total present value of benefits equal to Rs. 6,078,959, and Rs. 5,499,388 of costs. This would mean a benefit-cost ratio of 1.11, suggesting that this particular irrigation project was worth undertaking.

TABLE IV-7

BENEFITS AND COSTS OF DHUWAKOT IRRIGATION PROJECT BY YEAR

Year	Benefits[1/]	Costs			
		Production[2/]	Construction	Operation & Maintenance	Architect & Engineering
82/83	---	---	642,943	---	83,856
83/84	140,105	64,555	642,944	128,589	
84/85	555,569	276,415		128,589	
85/86	639,794	323,142		128,589	
86/87	732,254	372,680		128,589	
87/88	827,459	423,155		128,589	
88/89	846,500	433,250		128,589	
"	"	"		"	
"	"	"		"	
2003/04	846,500	433,250		128,589	

1/From Table IV-4.
2/From Table IV-5.

E. Overall RCUP Project Results

The benefit-cost ratios for the remaining irrigation projects were computed using the same conversion and adoption period that were assumed in the Dhuwakot project. Total crop benefits and costs upon full implementation were estimated based on budgets and adjusted for a five year conversion period. Benefit-cost ratios for these projects are given in Table IV-8. Computations are given in Appendix 1.

TABLE IV-8

BENEFIT-COST RATIOS FOR ALL RCUP IRRIGATION PROJECTS

Gorkha			Mustang		
1.	Ampipal	1.09	1.	Lamanthang	1.45
2.	Muchoktar	.76	2.	Kagbeni	.45
3.	Chhoprak	.70	3.	Chhonup	1.01
4.	Mallatar	1.06	4.	Charang	.67
5.	Muchok	1.06	5.	Ghami	.93
6.	Jaubari	1.25	6.	Ghami ward 1-4	1.31
7.	Simjung	.79	7.	Tukuche	2.41
8.	Dhuwakot	1.11	8.	Marpha	2.48
			9.	Kunjo	2.76

Myagdi		
1.	Begkhola	.93
2.	Ghatan	1.87
3.	Jheen	2.15

F. Implications for Adjusting Targets in RCUP

It is not obvious whether there is some difference between the seven projects that cannot be justified and the thirteen that can. A benefit/cost ratio of 1.0 or higher indicates that a given project represents an economicall efficient allocation of resources. All districts had projects that were justified, and there seems to be no clear relationship between size and economi efficiency either as measured by command area or by construction cost.

One hypothesis which deserves further examination is that there may be excessively high quality being applied to the architectural and engineering designs as well as for the construction work. Certainly the quality standards evident in the Dhuwakot project would be difficult for rural residents to finance without significant subsidies from HMG. Lower quality for architectural, engineering, and construction work would yield higher benefit/cost ratios if the quality standards are unnecessarily high, since the reduction in present value for benefits will be less than that for costs.

With the majority of RCUP's irrigation projects appearing to have benefit/cost ratios which exceed 1.0, we can safely conclude that this type of activity should not only be retained but probably expanded in scope. Further examination of each project will no doubt yield more precise guidelines for adjusting targets.

March 1985

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VI. DRINKING WATER[1/]

A. Introduction

1. Overview

Piped water systems in developing countries reduce the incidence of waterborne disease which are a major cause of sickness. Among small children they are a leading cause of death in Nepal. The World Health Organization considers that the provision of a safe water supply is the single most important activity that could be undertaken to improve the health of people living in rural areas. In addition to reducing the incidence of water-born diseases, the greater convenience and availability of water allows greater cleanliness which reduces hygiene related diseases. Time saving benefits result from reducing the distance to water sources, thereby giving increased time for leisure or other productive work. In Nepal these time savings to those fetching water can be considerable since a large part of the population lives in hill areas where springs, though plentiful during the wet season, are difficult to reach on steep paths. Due to the monsoon climate with its extended dry season, the flow of existing springs is greatly reduced during three to four months of the year. During this period the time required to fetch water increases from ten to thirty or more minutes per trip. Women, usually responsible for water fetching, may make from five to ten trips per day depending on family size. This task requires several hours each day.

Village water systems in Nepal are costly to build and expensive to maintain. Water systems are built with financial assistance from international aid agencies but villagers are left with maintenance costs. Institutions and skills are inadequate to maintain the systems which as a result often last for less than half the design life. Without a workable pricing or taxing system, and since the water is publicly provided, there is little incentive for individuals to take over the responsibility of caring for the system. Systems are sometimes built for dry season conditions even though water is abundant during six to eight months of the year. Such a system, if not more convenient than wet season springs, may not be maintained during the wet season. This result may mean that the new water system will not work when it is needed during the dry season.

Water like health or education has been considered a "basic need" of people, and therefore the problem of how to supply water has not been considered to be one which involves a great deal of economic analysis. It has been treated as primarily an engineering problem. However, all of the above problems are primarily not engineering but social problems. The most important problem with planning village water systems is that there is not enough donor money to build a new system in every village regardless of size or present water availability. Some criteria must be used in choosing which systems to build. As this study shows, some villages can be benefited by a water system more than others, and knowledge of benefits and costs can aid in making the decision of how and where to build water systems.

1/ This study was done by Kerry Livengood.

2. Analytical Fr mework

Economic methods can be used to measure the costs and benefits of public water systems in different villages as well as to suggest methods of creating incentives and institutions which will maintain water systems over time. Costs are relatively easy to measure since pipe, cement, labor and other inputs are purchased in the market. Benefits are much more difficult to measure. The most important benefits are improved health and added convenience. Studies have shown (Bradley, 1977) that major health related benefits can be obtained only by reducing all vectors of disease simultaneously through increased personal hygiene and use of toilets in addition to provision of clean water. Cleaner water is necessary for improved health but is not sufficient to ensure that the health of the population improves. Thus an improved water system alone, holding all other factors constant, will not greatly reduce the number of diseases or their incidence especially in adult populations. Villagers must adopt sanitation and improved hygiene practices as well as have access to clean water. The approach taken here will not be to attempt to quantify health benefits, since the project has not undertaken to educate villagers in health and sanitation practices. Instead we calculate the number of incremental days a water system must save in order to justify building the system.

Since health benefits from drinking water system improvement may be small and have proven difficult to quantify, a benefit-cost analysis of water system development relies primarily on benefits received by users from time savings. Time savings are more easily measured than health benefits but there are similar problems in valuing time savings due to decreased walking time as there are in valuing decreased time due to sickness. Time savings with no economically productive alternative use of time would have no measurable benefit. It is difficult to measure how time gained from decreased walking time is used. However, as long as villagers have alternative uses for their time such as the opportunity to increase labor time spent on their own farm, to take a job working for a neighboring farmer, or to work on construction projects, a choice to use the time in leisure means that leisure time is worth at least the benefits that are foregone.

3. Alternative Technical and Construction Approaches

A potable water supply makes obtaining water more convenient when gravity piped water replaces streams and springs. Since Nepal is mountainous, a water system usually involves utilization of existing springs or streams through gravity flow systems which do not require pumps or treatment of water. Storage tanks, pipes, break pressure tanks and tapstands are the major components of a village water system. All the systems in the project involve gravity piped systems delivered to public tapstands. In Nepal two approaches have been taken in developing drinking water systems. One is to allow a maximum of villager initiative in self-help projects but with little supervision; the second method relies on careful design studies and professional construction services. There are problems with both methods. The self-help method more often than not produces systems with plastic pipe

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strung through trees. The sophisticated approach in Nepal's climate of government bureaucracy is not only time consuming but, due to lack of maintenance and problems with siltation, often does not result in a longer lasting system.

For all but the Taple project RCUP has chosen to build water systems without requiring villagers to pay for systems or contribute labor to system construction. There is quite a lengthy process involved in planning and building a water system. The planning process for each system involves RCUP engineers, and engineering design firm, a building contractor, an agency of the government, and villagers. Each system has a design phase which includes site selection, surveys and estimates, and a building phase. The RCUP engineers are responsible for overseeing the design phase. A consulting engineering firm was employed to study each system in order to determine the feasibility of the system, locate sources, solve water rights problems and to design each system. The Department of Water Supply and Sewerage is responsible for large projects while the Ministry of Panchayat and Local Development handles smaller projects. The role of the two government agencies involved is to oversee the construction phase of each system.

Local people would not usually know how to maintain properly the water systems RCUP has built for them. As a result, the systems cease to function within a very short time. In most instances even if someone knew how to repair the malfunction, they would not have the proper tools for the job. Construction by professional contractors only turns over an intact water system without educating the villagers in the workings and the limitations of the system. In order to prepare villagers to take over the responsibility of maintenance of a system RCUP has attempted to train a maintenance worker for each system. A survey of systems found that though maintenance workers had been trained and had received tools still some systems were often not being repaired.

An alternative to the reliance on professional help is to include a number of villagers in the construction of the system and require villagers to provide labor while constructing the system and to pay user fees. The residents of Taple panchayat were requested by RCUP to allow the construction of the water system in ward nine to serve as a training school for all RCUP drinking water system maintenance workers involved with systems built by the Ministry of Panchayat and Local Development. In order to allow participation by local residents, part of the construction involved improving water collection tanks at the traditional source of water (kuwas) with villager help under the guidance of an American Peace Corp Volunteer. One tap was constructed in the center of the village by the maintenance workers while all other taps were to be constructed by a contractor. The single tap constructed by the maintenance workers has been in operation for nearly a year while the contractor has yet to complete the remaining taps in the system. However, the one tap is easily accessible to a large part of the village and is available when most other sources are dry during the dry season. As a result it is reported to be heavily utilized during the dry season.

An alternative to the two methods presently used to build water systems in Nepal is suggested by examination of the water system at Taple Panchayat. The seasonality problem with water flows means that system benefits are low during part of the year but significantly higher for the two to three month dry season. A very large expensive system probably cannot be justified based on benefits, even though high, for such a short period. One method to solve this problem and at the same time to provide safe water at natural sources is to build the system only to provide the minimum safe flow required for the dry season just as the one tapstand at Taple provides. Tapstands could be located so that they will save the most amount of time during the dry season when benefits are great. In order to provide safe water, natural sources can be improved with villager assistance by building enclosed reservoirs at the source and by protecting the watershed above the source from contamination.

Based on past RCUP experience and the above discussion, an analysis of two alternatives would seem to provide both a critique of past policies and a guide for future action. These alternatives are:

a) The approach as utilized by the project.
b) Provision of one third of costs by villagers by requiring villagers to provide labor to repair and protect natural sources and construction of a system designed to provide a minimum safe quantity of water for the dry season.

B. Physical Activity Targets and Completions

The RCUP project has undertaken twenty three projects requiring approximately $705,000. The targets for developing drinking water systems prepared in the original design study were over-ambitious and they under-estimated the cost of building drinking water systems using professional construction services. The major cause of under-estimating costs was not including sufficient fees for design of systems by architect and engineering firms and for contractors to build simple gravity flow water systems. For example, the design study cost estimate for the Shrinathkot systems was Rs. 567,400 while construction costs actually were Rs. 1,119,471. As a result, of the 103 wards covered in 33 villages in the first five years of the design phase, 82 wards in 23 villages have received approval for water system development. The design phase planned to build in 44 villages at a total cost of Rs. 11,315,400 while 23 systems were built at a cost of Rs. 11,042,728 including design cost but not including the cost to the project to oversee design and construction.

Table VI-1 presents data on drinking water systems which have been completed. Column 1 gives the name of each system according to Panchayat in which it is located which may or may not be the actual name of the village. The location by ward number is given in column 2 and system cost including architect and engineering design costs is given in column 3. The year or expected year of completion is given in column 4. The population to be served by the system in the base year and at the end of 15 years is shown in column 5. The type of source used before and after the system is constructed is given in column 6 and the distance to the old source given in column 7.

TABLE VI-1

LOCATION OF COMPLETED DRINKING WATER PROJECTS

(1) LOCATION IN PANCHAYATS	(2) WARD	(3) COST, RS.	(4) YR.	(5) POPULATION, YR.0/YR.15	(6) SOURCE OLD	(6) SOURCE NEW	(7) DISTANCE TO OLD, MINUTES
A. Gorkha							
1. Shrinathkot	1-6	1,177,448	84	1639/2206	spring	river	30
2. Manakamana	3,5-9	266,660	84	454/787	spring	river	25
3. Khoplang	2,4-6,8,9	1,093,011	84	2124/2858	spring	river	30
4. Jaubari	2,3	391,903	84	758/1000	spring	river	45
5. Dhuwakot	3-5	277,180	84	578/743	spring	river	15
6. Palungtar	9	510,092	84	2335/3445	kua	river	10
7. Chhoprak	6	593,240	83	1533/2063	spring	river	33
8. Saurpani	1-4	484,036	84	712/899	spring	spring	15
9. Simjung	1-6	1,039,622	84	2256/2863	spring	river	10
10. Swara		1,353,467	84	2454/3114	spring	spring	18
11. Taple	1-5,9	1,373,802	85	3331/4483	varies		15
B. Myagdi							
12. Piple	4	213,434	84	400/593			5
13. Baraha	1-4	648,733	86	1222/1645	old tap		5
14. Rakhu Bhagawati	8,9	373,201	84	723/1048			6
15. Jhee	1-5	405,506	84	1732/2165	spring	stream	5
16. Doba	5	193,049	85	215/479	spring	spring	6
17. Doba (Tatopani)	9	302,005	84	487/655	stream	stream	5
C. Mustang							
18. Chhusang	5,6	128,000					
19. Chhusang	8	73,500					
20. Marpha	1-4,9	655,853	85	1147/1434	canal	stream	5
21. Kowang	6	107,472	84	87/118	canal		5
22. Chhonop	3,4	115,829	84	201/251	spring		4
23. Lomanthang	1-8	212,385	84	603/753	canal	spring	5

C. Costs

Estimated costs of system construction were minutely detailed in reports prepared on each system. RCUP costs and engineering design costs were also available from budgets. The architect and engineering costs were approximately 8% of total system construction cost. Labor costs were approximately 35% of total system construction cost. Though each project was carefully planned, the connection between the design and actual product depends on the monitoring efforts of the government agency responsible. In the design report, the consultant estimates the cost of the system. These costs were, in most cases, considerably higher than actual construction costs. Without careful monitoring there may be little connection between what was designed by the consultant and what was built by the contractor. Consultant fees as high as 8% should also cover the cost of some monitoring activities.

Information on all systems was not available since some are yet to be constructed and several systems were located in an area of the Mustang district closed to foreigners.

D. Benefits from Savings in Travel Time

A potable water supply makes obtaining water more convenient when gravity piped water replaces streams and springs. Those who fetch water will have more time to devote to other activities. There are two effects from constructing a water system. First, there is a time saving made on each trip that was made to the old water source that is now made to the tapstand. Second, since water is both more abundant and cheaper, as measured in walking time, there will be a tendency to use more water. There is also a time savings made on these new trips to the water source, though these time savings are made on trips that the consumer was not willing to make when the water was less accessible. These two types of savings are consumer surplus benefits.

Calculation for productivity benefits can be summarized as follows. First, it is necessary to determine the amount of labor time needed to carry water for one year's time for each villager. Travel time per trip can be left as a variable and the total amount of labor time per year can be calculated based on assumptions for waiting time during the wet season and dry season. The time required to haul water each year from the old water source is calculated and adjusted for varying time taken during the dry season and wet season to fill water containers. Based on field studies, the length of the dry season is 91 days and 274 days for the wet season. Also, based on a survey of water use conducted by UNICEF in 1984 and a survey of six village in the Gorkha district conducted for this study, waiting time during the wet season was found to average 7 minutes during the wet season and 14 minutes during the dry season. In equation form labor time for hauling water for one trip per day for one year is:

$$TY = 91\,[(2 \times OW) + 14] + 274\,[(2 \times OW) + 7]$$

where

TY = time in minutes required to make one round-trip per day over a one-year period

OW = one-way time in minutes required to walk to old source

For the Shrinathkot system a one-way trip to the spring requires 30 minutes. This means that over a one-year period 25,092 minutes will be needed to make one round-trip per day carrying water. Assuming an eight hour work day this is approximately 52 work days which is determined by dividing by the number of minutes in an eight hour work day. Thus,

TYL = TY/480, where TYL is defined as the workday equivalent of TY.

The number of trips per year by everyone in a village depends on the amount of water used in the home by each person, the number of people in the village, and the amount of water hauled on each trip. The typical container used to haul water holds approximately 20 liters. Water usage in most studies have analyzed total water consumed. Only the water carried is relevant in this situation. Studies in East Africa (White, et al., 1972) found that water requirements are 4 to 18 liters per person per day. Since water is available while people travel to and from the fields or other locations, water hauling over longer distances is limited to water needed in the home, while other water consuming activities will be conducted at the water source. Based on a survey of six villages conducted as a part of this study, water consumption for distance of over 15 minutes is assumed to be 5 liters.

Next, the amount of time required for making one round-trip for one year is multiplied by the number of trips required for those people benefited by the water system. This gives the total time spent per year carrying water from the old water source. In equation form,

$$LTO = TYL\ [(P \times 5)/20],$$

where

LTO = days of labor time per year spent carrying water from old source

P = number of people benefited by new system in a given year

For Shrinathkot there are 1,639 users (see Table VI-1) of water who will be supplies by the new system at five liters per day per user. This quantity requires 8,195 liters of water per day. At 20 liters of water per trip this is equivalent to 409.75 trips per day. Over a one-year period 21,304 days of labor time would be required to fetch this amount of water for the existing population.

Next, time spent fetching water using the new system is calculated by computing the total amount of days required to haul the same amount of water from the newly constructed water tap. This is calculated in the same manner as above except that the time used to carry water is not the time to the old source but the time to the tap. This time expenditure also includes less time spent waiting in line during periods of low flow since the tap system will be much more dependable. Taps are generally built within a five minute walk of all users. Some users will come from further distances during the dry season, but generally the number of users is limited to the village area. For most of the year there is no waiting time at a tapstand other than the time required to fill the container. The survey of tapstand users in six villages found that the average time at a tapstand was under three minutes. For the new system, therefore,

$$TYN = 365\ [(2 \times 5) + 3]/480,$$

where

TYN = time in workdays per year spent carrying water from the new tap.

For the Shrinathkot system the "with system" time required for one trip per day equals 9.9 labor days.

Time used to haul water from the tap with the pre-tap system amount of 5 liters of water consumed per user is

$$LTN = P\ [(TYN \times 5)/20],$$

where

LTN = labor days spent carrying pre-tap system amount of water for all users benefited.

For the Shrinathkot system, total labor time after the tap system is constructed will be 4,056 labor days per year for all users. With no change in consumption after the system is constructed, the system will save 17,248 days of labor (equal to LTO minus LTN).

Water consumption increases when the distance to a water source is greatly reduced. Since there is not sufficient data to estimate the demand for water as a function of travel time, we will assume that demand is a linear function of travel time. Studies have shown (White, et al., 1972) that demand for water is fairly elastic, increasing two to three times when taps are made available in the home. Carruthers (1973) found that users close to water stands used quantities greatly exceeding more distant users. Water from a tapstand is not only nearer but the flows are more dependable and require less waiting time during the dry season. A UNICEF survey1/ of four systems in Nepal found that average consumption was 27 liters per head. Of this amount 42% was carried to the household. This would indicated that approximately 11.3 liters per capita are being carried from water taps, though this estimate might be high due to problems in measurement of flows at one system. Based on these studies we will assume water consumption doubles when travel time is reduced by 15 minutes or more. This assumption is conservatively biased since the analysis of water supply situations in the villages before construction of the tap system (studies carried out by RCUP during the design of each system) found that during April and May many sources will be dry. When a source dries up the villagers must walk longer distances to obtain water.

Since the increase in trips could result in increased time spent fetching water, our measure of labor time saved measures the areas under the linear demand curve for water above the new trip cost and to the right of the old quantity of trips taken. This is computed by subtracting the number of trips spent from the new number and multiplying by one-half the change in trip time. For the Shrinathkot system this is 8,685 days of labor. Total time savings equals 25,933 days.

1/ See UNICEF, 1984, Results of Water Consumption Pattern Survey, Lamidana Field Office. Eastern Development Region. Unpublished Report.

This information can be conveniently illustrated on a diagram showing the demand for water as a function of labor time.

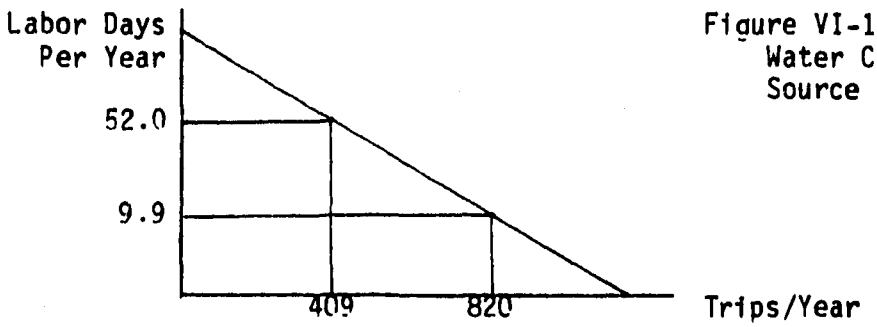

Figure VI-1. Demand for Water Carried From Source to Households

Labor time is multiplied by the alternative wage rate, which in this case is taken to be Rs. 7 for Gorkha and Myagdi and Rs. 18 in Mustang. This means for the Shrinathkot system in the Gorkha district, savings the first year equal Rs. 181,531. However, the population of Nepal is increasing at 2.6% per year, so there will be additional users each year that the system is in operation. Since there is some evidence of out migration from the Hills, the net growth was reduced to 2.0%. The population of Shrinathkot served by the system for the years 1984-88 and benefits for the system are given below with present values calculated using 10%/year discount factors.

	Population	Benefits	Present Value
1984	1,639	182,420	182,420
1985	1,672	186,094	169,176
1986	1,705	189,767	156,832
1987	1,739	193,551	145,418
1988	1,774	197,446	134,858
		Total Benefits	788,704

A summary of the assumptions used to calculate benefits is given below.

1. Waiting time without a system is 7 minutes during the wet season and 14 minutes during the dry season.
2. Water consumption without a system is 5 liters per day per person and increases to 10 liters per day after the system becomes available.
3. Waiting time with the new system is 3 minutes year-round.
4. Twenty liters of water is carried per trip.
5. The population growth rate is 2% in Gorkha and Myagdi and 1.5% in Mustang.
6. The engineering design studies suggested a 15 year life for the water systems. However, after an informal survey of Mustang, Gorkha, Myagdi and Makwanpur districts and in the Kathmandu Valley few systems were found to be in operation after only five years. For this analysis three different lifetimes for systems has been used, 5, 10, and 15 years.

7. Maintenance costs are assumed to be the cost of one worker at Rs. 200 per month for a five year life of system, Rs. 400 for a 10 year life and Rs. 600 for a 15 year life. Large systems often hire maintenance workers while small system users usually contribute rice or maize to a maintenance worker.
8. The wage rate in Gorkha and Myagdi is Rs. 7 per day and Rs. 18 per day in Mustang.

Since unskilled labor makes up approximately 25 percent of the construction cost of a system it was necessary to adjust labor costs for the opportunity cost of labor which is 67 percent below the actual wage rate paid. This requires an 8 percent reduction in the project cost (presented in Table VI-1) net of architects and engineering fees. This adjustment was made and is given in Table VI-2.

Based on the above assumptions and adjustments, a computer program was developed to calculate the costs and benefits of those systems that saved more than 5 minutes per trip on the average. Eleven systems qualified based on this criterion. The results of this analysis is presented in Table VI-3. Differences in rounding methods account for the Rs. 788,704 of benefits estimated above for Srinathkot compared to Rs. 788,541 reported in Table VI-3.

Out of the 11 systems that can be evaluated based on travel time savings, 3 systems have a B/C ratio greater than 1, assuming a 5 year stream of benefits. Without proper maintenance over half of the systems that would produce positive net benefits fall into the "red". A comparison of benefits for each different lifetime shows that considerable expenditures can be made on a system in order to capture future benefits that would be lost without maintenance. If a system were maintained so that it could last the entire 15 years all but three systems would be justified.

As important as maintenance is, if the systems are not meeting the need for which they are intended, there will be little incentive for users to maintain systems. The project has built considerably more expensive systems than those built by other donors. For example, cost estimates for the Simjung system prepared by the Swiss Agency for Technical Assistance were Rs. 101,113 with 3 taps planned while the RCUP system cost Rs. 1,177,447 and provided 43 taps for the same area in Simjung. The effects on the benefit-cost ratio of building smaller systems with local labor and renovation of traditional sources can be investigated. The average number of users per tap for the Gorkha district projects was approximately 70. If we build smaller systems with fewer taps, users must walk farther than the distances required with the large system but less than the distances with only traditional sources. Tapstands would serve those who must presently travel the longest distances and provide an emergency source during the dry season for those users who normally have plentiful water at traditional sources. If the system at Shrinathkot was built so that the number of users per tap were doubled, but in such a way that travel distances were cut to 15 rather than to 5 minutes, this would approximate the system suggested above. The cost of such a system could be estimated based on the average cost per tap of previous systems. The average cost per tap of previous systems built in Gorkha was Rs. 32,279. With 140 users per tap, 12 taps would have been built. Total cost of this smaller system would be Rs. 387,348, plus an expenditure of approximately Rs. 100,000 for repair of traditional sources, for a total cost of Rs. 487,348.

TABLE VI-2

ADJUSTMENT FOR SHADOW PRICE OF UNSKILLED LABOR

ALL FIGURES ARE IN RUPEES

SYSTEM NO.	TOTAL COST	A&E COST1/	UNSKILLED LABOR ADJUSTMENT2/	TOTAL ADJUSTED COST
1.	1,177,448	37,300	1,048,936	1,086,236
2.	266,660	44,100	204,755	248,855
3.	1,093,011	42,100	966,838	1,008,938
4.	391,903	45,000	346,904	391,904
5.	277,180	45,000	213,606	258,606
6.	510,092	78,300	397,249	475,549
7.	593,240	40,100	508,889	548,989
8.	484,036	43,800	405,017	448,817
9.	1,039,622	43,800	916,156	959,956
10.	1,353,467	43,800	1,204,894	1,248,694
11.	1,373,802	43,800	1,223,602	1,267,402
12.	213,434	37,700	161,675	199,378
13.	648,733	37,700	562,150	599,850
14.	373,201	37,700	308,661	346,361
15.	405,506	51,400	325,778	377,178
16.	193,049	39,400	141,357	180,757
17.	302,005	37,000	243,805	280,805
18.	128,000	32,000	88,320	120,320
19.	73,500	32,000	38,180	70,180
20.	655,853	32,000	573,945	605,945
21.	107,472	37,700	64,190	101,890
22.	115,829	32,000	77,123	109,215
23.	212,385	32,000	165,954	197,954

Notes:

1/ Obtained from RCUP records.

2/ Adjustments were made consistent with the description presented on page 9.

TABLE VI-3

BENEFITS IN SAVINGS OF TRAVEL TIME

LOCATIONS OF SYSTEMS	BENEFITS	COSTS1/	B/C RATIO
5-Year Life			
1. Shrinathkot	788,541	1,095,334	0.72
2. Manakamana	179,252	257,953	0.69
3. Khoplang	1,021,879	1,018,036	1.00
4. Jaubari	560,937	401,002	1.40
5. Dhuwakot	128,426	267,704	0.48
6. Palungtar	317,302	484,647	0.67
7. Chnoprak	816,933	558,087	1.46
8. Saurpani	158,191	457,915	0.35
9. Simjung	306,567	969,054	0.32
10. Swara	672,339	1,257,792	0.53
11. Taple	740,124	1,276,500	0.58
10-Year Life			
1. Shrinathkot	1,329,120	1,115,730	1.19
2. Manakamana	302,126	278,349	1.09
3. Khoplang	1,722,428	1,038,432	1.66
4. Jaubari	945,482	421,398	2.24
5. Dhuwakot	216,463	288,100	0.75
6. Palungtar	534,823	505,043	1.06
7. Chnoprak	1,376,973	578,483	2.38
8. Saurpani	266,638	478,311	0.56
9. Simjung	516,728	989,450	0.52
10. Swara	1,133,266	1,278,188	0.89
11. Taple	1,247,523	1,296,898	0.96
15-Year Life			
1. Shrinathkot	1,699,712	1,141,000	1.49
2. Manakamana	386,368	303,619	1.27
3. Khoplang	2,202,687	1,063,702	2.07
4. Jaubari	1,209,109	446,668	2.71
5. Dhuwakot	276,819	313,370	0.88
6. Palungtar	683,949	530,313	1.29
7. Chnoprak	1,760,911	603,753	2.92
8. Saurpani	340,989	503,581	0.68
9. Simjung	660,810	1,014,720	0.65
10. Swara	1,449,251	1,303,458	0.11
11. Taple	1,595,368	1,322,166	1.21

1/ System costs differ from those in Table VI-2 by the present value of a stream of maintenance costs over a 5, 10, and 15 year period. Present values of these costs at a 10 percent disount rate are Rs. 9,098, Rs. 29,494, and Rs. 54,764, respectively.

With a cost of Rs. 487,348 and travel time reduced to 15 minutes and by still assuming a 5 year life total benefits equal Rs. 505,633 to give a benefit-cost ratio of 1.02. With a smaller system, and perhaps a system that is needed year round, system life could be expected to be extended without increased maintenance expenditures. Construction of this type of system would, however, require the increased involvement of villagers in order to identify those traditional sources of water that do not provide permanent water flows year round and to determine appropriate sites for taps to obtain the greates reduction in travel times for the dry season.

E. Health Benefits

A number of systems do not save significant amounts of travel time for water users. In some instances, as in Marpha, to go to the tap stand will actually take more time since the old source of water was a canal that ran the entire length of the village. For these systems the rationale for building them was not travel time savings but health benefits. Time savings can also be obtained from health benefits of water systems. If a water system combined with improved sanitation practices reduces sickness, then productive time becomes available that would have otherwise been lost while being sick. Such time savings required to justify a system are limited by the amount of sickness that can be attributed to hygiene related sources. Based on an economic life of 10 years for the water system and no travel time savings, it is useful to estimate what these time savings from improved health would have to be in order to justify building the remaining systems. Using the computer program, time savings that give a B/C ratio of 1.0 were determined. This time saving can be compared to days of labor that might be lost to sickness. This information is presented below in Table VI-4.

TABLE VI-4

HEALTH BENEFITS REQUIRED TO JUSTIFY WATER SYSTEMS

SYSTEM	VILLAGE LABOR, DAYS	LABOR/ WORKER, DAYS
12. Piple	4,305	21.5
13. Baraha	13,152	21.5
14. Rakhu Bhagawati	7,370	20.4
15. Jhee	8,271	9.5
16. Doba	4,032	37.5
17. Doba (Tatopani)	----------	----------
18. Chhusang	----------	----------
19. Chhusang (WARD 8)	----------	----------
20. Marpha	5,150	9.0
21. Kowang	936	21.5
22. Chhonop	1,017	10.1
23. Lomanthang	1,779	5.9

The first column gives the total labor days that construction of the system would have to be realized in the village in order to make the system's costs equal to the system's benefits. Assuming that half of the villagers are economically productive or able to use the time saved in a productive occupation, then the second column gives the labor time per worker that would have to be saved by the system in the form of decreased morbidity.

An example helps to clarify the concept. If the Piple system were able to save each water carrier 16 minutes on each trip taken, then the following computations are valid as shown in Table VI-5. By following computations identical to those given above for the Shrinathkot system, the time savings given in column 3 and valued at Rs. 7 per day give the annual benefits shown in column 4. Discounted at 10 percent, these benefits total to Rs. 219,636.

Including Rs. 400 per month maintenance costs, present value of total costs are Rs. 228,872. Taking account of the Rs. 219,636 present value of benefits reported in Table VI-5, the water system in Piple would be estimated to yield a benefit-cost ratio of approximately 1.0.

TABLE VI-5

TIME SAVINGS REQUIRED TO JUSTIFY THE PIPLE SYSTEM

		BENEFITS FOR PIPLE WATER SYSTEM		
YEAR (1)	POPULATION (2)	TIME DAYS SAVINGS (3)	VALUE OF TIME RS. (4)	PRESENT VALUE RS. (5)
1984	400	4,305	30,135	30,135
1985	408	4,392	30,744	27,949
1986	416	4,480	31,360	25,917
1987	424	4,569	31,983	24,029
1988	433	4,660	32,620	22,280
1989	442	4,753	33,271	20,659
1990	450	4,849	33,943	19,160
1991	459	4,994	34,608	17,759
1992	469	5,044	35,308	16,471
1993	478	5,146	36,022	15,277
		Total Present Value		219,636

Three systems could not be evaluated due to restrictions on collecting data. The two Chhusang systems are in the restricted zone, and the Tatopani system was found to serve a great number of trekkers while local people had previously built limited private tap systems.

Studies have found (McJunkin, 1982) that health savings of up to 12 days can be obtained through the combined effects of improved water and use of good health and sanitation practices. With 12 days as a guide, only four systems qualify since all others require more than 12 days which could not be delivered based on potential health benefits.

F. Implications for Adjusting Targets in RCUP

Based on the above analysis, criteria for future water project construction and selection could be based on time savings and potential health benefits. A system could be built that would maximize the benefits of alternative tapstand locations by considering travel times during the dry season relative to the wet season and by including traditional water sources and their upkeep. Evaluation studies should involve villagers in determining where taps are needed and where improvements in traditional water sources would be adequate. Villagers should also be asked to contribute at least a third of the cost of the system by providing labor during the building phase. Since the village women are the most involved in hauling and using water, a program that involves women in maintenance of the system might be implemented on a trial basis to discover if this vested interest in the upkeep of the water system might improve system performance. An alternative would be to institute a system of user fees to provide more ample wages for system maintenance workers.

For those systems that do not save time in fetching water but are considered important for health reasons, systems in which costs require more than 12 days of time savings per year should be evaluated for mitigating factors such as presence of contagious disease or risk to infants. Otherwise these systems will probably not represent an efficient allocation of RCUP resources.

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VII. THE INSTITUTE OF RENEWABLE NATURAL RESOURCES[1/]

A. Introduction

The Resource Conservation and Utilization Project, in attempting to halt and reverse the deterioration of the Nepalese environment, requires well-trained workers who understand both environmental relationships, as between vegetative cover and erosion, and relationships between society and the environment. During the planning stages of the project, Nepal had the capability to train, in-country, 200 forest technicians. There was no college level training in-country for the professionals required to manage resources such as forests, soil, and wildlife. Three alternatives exist for training. Training capability could be developed in-country, students could be sent out-of-country, or personnel with the required skills could be hired from foreign countries. A choice was made at that time to develop in-country training capability. The objective of this training program was to provide a "cadre of professionals and technicians in conservation and utilization of natural resources, and help in institution building that will give Nepal a self-sufficiency in the training of future personnel." The alternative of continuing to train some workers out-of-country and to hire some from outside sources was not quantified. The main purpose of this analysis is to compare the costs of developing workers in Nepal to the alternative of training the students at schools outside the country.

The approach to developing a resource management training school in Nepal was put together jointly by a team representing the Ministry of Overseas Development of the United Kingdom and the Agency for International Development of the United States. A study team was organized at the end of 1978, with the following objectives:

1. Estimate the number of trainees based on the requirements for resource managers country-wide.

2. Outline the curriculum.

3. Prepare estimates of staffing requirements for both training of Nepali faculty and expatriate assistance.

4. Estimate costs of developing the school.

The study team also looked at in-service training requirements of the departments involved in resource management and at improvements that could be made in training of technicians at the existing school.

Manpower training estimates were based on a survey of the Departments of Forestry, and Soil and Water Conservation. The survey estimated "deficits" on a ten-year basis in order to determine the number of professional workers that would be "completely adequate for the Ministry's needs." The survey determined that total annual output of the training program would need to be 48 graduates in order to meet the requirements of the various departments for Bachelor of Science level professionals. The study team urged a staff review as it was felt that "many of the figures appear to be high (Woods, et al., 1979)."

1/ This study was done by Kerry Livingood.

A three-year diploma course in forestry, and soil and water conservation was recommended with an expected intake of 30 per year. Those entering as first year students were expected to have a certificate and at least a year of practical experience. Since experience is only gained through working in the public sector, this effectively ensured that only departmental employees would gain entrance at this level. Students with a diploma (Bachelor of Science) degree could gain entrance in the second year through taking a special orientation course. Ten additional students could gain admission by this method. Thus, total output of diplomas could be as high as 40 depending on the failure or drop-out rate.1/ For IRNR a two-year certificate or technician course was also recommended with an expected intake of 110 students per year. With a teacher to student ratio of 1:10, the study team recommended that twelve new lecturers would be needed. These would be obtained through overseas training. Expatriate assistance would total six and would first develop courses and then give assistance to staff returning from training in foreign schools. Total costs were estimated as shown in Table VII-1.

The school was jointly funded, with the World Bank providing funds for the physical facilities to be built in Pokhara and the governments of Nepal and the United States providing funds for equipment, development of curriculum, and staffing. The school was named unofficially the Institute of Renewable Natural Resources to emphasize that it was more than just a forestry school, that soil, water, and wildlife were also an important part of the training provided. The Institute began classes in the fall of 1981 when 30 students were admitted from various departments of the Ministry of Forest and Soil Conservation. Since classes started before construction of physical facilities, they were held in 1981/82 in Pokhara at another campus of the Tribhuvan University system and in the following two years in Hetaura at the forestry technician school. After a six-week preparatory course, ten students with B.S. degrees were admitted in the fall of 1982 into the second year class, and another 30 students were admitted as first year students.

The first group of potential teachers were sent to schools in the United States beginning in March 1980. The first full-time expatriate assigned to the Institute arrived early in 1981 when the Assistant to the Dean position was filled by a silviculturalist from Virginia Polytechnic Institute and State University.

Since the first year curriculum was only basic courses, expatriate assistance was not needed until fall 1982 when a soil scientist, civil engineer and resource economist arrived. The first class graduated in the fall of 1984. Actual student enrollment for the years 1981-84 and estimated enrollment for 1985-91 are shown in Table VII-2.

1/ This estimated maximum output of 40 is lower than the estimated annual Departmental requirements of 48 which was discussed on page 1. Thus, the planned output of diploma students is conservatively low.

TABLE VII-1

DESIGN TEAM'S ES[illegible] OF COSTS FOR ESTABLISHING IRNR

COST CATEGORIES	ESTIMATED COSTS ('000 Rs.) BY HMG FISCAL YEARS						
	TOTAL	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85
Expatriate Costs	970.0	30.0	230.0	380.0	230.0	50.0	50.0
Overseas Training	356.5	37.0	45.4	48.0	64.0	78.1	84.0
Staff and Salaries	307.4	-	22.2	51.2	62.8	84.4	86.8
Physical Facilities	1,364.2	-	322.1	640.5	401.6	-	-
Equipment	292.8	-	24.2	198.7	69.9	-	-
Maintenance	224.6	-	25.8	32.4	44.1	59.9	62.4
TOTAL	3,515.5	67.0	669.7	1,350.8	872.4	272.4	283.2
Present Value @ 10% Discount Factors	2,809.5	67.0	608.8	1,116.4	655.4	186.1	175.8

TABLE VII-2

STUDENT ENROLLMENT

	NUMBERS OF STUDENTS BY ACADEMIC YEARS									
	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
CERTIFICATE COURSE										
1st Year	-	-	-	-	-	40	75	100	100	110
2nd Year	-	-	-	-	-	-	35	70	100	100
Total	-	-	-	-	-	40	110	170	200	210
DIPLOMA COURSE										
1st Year	-	10	10	10	10	10	10	10	10	10
1st Year	30	30	30	30	30	30	30	30	30	30
2nd Year	-	36	36	36	36	36	36	36	36	36
3rd Year	-	-	35	35	35	35	35	35	35	35
Total	30	76	111	111	111	111	111	111	111	111

B. Analytical Method

Cost-benefit analysis in this case involves comparing the costs of the alternative already chosen (developing in-country training) to the cost of sending students outside the country for training. The costs of out-of-country training are the benefits from choosing to develop in-country training. If the costs are higher for out-of-country training the benefit-cost ratio will be greater than one. If costs are less for out-of-country training then the benefit-cost ratio will be less than one. For almost any product, a developing country faces the problem of whether to produce a good or to import it. Unless the country can eventually produce the good at a lower cost than the cost of importing it, the industry will not be competitive in the world market and the industry will not contribute to development.

C. IRNR Costs

1. Overseas Training for Faculty

Beginning in 1981 the first of eighteen faculty were sent to schools in the United States to work on either a Master of Science or a professional degree such as a Master of Forestry. Costs include airfare, tuition, books, stipend, and medical expenses. Expenses varied depending on the school and length of time required to complete coursework. Actual or estimated costs for each participant are given in Table VII-3. All but one student returned to the Institute to teach, and all fulfilled the requirements for their degree.

Overseas training costs are project costs involving foreign exchange. Dollars are being converted through RCUP into Nepalese Rupees at the official government rate, rather than at the free market rate which is approximately 20% higher. Use of the official foreign exchange rate, therefore, understates the true economic cost of overseas training. To correct for this distortion, the RCUP's reported costs of overseas training must be increased by 20%. This adjustment is made in Table VII-3.

2. Physical Facilities and Site

The World Bank, as a part of the Community Forestry Program, is providing funds for construction of classrooms, hostels, administration buildings and residential buildings in Pokhara on 71.5 hectares of land given by the Department of Forest. In addition to this area 3.5 hectares were purchased at a cost of Rs. 256,000 per hectare, and 5.7 hectares were purchased for Rs. 157,000 per hectare. Though most of the land was a gift, there is still an opportunity cost for land. This is the value of the land in its most productive use. Market value is one indicator of this opportunity cost. Land prices vary with location and suitability for business or agricultural use. Though the campus is near one of the fastest growing cities in Nepal, 71.5 hectares of the land is hilly, suitable neither for home or business. In areas suitable for home or business, land values range from Rs. 295,000

ACTUAL AND E[illegible] OVERSEAS [illegible]G COSTS FOR NEW FACULTY

NAME	PERIOD	ALL FIGURES ARE IN U.S. DOLLARS BY HMG FISCAL YEARS							
		1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
1. Balla, M.K.	03/80-01/83	8,428	11,752	2,178					
2. Das, A.K.	01/81-07/83	39,287	14,932	8,514					
3. Deo, N.	01/81-07/83	11,670	14,469	10,072					
4. Devkota, I.	08/81-07/83	2,914	14,406	12,686					
5. Haque, M.S.	08/83-07/86			7,632	17,892	17,892	7,601		
6. Joshi, S.B.	01/81-07/83	11,063	16,357	7,322					
7. Kanel, K.R.	01/81-06/83	11,845	17,555	9,517					
8. Karki, M.B.	05/80-08/82	8,896	14,046						
9. Karmacharya, S.	01/81/06/83	9,993	15,682	7,369					
10. Koirala, B.	01/81-06/83	13,311	16,977	9,573					
11. Mehta, J.N.	09/84-09/86					3,000	15,000	10,000	
12. Nepal, S.	12/81-12/84		2,667	14,339	14,339				
13. Rayachetri, M.	09/84-03/87					3,000	13,000	10,000	
14. Rayamajhi, J.	09/84-01/83	10,577	14,504	7,974					
15. Sah, R.	09/81-09/83	2,825	11,729	11,599	7,000				
16. Sainju, U.M.	03/80-10/82	5,432	13,912						
17. Shresta, R.B.	04/83-05/84			9,708					
18. Tuladhar, K.	04/83-05/84			11,897	14,504	10,577			
19. Rana, S.							9,000	13,000	11,000
20. Pradan, P.							9,000	13,000	11,000
21. Replacement							9,000	13,000	11,000
22. Replacement							9,000	13,000	11,000
TOTAL COSTS		106,330	181,654	157,679	71,784	48,562	71,600	74,000	44,000
ESTIMATED FREE MARKET FOR. EXCH. RATE, Rs./U.S.$		13.2	15.6	16.8	19.2	20.4	21.6	22.8	24.0
ADJUSTED TOTAL COSTS IN '000 Rs.		1,403.6	2,833.8	2,649.0	1,378.3	990.7	1,546.6	1,687.2	1,056.0

per hectare to almost double this amount. Land values for pasture and forestland in rural areas average Rs. 40,000 per hectare based on land registration values. Using Rs. 295,500 for the 9.2 hectares of level land and Rs. 40,000 for the hilly area, total opportunity is Rs. 5,574,000.

Total construction cost of the physical facilities is Rs. 42,704,092. A considerable amount of underutilized labor is to be employed on the project. From the work program made available by the contractors, approximately 180,000 man-days of labor are to be employed in the various stages of construction. One fifth of this is skilled labor paid at Rs. 35 per day, and the remaining time is unskilled labor paid at Rs. 22 per day. Based on these figures, total cost of labor will be Rs. 4.4 million. Labor is available in Nepal during those times of the year when there is little agricultural work being done on the farm. This is approximately half of the year. Since skilled labor is fully employed and surplus unskilled labor is available for one-half the year, we can determine the total payments to workers which would have been required to hire them away from alternative labor. This rate is approximately Rs. 8 in the hill area surrounding Pokhara, so that approximately half of the wages paid for the 140,000 man-days provided by unskilled labor must be adjusted due to the availability of surplus labor. This adjustment gives a total construction cost of Rs. 41,696,092. Construction began July 1, 1984 and is expected to be completed by May, 1986.[1/]

Since the contractor used the official foreign exchange rate rather than the actual market rate, which is about 20% higher, an adjustment of that portion of construction costs involving materials produced outside Nepal is necessary. Civil works involve, except for cement, locally available rock and brick, while electrical, water, and sanitation systems require materials produced outside Nepal. Civil works are approximately 78% of the total construction cost while water, electrical, and sanitation systems make up the remaining 22%. Cement was estimated to make up approximately one-third of the civil works cost. Approximately 48% of the total construction cost involves foreign exchange, thus 48% of the total construction cost requires a 20% increase. Allocating construction costs proportionally over the construction period gives costs as shown in Table VII-4 for the years 1984/85 through 1986/87.

The Institute is temporarily located in Hetaura while the campus is being constructed. Some costs have been incurred to adapt buildings and offices for use as well as to rent hostels for 120 students. These costs are also included in Table VII-4.

3. Equipment

The equipment for teaching and research is provided through the project. Actual costs for 1982 and 1983 were obtained and cover a large part of the equipment needed for teaching, since classes are already being conducted. All other estimates are based on remaining equipment requirements. Equipment costs are given by year in Table VII-4 and have been adjusted upward by 20% to reflect the true opportunity cost of foreign exchange.

1/ The cost figures in this discussion are derived from the winning bid submitted by the Chinese contractor for constructing the Pokhara campus of IRNR.

TABLE VII-4

SUMMARY OF IRNR COSTS

COST CATEGORIES	ALL COSTS ARE IN '000 RS. BY HMG FISCAL YEARS							
	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Overseas Training for New Faculty	1,403.6	2,833.8	2,649.3	1,378.3	990.7	1,546.6	1,687.2	1,056.0
Land and Physical Facilities	5,574.0	32.5	14.0	45.0	11,791.2	23,582.4	9,977.2	-
Equipment	-	3,847.5	66.0	448.0	612.0	497.4	497.4	497.4
Student Support	-	-	48.0	96.0	96.0	96.0	144.0	225.6
Staff Salaries	57.0	444.5	1,001.0	1,515.0	1,821.4	2,053.2	1,111.0	1,111.0
Maintenance & Utilities	-	-	19.5	26.0	61.0	61.0	282.0	338.5
Operating Costs	-	-	609.4	696.0	1,045.0	1,045.0	1,045.0	1,045.0
Library	-	-	42.6	129.6	986.4	237.6	30.0	30.0
Vehicles	-	358.8	897.6	499.2	-	-	-	-
Research	-	-	-	-	340.0	525.0	525.0	525.0
Expatriates	1,852.6	1,596.0	6,712.1	6,931.4	5,138.2	5,153.6	5,153.6	5,468.6
TOTAL	8,887.2	9,113.2	12,149.2	11,764.5	22,881.9	34,797.8	20,452.4	10,297.1

4. Student Support

A stipend of approximately Rs. 400 per month is being paid to those students entering with a B.Sc. degree. Those students who are full-time employees on leave to attend school receive their regular salary which varies from Rs. 600 to over Rs. 1,000 per month depending on seniority. This salary would be paid to these department employees whether the student is trained in-country or out and is therefore not included in the estimates of incremental costs for establishing IRNR. The stipend for diploma students is Rs. 4,800 per student per year. Approximately 25% of certificate students would receive a scholarship when the certificate program begins upon completion of the Pokhara campus.1/ Students who receive salaries from a department are not eligible for stipends. According to the project Allowance Plan, the stipend is an incentive whose purposes are to draw better students to the Institute, to increase the percentage of female students admitted to the Institute, and to encourage students from remote areas of Nepal to seek admission to the Institute. This represents a real cost to the project since many of the students, especially the female ones, would not have been able to attend without receiving a scholarship or stipend.

5. Staff Salaries

Staff costs include salaries paid by the Tribhuvan University system to teachers and administrative staff, and a project allowance, provident fund and housing allowance paid through the RCUP. The housing allowance is paid only to the staff of the Pokhara campus while both the Pokhara and Hetaura campus staff receive the project allowance and provident fund. Project allowances, the provident fund and housing allowances were included as inducements to counteract the disadvantages of living and working in Hetaura and will be phased out when the Pokhara campus is completed.

As shown in Table VII-5, in the HMG Fiscal Year 1983-84, the Pokhara campus employed 18 teachers and 32 administrative staff. Salary costs were calculated for the 1980-1984 period by multiplying salary by the numbers of staff holding that position. From Table VII-5, total salaries in 1983-84 were Rs. 593,000.

A project allowance of 30% and provident fund of 10% were paid to the staff of the Pokhara campus beginning in 1981-82 and to the staff of the Hetaura campus beginning in 1982-83. Salaries for estimating project cost for the Pokhara campus were Rs. 593,000 for 1983-84 and Rs. 977,520 2/ for all years in which the staff of the Hetaura campus receive benefits. A housing allowance of approximately Rs. 2,801 per year were paid to each Pokhara campus staff member. Including all benefits to both campuses, the total cost to the project of Rs. 768,258 for HMG Fiscal Year 1983-84 is calculated as shown below:

1/ Payment of a stipend to certificate students has received criticism from some IRNR administrators on the grounds that both the Hetaura and Pokhara campus programs should be treated equally. For this analysis it will be assumed that stipends will be paid to 10 students in 1986-87 and to a maximum of 27 students thereafter.

2/ This figure is the basis used for calculating the allowances paid to Hetaura campus staff. See page 10.

TABLE VII-5

HMG STAFF AND SALARIES COSTS FOR IRNR

	SALARY PRIOR TO 1984-85	NUMBERS OF STAFF BY HMG FISCAL YEAR				SALARY IN/AFTER 1984-85	NUMBERS OF STAFF BY HMG FISCAL YEAR		
		1980-81	1981-82	1982-83	1983-84		1984-85	1985-86	1986-87
Teaching Staff									
Program In Charge	24,606	0	1	1	1	31,151	1	1	1
Lecturer	20,817	0	4	4	12	26,354	12	16	17
Asst. Lecturer	16,412	0	0	0	1	20,778	2	2	2
Demonstrator	14,651	0	2	2	4	18,548	4	4	5
Research Asst.	12,771	0	0	0	0	16,168	0	1	2
Lab Asst.	10,221	0	0	0	0	12,940	1	1	3
Instructor	17,118	0	0	0	0	21,671	0	1	1
Total Number of Staff		0	7	7	18		20	26	31
Cost in '000 Rs.		0	137	137	349		476	619	706
Administrative Staff									
Account. Off.	17,818	1	1	1	1	22,558	1	1	1
Asst. Adm. Off.	16,453	1	1	1	2	20,829	1	1	1
Asst. Lib.	15,237	0	1	1	1	19,290	1	1	1
Clerk	9,400	1	1	1	3	11,900	3	3	3
Accountant	13,605	1	1	1	1	17,223	1	1	1
Storekeeper	11,894	0	0	1	1	15,058	2	2	3
Typist	9,400	0	1	1	2	11,900	1	1	1
Memographer	6,707	0	0	0	0	8,491	1	1	1
Lab Asst.	6,707	0	0	0	0	8,491	1	1	1
Plant Collector	6,777	0	0	0	0	8,580	0	0	1
Electrician	3,549	0	0	0	0	4,493	0	0	1
Driver	7,398	0	1	2	2	9,366	2	2	2
Health Asst.	2,662	0	0	0	0	3,370	0	0	1
Cook	5,032	0	1	2	2	6,371	2	2	3
Gardner	5,383	0	0	0	0	6,815	1	1	4
Peon	5,032	0	1	2	2	6,371	2	2	3
Guard	5,032	0	2	4	9	6,371	9	9	13
Cleaner	4,122	0	2	3	5	5,218	5	5	5
Matron	5,032	0	0	0	1	6,371	1	1	1
Total Number of Staff		4	13	20	32		34	34	47
Cost in '000 Rs.		57	118	161	244		315	315	405
TOTAL SALARY		57	255	298	593		791	934	1,111

	Rs.
Pokhara Campus	
Provident Fund (10%)	59,300
Project Allowance (30%)	177,900
Housing Allowance	140,050
Hetaura Campus	
Provident Fund (10%)	97,752
Project Allowance (30%)	293,256
TOTAL Project Allowances	768,258

Project costs for salaries for the years 1980-81, 1981-82, and 1982-83 were computed similarly except that the Hetaura campus staff did not receive the provident fund or the project allowance in 1980-81 when classes were held in Pokhara.

Salaries were increased by approximately 27% in 1984-85. Since this is the first major pay increase in three years, it will be included in order to cover potential increases in productivity that were gained through overseas training. Future pay increases will not be included since inflation would be expected to affect all cost categories equally.

All costs absorbed by RCUP required an increase by 20% in order to compensate for the difference between the free market foreign exchange rate and the official foreign exchange rate. These adjustments are shown in Table VII-6.

6. Maintenance and Utilities

With donor assisted projects, funds for physical facilities are often the major form of assistance. HMG is left to find the funds to maintain and repair these facilities, and often there are insufficient funds budgeted for regular maintenance. The Hetaura campus is only 17 years old, but its water and electrical systems would now be easier to replace than to repair. Without a dependable system of water and electricity, laboratories and toilet facilities cannot be used. The Hetaura campus budgets Rs. 95,000 for maintenance which is either not used effectively or is not sufficient to maintain the facilities. Maintenance is not adequate at the Hetaura campus, and, therefore, more will be eventually required at the Pokhara campus. Maintenance on the new campus will be expected to increase yearly as the campus ages, with very little maintenance required at first. Maintenance is usually 5 to 7% of the normal operating budget on other university campuses in Nepal. Therefore, maintenance is projected to be 5% of the budget in the first year after completion and increases by 1% per year until it reaches 7%. Due to the problem of projecting beyond year 30, this analysis ends in 2010 even though the grounds, building, and school will still be in operation. Rather than projecting beyond 2010, grounds and building value are estimated for that point in time and their value recovered by depreciating buildings based on a 40-year lifetime.

7. Operating Costs

Operating costs were obtained from Pokhara campus budgets given in Table VII-7 and by projecting costs based on those of other campuses. Operating costs include insurance, fuel, postage, field tour costs, travel,

TABLE VII-6

STAFF COSTS IN '000 RS. WITH ADJUSTMENT FOR SHADOW FOREIGN EXCHANGE RATE

HMG FISCAL YEARS	HMG COSTS 1/	RCUP COSTS 2/	ADJUSTED RCUP COSTS	ADJUSTED TOTAL COSTS
1980/81	57.0	-	-	57.0
1981/82	255.0	158.0	189.6	444.6
1982/83	298.0	585.8	703.0	1,001.0
1983/84	593.0	768.3	922.0	1,515.0
1984/85	791.0	858.7	1,030.4	1,821.4
1985/86	934.0	932.7	1,119.2	2,053.2
1986/87	1,111.0	-	-	1,111.0

1/ From Table VII-5.

2/ Based on explanation given in Section 5, "Staff Salaries".

TABLE VII-7

ANNUAL RECURRENT COSTS FOR POKHARA CAMPUS

COST CATEGORIES	'000 RS. BY HMG FISCAL YEARS		
	1982-83	1983-84	1984-85
Exam Expenses	1,500	2,000	2,000
Electricity and Water	14,500	16,000	20,000
Rent	150,000	150,000	230,000
Maintenance & Repair	5,000	10,000	41,000
Fuel Costs	117,000	90,000	116,000
Advertisements	18,000	15,000	10,000
Bank Charge	3,000	5,000	5,000
Telephone & Postage	27,500	17,000	20,000
Printing and Stationery	60,900	90,000	105,000
Magazines	11,000	31,000	15,000
Travel	25,000	25,000	55,000
Special Occasions	10,000	12,000	5,000
Receptions	1,000	3,000	5,000
Overtime	2,000	2,000	5,000
Meeting Allowance	-	10,000	25,000
Office & General Exp.	21,500	20,000	25,000
Student Welfare	89,000	110,000	236,000
Publications	-	-	5,000
Chemicals & Materials	50,500	85,000	100,000
Loading & Delivery	2,000	3,000	20,000
TOTAL RECURRENT COSTS	609,400	696,000	1,045,000

office materials, and chemicals and laboratory materials. At the present time, the Pokhara campus operating costs are already double those of the Hetaura campus with half as many students.

8. Library

Library materials are not easily acquired in Nepal, but without a library the Institute will not be able to carry out research or expand with a graduate program. A considerable number of books have been donated by schools in the United States. The present goal is to have 15,000 volumes in the library when the Pokhara campus is completed.

9. Vehicles

Two small jeeps and one four-wheel drive station wagon have been purchased for use by the IRNR. Two more vehicles have now been ordered and should be available early in 1985. Two buses were purchased for field trips at a cost of $28,000 each. These vehicles, if maintained, could be serviceable for five years when others would need to be purchased. As few vehicles are purchased by Tribhuvan University, replacement of these vehicles is not expected and costs have not been included. Costs for these items are included in the Vehicles line item of Table VII-4.

10. Research

The Institute, with 18 trained professionals, could provide very important research services not now available except through imported experts. With proper guidance, the faculty could carry out applied research in resource management problems in Nepal. A number of proposals have been prepared, and research work began in the fall of 1984. One benefit of training forestry professionals to work on the staff of the Institute is the research work that will be done as these faculty members work on problems that would have otherwise required out-of-country experts. The faculty can solve many resource management problems at a lower cost to Nepal. Based on experience at the Rampur Campus, Institute of Agriculture and Animal Science, and the Agricultural Project Services Center, we project that returning faculty take three to five years to begin consulting work and approximately half of returning teachers take advantage of research and consulting opportunities. Faculty at Rampur are able to make up to Rs. 92,000 per year in consulting work. Workers at APROSC are able to double their salaries of approximately Rs. 24,000 per year.1/ Based on this potential earning ability, half of the faculty (nine) are projected to make Rs. 24,000 per year over their professional lifetime, which is assumed to be 25 years. Since teachers began returning in 1982, benefits would begin accruing in 1987 at the rate of Rs. 216,000 per year.

1/ Personal conversation with Michael Wallace, Agricultural Development Council representative.

11. Expatriate Faculty

Expatriate faculty and advisers assist in the six major areas for which RCUP has responsibility: (1) spatial planning, (2) curriculum development, (3) library development, (4) research program development, (5) teaching, and (6) outreach planning and coordination. The areas of curriculum development and teaching consume the majority of the expatriates' time. These faculty include the assistant to the dean, in a purely administrative role, and three faculty members: a soil scientist, an engineer-hydrologist, and a resource economist. Future assistance plans include a forest management expert to assist in teaching and research, a combined soil scientist/assistant to the dean position, a forest engineer, and a Peace Corps Volunteer to assist in teaching remote sensing. Expatriate faculty costs are given in Table VII-8.

D. Out-of-Country Training

In the past, professionals in resource management have been sent out-of-country, primarily to Dehra Dun in India for training. In recent years it has become increasingly difficult to enroll Nepalese students in Dehra Dun, and students have been sent to Pakistan, New Zealand, Australia, and the Philippines. Costs vary at the different universities as well as the air fares to send students to them. A Bachelor of Science degree in Forestry at Los Banos in the Philippines costs an average of $6,800, and the Associate of Indian Forestry College (A.I.F.C.) degree costs around $7,000 per year. Approximate costs in Thailand are $6,000 per year. The approximate length of program for students with a B.Sc. is two years, and for department employees with a certificate from the Hetaura campus it would require three years. The equivalent to the certificate degree would require two years. Table VII-9 gives the total costs of out-of-country training at an average cost of $6,000 per year per diploma student. Certificate students could be sent to schools in India, such as Birsa Agricultural University, for approximately $3,000 per student per year.

E. Comparison of In-Country and Out-of-Country Costs

As detailed in Table VII-10, the present value in-country training costs at a 10% rate of discount is Rs. 134,589,800 compared to Rs. 186,309,500 for the out-of-country alternative. This gives a benefit-cost ratio of 1.38. There are two adjustments that further reduce the present value of IRNR costs and raise the B/C ratio. The first is faculty consulting benefits. An estimated Rs. 216,000 per year is expected to be realized beginning in 1987 (see Section 10. Research). The present value (at 10%/year discount factors) of this earnings stream is Rs. 1,006,100. The second must be made due to the time horizon of this study being limited to 30 years. Since the land and facilities will still exist at the end of the time horizon used in this study, their value at that date must be estimated. Since facilities will be 24 years old, and assuming a building life of 40 years, the value of the physical facilities is taken to be reduced by 60%. This leaves Rs. 17,081,637 in facilities. Land is valued at its original opportunity cost of Rs. 5,574,000. Present value of this sum (facilities plus land) discounted for 30 years equals Rs. 1,298,400. The present value of net in-country costs including these two adjustments is Rs. 132,285,300. The adjusted B/C ratio rises slightly to 1.41.

TABLE VII-8

EXPATRIATE COSTS

POSITION	ALL FIGURES ARE IN '000 Rs. BY HMG FISCAL YEARS							
	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Assistant to the Dean	1,543.8	1,330.0	1,701.3	1,822.0	-	-	-	-
Soil Scientist	-	-	1,426.4	1,361.1	1,782.6	1,977.9	1,977.9	1,687.8
Civil Engineer	-	-	1,249.6	1,158.4	-	-	-	-
Resource Economist	-	-	1,216.1	1,434.7	-	-	-	-
Forest Management	-	-	-	-	1,249.6	1,158.4	1,158.4	1,434.7
Forest Engineer/Silvi.	-	-	-	-	1,249.6	1,158.4	1,158.4	1,434.7
TOTAL	1,543.8	1,330.0	5,593.4	5,776.2	4,281.8	4,294.7	4,294.7	4,557.2
Adjusted Total For 20% Diff. Between Official and Free Market Fx. Rates	1,852.6	1,596.0	6,712.1	6,931.4	5,138.2	5,153.6	5,153.6	5,468.6

TABLE VII-9

OUT-OF-COUNTRY TRAINING COSTS IN '000 RS.

	NUMBER OF STUDENTS		TRAINING COSTS IN '000 RS.		
	DIPLOMA	CERTIFICATE	DIPLOMA 1/	CERTIFICATE 2/	TOTAL
HMG FISCAL YEARS					
1981/82	30	-	2,376	-	2,376
1982/83	66	-	6,178	-	6,178
1983/84	101	-	10,181	-	10,181
1984/85	101	-	11,635	-	11,635
1985/86	101	-	12,362	-	12,362
1986/87	101	40	13,090	2,592	15,682
1987/88	101	110	13,817	7,524	21,341
1988/89	101	180	14,544	12,960	27,504
1989/90	101	210	14,544	15,120	29,664
1990/91	101	210	15,271	15,876	31,147
1991/92	101	210	15,998	16,632	32,630
1992/93	101	210	16,726	17,388	34,114
1993/94	101	210	17,453	18,144	35,897
1994/95	101	210	18,180	18,900	37,080
to 1995-2010					

1/ Cost estimates are based on a memorandum obtained from John Cool, Agricultural Development Council in Kathmandu, and Gerald Nelson, Agricultural Development Council in Manila.

2/ Estimates are based on costs of sending students to similar programs in Indian colleges.

TABLE VII-10

COMPARISON OF IN-COUNTRY TO OUT-OF-COUNTRY COSTS

	ALL FIGURES ARE IN '000 RS.			
	OUT-OF-COUNTRY COSTS		IN-COUNTRY COSTS	
	ESTIMATED COSTS	PRESENT VALUE	ESTIMATED COSTS	PRESENT VALUE
HMG FISCAL YEARS				
1980/81	-	-	8,887.4	8,887.2
1981/82	2,376	2,160.0	9,113.2	8,284.7
1982/83	6,178	5,105.8	12,149.2	10,040.7
1983/84	10,181	7,649.1	11,764.5	8,838.8
1984/85	11,635	7,946.9	22,881.9	15,628.6
1985/86	12,362	7,675.8	34,707.8	21,606.7
1986/87	15,682	8,852.1	20,452.4	11,544.8
1987/88	21,341	10,951.3	10,297.1	5,284.0
1988/89	27,504	12,830.8	10,297.1	4,803.7
1989/90	29,664	12,580.4	10,297.1	4,367.0
1990/91	31,147	12,008.5	10,297.1	3,970.0
1991/92	32,630	11,436.6	10,297.1	3,609.1
1992/93	34,114	10,869.8	10,297.1	3,281.0
1993/94	35,897	10,869.8	10,297.1	2,982.7
1994/95	37,080	9,764.3	10,297.1	2,711.5
1995-2010	37,080	67,516.6	10,297.1	18,749.3
TOTAL		186,309.5		134,589.8

F. Implications for Adjusting Targets in RCUP

With a benefit-cost ratio of 1.4 and net benefits of over Rs. 54 million, in-country training is a relatively more effective method of developing resource management skills in Nepal based on a comparison of costs as given in this study. This conclusion is derived from the assumption that Nepal can and will utilize all the resource managers that will be trained. If a surplus of resource managers is produced at some time in the future, then this will reduce the advantages of investing in the IRNR unless spare capacity were to be filled by admitting students from other countries. Since there currently seems to be a shortage of training capacity in Asia for foresters, the prospect of attracting foreign students would seem bright.

The investment in IRNR, therefore would appear to be an efficient allocation of resources. Positive net benefits are forecast, and this is the main criterion for judging economic efficiency. At this time no adjustment of targets with respect to enrollment and physical facilities would seem to be necessary.