Paper 8: Conjunctive Water Use in Nepal - Practices and Performance in Selected Irrigation Command Area

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INTRODUCTION

Nepalese farmers have practiced conjunctive water use in either known or unknown forms since long. Farmers within the command area of an irrigation system have a practice to tap and use whatever sources of water are available during scarcity. Farmers, at large, were observed to be using different sources of water, some in conjunctive forms and some in the form of water augmentation measures.

Conjunctive water use primarily involves the use of two or more sources of water, which ensures increased crop yields and production. With conjunctive water use, more area can be brought under irrigation with reduced risk of crop damage and increased crop production. Unfortunately, such practices have not attained significant strive in Nepal. Although farmers have long been involved in using diverse sources of water depending upon their accessibility and availability, conjunctive water use practices of larger scale to create substantial impact in agriculture are lacking. This study tries to assess, analyze and document conjunctive water use practices prevalent in three selected irrigation command areas of Nepal.

Despite the significant emphasis given on the use of ground water and intensification of shallow tube wells by Agricultural Perspective Plan (APP, 1995), no major effort has yet been made to effectively exploit the ground water potential. APP further signifies that shallow tube wells are the core of the *Terai* irrigation strategy. It is also stated in APP that the institutional priorities must rest far more on shallow tube well development than on other aspects of irrigation. The irrigation policy, (IP, 1992) has also mentioned the need for promoting conjunctive water and optimizing the use of available water sources to promote irrigated agriculture. Unfortunately, no attention has yet been given towards implementing these policies.

This paper is based on a study carried in selected irrigation systems, which are at different stages of management transfer under IMTP first and second phases. The selected sites for the study were: i) Eastern Kamala Irrigation System (EKIS), Hardinath Irrigation System (HIS), and iii) West Gandak Irrigation System (WGIS). Data were

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collected in the field primarily from the key informant farmers involved in using diverse sources of water either in conjunctive or other forms. Individual farmers as well as groups using different sources of irrigation: tube wells, canal water, drainage etc. were interviewed to solicit the needed information. It is, however, notable that only two out of five cases represent ideal conjunctive form in terms of using water from two sources at a time whereas the other cases are more of the water augmentation type. The five cases surveyed are briefly discussed below.

Table 8.1: Different Forms of Water Use in Irrigation Command Area

Water Use Practices	EKIS	HIS	WGIS
Irrigation drainage + stream water	*		
STWs + Drainage	*		
Canal water + STWs		*	*
STWs only			*

Source: Field Survey

DESCRIPTION OF THE CASE STUDIES

Irrigation Drainage and Stream Water in EKIS

The southern portion of the eastern branch canal of Kamala Irrigation System is an interesting case of water augmentation from two different sources viz. irrigation drainage and a local stream. In this case, the downstream farmers of the command area use the drainage water of the canal to augment a local stream. According to farmers, drainage water contributes about 60% of the water requirement for paddy whereas the proportion is even higher during winter.

Table 8.2: Proportion of Water Available from Drainage and Stream in Different Seasons

S. No.	*Season*	*Crops*	*Drainage Water*	*Stream Water*
1	Monsoon	Paddy	60%	40%
2	Winter	Wheat	50%	50%
3	Spring	-	-	-

Source: Field Survey

Farmers through informal groups adopt the water augmentation measure. Generally, the people of Thengi Village who have settled close to the diversion site take the lead in constructing the dam and managing it later. Construction is carried out during the month of June/July. About 200-250 households are involved directly in the construction of about 25-30 feet high dam.

Crop yields were reported to be 2.4 mt/ ha for paddy and 1.5 mt/ha for wheat. The water augmentation has contributed to expand cropped area, particularly in wheat. Farmers reported that the augmentation of water has contributed to expand wheat cultivation in 20-25% area.

Shallow Tube Wells and Drainage in EKIS

Ground water in EKIS is being utilized in limited parts through tube wells installed with the support of ADBN and IFAD. Tube wells installed with ADBN support are scattered over the command area and are totally under private management of farmers who use them mostly in lands not irrigated by canal system. IFAD, on the other hand, is implementing a shallow tube well program in Manpur cluster which is located at the tail end of the EKIS system where canal water virtually does not reach in absence of canal network except during high flood times. This case thus represents the use of tube wells with the rainwater and occasional drainage water coming from the canal system. The area is served by five shallow tube wells supported by IFAD commanding about 45 ha lands of about the same number of households.

Table 8.3: Crop-wise Water Supplies from Different Sources in the Area

Seasons	Crops	Water Supplies from Different Sources (in %)		
		Rain Water	Drainage Water	STWs
1. Summer	- Main paddy	75	10	15 (40 to 50 hrs.)
2. Winter	- Wheat	40	-	60 (120 to 130 hrs)
	- Vegetables/potato	30	-	70 (20 to 25 hrs.)
3. Spring	- Early paddy	20	-	80 (100 to 150 hrs.)

Source: STW Committee Members

Farmers use rainwater and water from STWs to meet most of the requirements as seen in the table above. The STWs greatly meet water requirements for wheat and early paddy compared to main paddy during summer (Table 8.3).

The STWs installed in the area are managed by groups of farmers. The groups generally constitute about 7 or more farmers of the same location who form an executive body. Farmers have contributed about 15% against the total cost of the tube well that amounts to NRs. 300,000 per STW. Farmers were also imparted some technical training to operate and maintain the tube well.

Farmers on rotational basis, which is planned instantly on the basis of priorities, operate pumps. The cost of operation, which amounts to about NRs. 20 per hour, is borne fully by each individual farmer. On an average, the pumps are operated for about 300 - 350 hours per year or an average of 40- 50 hours per household but some tube wells were operated up to 500 hours. The estimated operation cost is as presented in Table 8.4.

Table 8.4: Annual Average Cost of Operation of a Shallow Tube Well (500 hours/year)

S. No.	*Cost Items*	*Quantity*	*Amount (NRs.)*
1	Diesel	500 liter	8,000
2	Mobil		800
3	Operator Charge	500 hours	2,500
	Total		11,300

Source: Ground water Office, Lahan

Farmers raise repair and maintenance funds as and when required generally at the rate of NRs. 50 per bigha. The average cost of repair and maintenance per tube well was about NRs. 750 last year.

Some changes were noted in the cropping patterns of the area following the use of tube wells. On an average, additional 2 ha lands were brought under wheat cultivation under each STW increasing the total wheat area to 35 ha from 25 ha. Similarly, water availability from STWs has enabled farmers to cultivate early paddy in more area than before. Higher discharges from the STWs and the field channels make water delivery quite efficient at the farm contributing to some increment in the cropping intensity (Table 8.5).

Table 8.5: Cropping Intensity Before and After STWs

Total Cultivated Land = 45 ha.	*Before (ha)*	*Present (ha)*
Cropped Area (ha)		
i) Paddy	45	45
ii) Wheat	25	35
iii) Other crops (vegetables and potato)	10	15
iv) Early paddy	2	10
Cropping Intensity (%)	182	203

Source: Field Survey

Farmers also reported increment in crop yields, particularly of wheat and early paddy after the use of shallow tube wells although they are still low as compared to other irrigated places. The yields under two conditions are presented in Table 8.6.

Table 8.6: Yields of Major Crops under Irrigated and Rain-fed Lands

S. No.	*Crops*	*Yield (MT/ha)*	
		Irrigated with STWs	***Rain-fed***
1	Main Paddy	2.2	1.5
2	Wheat	1.8	1.0
3	Early Paddy	1.9	N. A.

Source: Field Survey

Canal Water and STWs in HIS

In HIS command area, there are pockets where farmers to supplement water during shortage have installed STWs. The concentration of STWs is high in the middle portion of the command area. In total, about 25-30 STWs existed in HIS command area. All STWs are privately owned and managed.

Farmers of HIS use canal water as long as it is available from the canal. In paddy, most of the water requirements both during plantation and irrigation are met from canal water together with rain water whereas for wheat during winter STWs are used more intensively. However, in the middle and tail portion, rainwater and ground water still remain important sources of irrigation compared to the head portion (Table 8.7).

Table 8.7: Water Use Proportions by Farmers in Different Canal Sections (in %)

S. No.	*Crops*	*Canal Water*			*Rainwater & Ground water*		
		Head	***Middle***	***Tail***	***Head***	***Middle***	***Tail***
1	Paddy	80	30	5	20	70	95
2	Wheat	75	20	-	25	80	100
3	E. Paddy	-	-	-	100	100	100

Source: Field Survey

Farmers reported that only about 50% of the installed STWs are used on a regular basis for one or other reasons. Various reasons were pointed out for not using the STWs. These are: distance of land from borings, lack of field channels for conveying water, reduced discharges of tube well, difficulty in taking pump sets to the boring sites etc.

Summer paddy is the dominant crop in the entire command area. Wheat is the second important crop grown in about 40%-50% lands. Wheat cultivation thus confines mainly to land close to canal and boring holes or wet lands with high moisture content. Early paddy is grown only in part, mostly in the middle reach and a little in the head reach.

Significant variations were noticed in crop productions in the area. Farmers using STWs have higher yields compared to those who depended only on canal water. The comparative yields are tabulated below.

Table 8.8: Average Yields of Major Crops With and Without Conjunctive Water Use

S. No.	*Crops*	*With Conjunctive Use (mt/ha)*	*Without Conjunctive Use (mt/ha)*
1	Paddy	3	1.8
2	Wheat	1.8	1.0
3	E. Paddy	2.7	1.3

Source: Field Survey

Hardinath Agricultural Farm is an ideal example where the Farm makes conjunctive use of canal and ground water in its 42.5 ha land. According to the Farm In-charge, about 75% water requirement for paddy both during plantation and subsequent irrigation is met from canal water whereas remaining 25% is met from ground water. In case of paddy, ground water is needed partly for transplantation and for subsequent irrigation.

Table 8.9: Proportion of Water Use by Farms in Different Crops

S. No.	*Crops*	*Area (ha)*	*Share of Water Use (in %)*	
			Canal Water	*Ground water*
1	Paddy	21	75	25
2	Wheat	14.5	60	40
3	E. Paddy	1.4	-	100
4	Maize	1.4	20	80

Source: Agricultural Farm

The Farm generally uses canal water after allowing sufficient water to downstream farmer. For wheat, the proportion of water used from canal becomes less (40%). Ground water is exclusively used for early paddy plantation and its irrigation. The use of ground water is also high (80%) for maize.

Shallow Tube Wells and Canal Water in WGIS

West Gandak Irrigation System (WGIS) is a perennial system, which receives water from Narayani River. The canal water is used largely for summer crop and partly for winter and spring crops. Despite its perennial source, the command area frequently encounters the shortage of irrigation water particularly during April-May when repair and maintenance works in Indian canal causes obstructions.

Located at the tail reach of WGIS, farmers of Palhi and Germi VDCs use ground water, all from their personal tube wells. There are about 40-50 farmers with tube well in these two VDCs. The use of STWs in Palhi and Germi varies considerably mainly on account of differences in farming practices and ethnic composition. Prior to the introduction of STWs under ADBN support, these farmers used to have their local traditional systems called "Dhikuli", a manually operated water-lifting device.

In Palhi, farmers operate STWs largely as an alternative means to irrigate lands where canal water does not reach at all because of higher elevation. Farmers thus use tube wells for seedbed preparation of monsoon paddy from May last week to June 1st week. Only few farmers, and that too at critical needs, operate STWs to irrigate paddy fields. But for wheat, each farmer, on an average operate the STW for about 100 to 150 hours.

The case of conjunctive water use in Germi VDC is more interesting. The farmers mostly constitute the local vegetable growers. Altogether, about 40-50 farmers of Germi use STWs mainly for growing vegetables. The main vegetables grown by the farmers, are: bitter guards, lady's finger, guards, chilly, cucumber, egg plant, radish, onion, tomato, garlic etc. Use of STWs for paddy seedbed and irrigation is limited in this village. Vegetable is grown in commercial scale in this village.

Water application requirements in vegetables are different than in other crops. Compared to other cereal crops, vegetable requires more water at frequent intervals and in right quantity. Water application in vegetable can be divided in two stages: one at the initial stage for 3-4 times with about 7 days of interval and the other at a later stage with 8-10 times with 3 days of interval. To the vegetable growers, canal water is more easily available in winter than in spring.

Table 8.10: Irrigation Intervals and Frequency

Stages	*Irrigation Intervals*	*No. of irrigation*
Initial Stage	7 days interval	3-4 times
Later Stage	3 days interval	8-10 times

Source: Field Survey

Farmers estimated that canal water hardly meets 15-20% of total water requirements of vegetables and a higher proportion of water has to be applied from tube wells. Whereas for paddy and wheat, the proportion of water used from canal is higher at about 50-60% and the remaining has to be met from rainwater or ground water.

Farmers operate STWs entirely on the basis of personal judgment. As such operation hours vary considerably from one farmer to another. Normally, a STW owner operates tube well from 50 to 200 hours for vegetables depending upon the cropped area.

Farmers growing vegetables with the use of STWs seemed to have higher incomes than those without STWs. Possessing a tube well itself offers greater flexibility to farmers in the selection of cropping patterns and seed varieties. Besides, the lands with STWs are more intensively cultivated than the lands without them. The cropping intensity of farmers growing vegetable was estimated to be about 250% whereas for others without STWs it was reported to be less than 200%.

NEED OF TUBE WELLS IN THE COMMAND AREA

The surface irrigation command areas largely face deficit in water supplies from the canal systems although the reasons vary across the systems. Kamala and Hardinath are seasonal systems designed only for monsoon season and the discharge at source decreases considerably after the monsoon season. These canals deliver limited water during winter whereas in spring there is virtually no water for irrigation. Water supply in West Gandak, despite having abundant water at source, is disrupted during spring because of maintenance work at the Indian main canal system. On top of these problems, most parts of the command area face water shortage in absence of tertiaries, field channels and watercourses. Some areas cannot be irrigated even if there is adequate water in the canal system because of elevation problem. All these factors make it necessary to have tube wells or other forms of irrigation that augment or substitute water supply in the command area. Even if the available water is managed efficiently by farmers, the need for tube wells cannot be ruled out in most areas as the supplies shrink considerably in dry season.

ADVANTAGES OF SHALLOW TUBE WELLS

Shallow tube wells installed in the irrigation command areas are largely found beneficial for farmers ensuring better crop production. As observed in the field, the incremental benefits from tube wells far outweigh the incremental costs. However, detailed investigations are necessary to come up with empirical evidences on the cost and returns of tube wells while used in conjunctive and non-conjunctive forms with the canal water. The benefits are summarized below.

Higher Net Returns

Installation of tube wells involves additional cost to the farmers of the command area. Further cost is incurred when they operate tube wells for irrigation. Use of tube wells, therefore, incurs higher cost of production as well as gives higher returns to the farmers.

A probe into the case of HIS area reveals that the operational cost of tube wells comes to about NRs. 4,000-5,000 per ha a year (assuming 200 hours of operation per ha and a charge of NRs. 20-25 per hour). Whereas, the incremental crop production per ha amounts to about 3,000 kg of different crops which fetches a market value of over NRs. 18,000. If the cost of tube well is valued at par with rental charge the cost amounts to NRs. 12,000 which is also as low as two third of the gross returns.

Comparison of crop yields under conjunctive use and under shallow tube wells alone is also found interesting. In Hardinath, yields under conjunctive use are estimated to be higher for monsoon paddy and early paddy compared to the fields of EKIS where farmers use shallow tube wells only (Table 8.11).

Table 8.11: Crop Yields in Conjunctive Water Use Farms and Under Shallow Tube wells Alone (Mt/ha)

Crops	*Conjunctive Water Use Farms (HIS)*	*Shallow Tube well Farms (EKIS)*
Monsoon Paddy	3	2.3
Wheat	1.8	1.8
Early Paddy	2.7	2.2

Source: Field Survey

Flexibility

In conjunctive water use system, tube wells offer greater flexibility to the farmers since the farmers themselves hold their operation in control till last minute as long as they receive water from canal, which is much cheaper. As soon as water requirements are felt critical farmers start pumping them in their fields until other cheaper forms of water (rainfall or canal water) are available. Such practices were noticed in case of large and medium farmers of Hardinath Irrigation Systems, and in West Gandak.

Reliability

One of the advantages of tube wells is its reliability for water supply as its operation is controlled individually by the owners. Farmers in most cases were noticed to have used tube wells as a reliable back up support to meet the emergency needs. In Germi VDC of WGIS, most farmers use water from tube wells to grow rice seedlings. In Palhi of the same system, farmers rely exclusively on tube wells for frequent irrigation in their vegetable fields. Without tube wells these farmers can hardly imagine of irrigated agriculture in their fields. Farmers in HIS and EKIS also rely significantly on tube wells using them as the last resort after other sources (rain water, canal water) fail to meet water needs.

CONSTRAINTS IN CONJUNCTIVE WATER USE IN NEPAL

i) Decreasing water at source of canal water system and reducing water table in ground water aquifer perpetuate great threat from long term perspective of conjunctive water use. This issue calls for constant monitoring of the discharges of both sources and implementation of effective mitigating measures.

ii) Rising cost of diesel, almost every year, has consistently been a cause of disappointment among farmers of all categories. Decreasing use of tube well by poor farmers is a direct implication of increasing cost of diesel and increasing rental charge of pump sets.

iii) No institutional framework is developed for the promotion of conjunctive water use. The water use policy is completely silent about conjunctive water use, which is one of the reasons limiting the practice of conjunctive water use by farmers.

iv) Lack of adequate research and investigation on conjunctive water use is a major constraint. For lack of such studies no empirical evidences are available for widespread promotion of conjunctive water use.

ISSUES RELATED TO CONJUNCTIVE WATER USE

Involving Poor and Marginal Farmers

The findings clearly show that primarily large and medium farmers realize the benefit of conjunctive water use (by using shallow tube wells and canal water). The small and marginal farmers have not been able to benefit from the use of tube wells. This is primarily due to their small and fragmented holdings and lack of their own pumping sets. There is possibility that these small holders could be involved in conjunctive use if they are sufficiently convinced, motivated and organized for rotational use of pump sets to realize higher returns even from their small holdings.

Subsidies

HMGN is encouraging the use of ground water, especially the shallow tube wells, by farmers in the *Terai* through the provision of subsidies. Subsidies are provided in tube wells installed through the ADBN and IFAD. To provide further impetus to encourage the operation of shallow tube wells in line with APP, HMGN has recently adopted policies to promote shallow tube wells by providing subsidies in electricity for pumping irrigation water. However, the policy of subsidy contradicts with HMGN's policy of cutting financial burden in irrigation, which therefore may be implemented only after detailed analysis.

Use of Tube Wells and Drainage Water in the Command Area

Given the fact that Nepalese farmers have strong urge to make best utilization of available water for irrigation, it is essential to emphasize on using the tube wells and drainage water either from canal or other forms in the command area to enhance irrigated agriculture. Specially, the need to find new sources of water is more imperative in areas where water supply is difficult from surface irrigation systems. The need of conjunctive water use from drainage and deep or medium tube wells should be considered crucial in the face of increasing water shortage in large parts of the command area belonging to the irrigation systems. Both agencies/WUAs and farmers should find solutions to enhance conjunctive water use through the use of available possible sources.

Active and Coordinated Management

The experience thus far indicates that while using water sources other than the canal system farmers take the sole responsibility themselves. At present, there is hardly any involvement of system staff or WUAs in implementing and managing conjunctive water use. This is partly due to the fact that farmers operating personal tube wells prefer not to be controlled by outsiders. However, there should be some linkage between agency staff or WUAs with the tube well owners to enable communication about water requirements so that both sources could be used optimally during critical hours of shortage. Complete lack of coordination between tube well owners and system managers (or WUA in transferred cases) within the command area could give rise to poor communication and greater uncertainty in water supply, especially from the canal system.

It is, however, noteworthy that if the case is of medium or deep tube wells that are to be installed in an irrigation command area, the management should be active with well coordinated activities between agency staff/WUAs and tube well users. With an effective and coordinated management water from either sources could be used for mutual benefits of the farmers depending upon the accessibility and availability of water. Active WUAs could play important role in developing tube wells in the portions of the command area where water supply is difficult from canal systems for different reasons and take the responsibility for managing both sources.

KEY FINDING AND POLICY RECOMMENDATIONS

i) Effective conjunctive water use requires deliberate policies and their implementation. The APP and the IP outlines the need for promoting ground water and conjunctive water use but there has not been serious effort to translate the policies into actions. The concerned government agencies should give attention to implement water use policies as stated in APP and IP to enhance the utilization of ground water either exclusively or together with canal water in command area based on technical and economic feasibility.

ii) Agencies' role on conjunctive water use is virtually lacking in all command areas and joint efforts between farmers and agency on conjunctive water use are disappointing. The gap is considerable between tube well owners and system managers or WUAs about water availability and water use practices within the command area. It is therefore important to have a detailed inventory of various water sources being used in the command area.

iii) Farmers are not aware of the benefits of conjunctive water use. The level of knowledge about conjunctive water is very poor especially among small and marginal farmers. There is a possibility to benefit smaller farmers by promoting conjunctive water use practices within the command area.

iv) Extension services and technical advises are poor in the command areas that are essential to boost the level of knowledge of farmers on conjunctive water use. Significant variations are noticed in the efficiency of tube wells installed in different places that are attributed to the technological variation. Farmers claim that the existing technologies used in shallow tube wells, especially those installed through ADBN are of poor quality. The technological problems concern with low or decreasing discharges and lack of field channels. DOI should therefore consider adopting appropriate tube well development technology.

v) A great hurdle in enhancing the use of tube wells is the rising cost of diesel and lack of electricity in the villages. Unavailability of diesel further restricts the use of tube wells in rural areas. Farmers in all areas have demanded subsidy on diesel or electricity for pumping depending upon their availability. The demand seems genuine and is an influence of Indian farmers across the border who are enjoying similar subsidies. Initially, capital subsidies could be important for the installation of tube wells for conjunctive water use. Subsidies on operational cost such as diesel and electricity would be essential to encourage farmers to operate tube well for longer hours for optimal gains. However, the provision of subsidy may be considered only after detailed analysis.

vi) In all command areas under surface irrigation, system managers considered it essential to promote conjunctive water use. They are well convinced with the notion that the potential for increasing agricultural production could be realized through conjunctive water use practices. Investments in tube wells were thus considered worthwhile and so is the promotion of conjunctive water use for sustained improvement in agricultural practices.

vii) The coordination and joint management of tube wells and canal system is concerned vital in case of conjunctive water use. As far as the individual tube wells with limited capacity are concerned, the issue of coordination will not be serious since farmers can manage them personally as they have been doing so far. But the case will be different if the installation of medium or deep tube wells with larger capacity is concerned in a command area. In such case, the WUA or agency needs to coordinate more effectively with tube well users for joint utilization of canal and ground water within the command area.

viii) Institutional arrangements right from central to field level is inadequate to enhance the installation and use of tube wells in conjunction with canal water. APP has even mentioned about a separate department of shallow tube wells if the ground water potential is to be achieved effectively at a larger scale. To begin with, a separate unit is necessary to look after conjunctive water use, probably within the set up of DOI. Primarily, the institutional functions should concentrate on: a) identification of cost effective management technology, b) research on inputs of STWs, c) conjunctive water use in the command area and dissemination of the results, and d) technical advice on incorporating management of drainage water and tube wells by the agency and WUAs.

RECOMMENDATIONS ON FUTURE RESEARCH AREAS

In view of limited experience and knowledge on conjunctive water use in Nepal, further studies are essential to address several issues associated with conjunctive water use. Such studies need to be conducted in a wider perspective both in terms of contents and scope. Only on the basis of such a study, conjunctive water use policy including farmers' needs and perceptions could be formulated. The proposed studies should concentrate on the following areas:

- Technical and economic feasibility including incremental costs and returns from conjunctive water use,
- Special case studies on conjunctive water use by different farm sizes,
- Management practices in conjunctive water use under private and group management, and
- Action research (implementation) of conjunctive water use to understand the weaknesses and strengths of the practices for policy purposes.

Figure 8.1: Conjuctive Use Practice in Kamala Irrigation Project

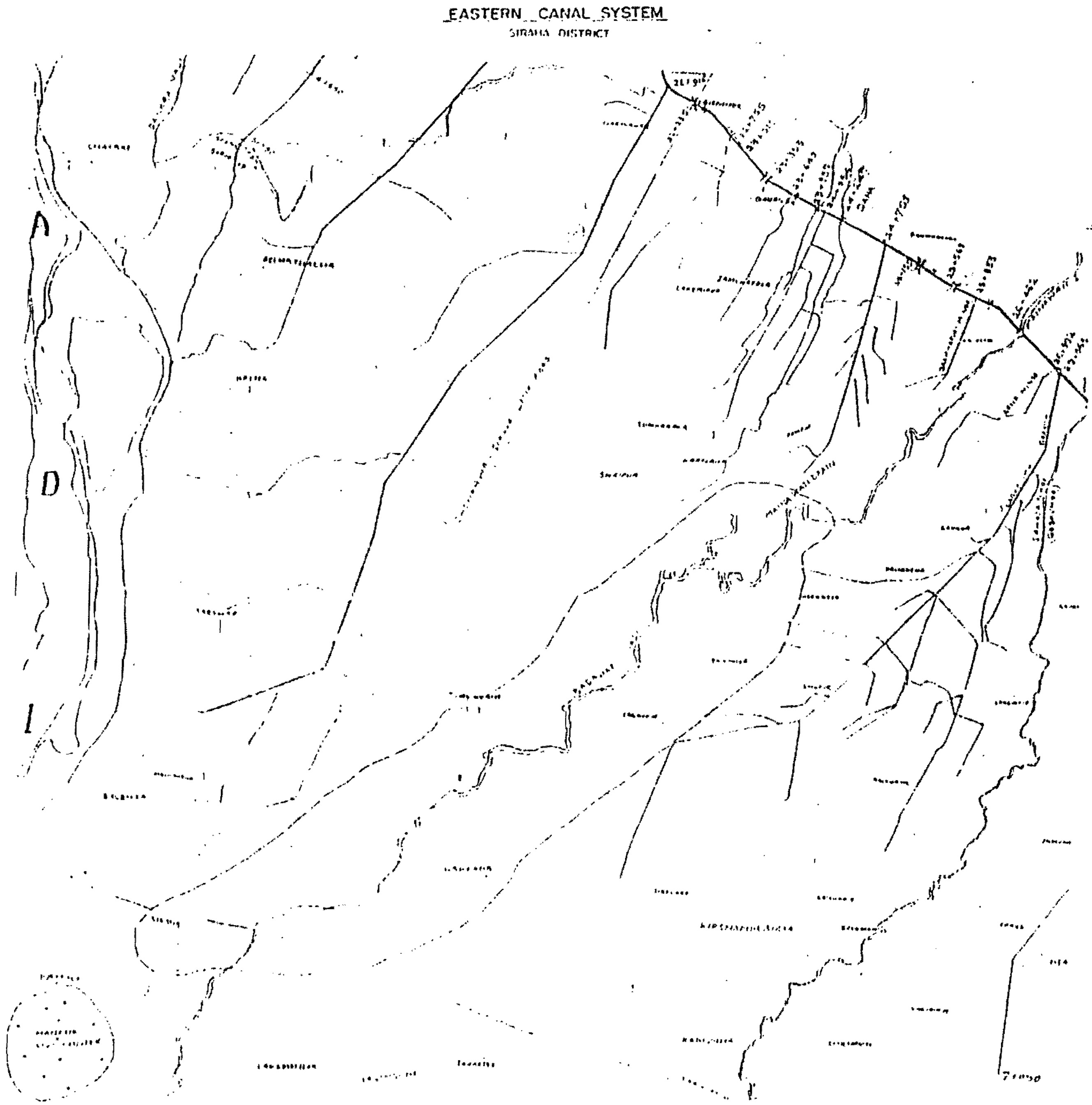

Figure 8.2: Conjuctive Use Practice in Hardinath Irrigation System

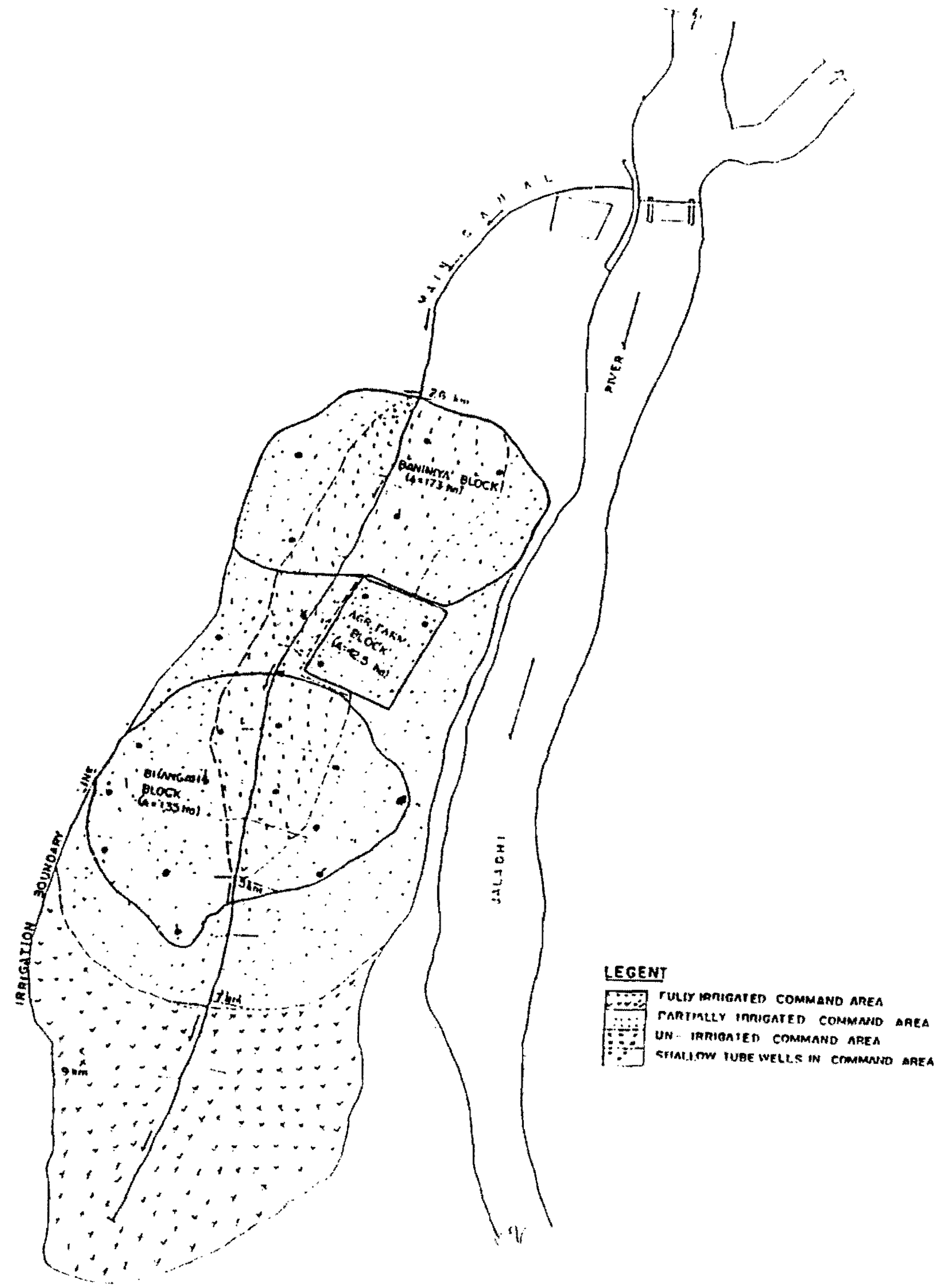

Figure 8.3: Conjuctive Use Practice in Nepal West Gandak Irrigation System