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Transactions Matter but They Hardly Cost: Irrigation Management in the Kathmandu Valley

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Contents

Abstract

This study estimates the transaction costs entailed in maintaining Farmer Managed Irrigation Systems (FMIS) in Nepal based on a case study of 60 irrigation systems in the Kathmandu valley. It analyzes the factors influencing transaction costs and compares these costs with the production cost in agriculture. The findings show that the main elements in transaction costs are time spent watching, waiting, and negotiating over water use. Time spent on transactions is relatively low for FMIS, amounting to 5 per cent of the total time required for the production of crops. Transaction time costs are higher for households cultivating land downstream of a canal compared to households cultivating upstream. A comparison of transaction time costs in terms of crop seasons shows time costs for winter crops to be three times higher than that for summer crops. The total value of output per hectare is significantly affected by transaction costs, reliability of the irrigation facility, and infrastructure quality. However, free riders pose a problem for collective action. Controlling free-riding or deviant behavior would therefore improve institutional efficiency and reduce ex-post transaction costs.

Key Words: Transaction cost, Irrigation systems, Agricultural productivity, Institutions, Nepal.

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1. Introduction

Agriculture remains to date the main source of subsistence for a majority of people in the developing countries. In Nepal, it contributes about 32 per cent of the GDP, providing employment for more than two thirds of the population of the country (NPC, 2007). Improvements in rural incomes are crucially dependent on productivity-enhancing infrastructure, irrigation being one of them. Nepal is famous for its farmer managed irrigation systems (FMIS). There are about 16,000 FMIS in Nepal which irrigate approximately 714,000 ha of cultivated area or 67 per cent of the total irrigable area of the country (Pradhan, 2002). For a while, the government of Nepal has considered irrigation development to be the domain of local concerns, which led farmers in disparate locations of the country to organize themselves to construct, govern, operate and maintain a large number of irrigation systems (Lam, 1998; Shivakoti et al., 2002).

Irrigation systems have two semi-public good features that have to do with non-exclusivity and rivalry: that is, it is costly to exclude potential beneficiaries from using it (which relates to non-exclusivity) while the use of the good, i.e., water, by one individual reduces its availability to others (which relates to rivalry). Thus, irrigation systems are characterized as common pool resources, and, water allocation and provisioning are two potential problems associated with collective action to manage these systems (Ostrom, 1990). The operation and maintenance of an irrigation system requires coordination among many farmers and is riddled with free-rider problems. Thus collective action is weakened considerably when each farmer has the incentive to use more water but to invest less in the system. These problems often result in poor maintenance as well as conflicts when it comes to water allocation (Tang, 1992).

In the absence of access to irrigation water on an individual basis, the institutional development of collectively managed irrigation systems assumes importance. The nature of institutional development, however, has a symbiotic relationship with transaction costs. While the efficiency of a system is influenced by the transaction cost, institutional malleability in turn determines the degree of transactions costs. No empirical studies to date have however studied transaction costs with regard to FMIS in Nepal. It is therefore important to understand how transactions costs influence agricultural productivity on farms in Nepal. Our study aims to fill this gap in the literature.

The rest of the paper is organized as follows: Section 2 provides the history of FMIS development in Nepal while also locating the study in the relevant literature on Transaction Costs. Section 3 details the study area and data collection strategy. In Section 4, we analyze our data while concluding with policy implications in Section 5.

2. FMIS: A Review

In the 1960s and 1970s, Nepal invested heavily in the construction of irrigation canals built with the support of external agencies and managed by the government. However, despite sophisticated engineering infrastructure and the presence of highly trained staff, the performance of these government-managed irrigation systems was not satisfactory (APROSC, 1978), leading to both severe deprivation of tail-enders and low productivity (WECS, 1982). Until the 1980s, there was no formal recognition of the potential contribution of Farmer Managed Irrigation System (Pradhan, 2002). However, with the onset of the basic needs fulfillment program of the government in the 1980s, there was acknowledgement that a high rate of agricultural development was not possible without the development of irrigation. But since the government found it difficult to develop large infrastructure as a means of achieving the desired rate of agricultural growth, it started in the 1980s to provide assistance to FMIS in different parts of the country with support from different donor-driven programs (such as Irrigation Line of Credit–ILC, Irrigation Sector Program–ISP, etc.). This helped increase irrigated area (Pradhan, 2002). For this reason, many of the FMIS came under the domain of the Irrigation Department for a short period of time.

After 1990, the need to devolve responsibility for irrigation water resource management to local user organizations gained further importance in Nepal. Encoded in the Water Resource Act of 1992, Water Resource Regulation of 1993, and Irrigation Regulation of 1999, was a requirement to register canals even if they had been managed traditionally by farmers. The right over the source and the canal was secure only after registration as the Acts established the ownership of water with the state The Government of Nepal also adopted a policy of not only transferring irrigation systems to farmers but also of creating a strong institution of farmers for the management of irrigation water (NPC, 2007).

Despite all these regulatory provisions, there is evidence to suggest that the institutional development of irrigation systems is not progressing well. Even in the Kathmandu Valley, less than 50 per cent of irrigation institutions have been registered following the legal provisions (Dulal, 2002). A question therefore arises as to why institutional growth has been so slow. One of the factors that influences institutional growth is transaction costs. Against this backdrop, the paper attempts to estimate the transaction costs of FMIS in Nepal. The specific objectives of the study are to:

a) assess the major components of transaction costs in FMIS and factors influencing the transaction costs incurred by households;
b) assess the relative share of transaction costs in total human cost incurred in the production process and the total production costs;
c) assess the role of transaction costs in influencing institutional development as well as its impact on production.

2.1 Transaction Costs – A Brief Discussion

Transaction costs refer to costs that arise when an individual or a group of individuals exchange ownership rights for economic assets and enforce their exclusive rights. It includes the costs of (a) information search; (b) bargaining and negotiation; (c) ensuring fulfillment of contract; (d) compensation valuation; and (e) legal expenses for gathering evidence, presenting a case, challenging opponents, awarding and collecting damages, etc. (Field et al., 1995).

Transaction costs were emphasized by North (1990), who divided the total costs of production into transformation costs – the cost of inputs of land, labour and capital involvement in transforming the physical attributes of a good, and transaction costs- the cost of defining, protecting and enforcing the property rights to goods. He defined transaction costs as the costs of measuring the valuable attributes of what is being exchanged and the costs of protecting rights and policing and enforcing agreements. Institutions lower transaction costs and are the key to the performance of economies. Holloway et al., (2000) defined transaction costs as 'the costs of searching for a partner (or group) with whom to exchange, screening potential partners to ascertain their trustworthiness, bargaining with potential partners (and officials) to reach an agreement, transferring the products, monitoring the agreement to see that its conditions are fulfilled, and enforcing the exchange agreement'.

At the community level, transaction costs of collective action are influenced by the physical characteristics of a resource and social capital of the community members (Ostrom, 1994). North (1990) considers social capital to be institutions that lower transaction costs and perform better than markets. Social capital generates mutually beneficial collective action (Fukuyama,1995; Ostrom 1994; Uphoff and Wijeratne, 2000). A high level of trust and strong civic and social norms lower transactions costs of exchange.

There are four key character and contextual factors associated with transaction costs that are relevant to natural resource management: uncertainty, asset specificity, frequency, and care or effort intensity (Williamson, 1991; Fenoaltea, 1984; Birner et. al., 2000). The efficient management of common property resources is often challenged by sources of uncertainty that results in high levels of transaction costs. Frequency of decision making is another attribute of transaction costs as many activities carried out to implement management decisions are frequent ranging from daily to seasonal (Binner et al., 2000). While effort intensive transactions are related to production activities, care intensive transactions are characteristics of protection activities (Fenoaltea, 1984).

There are several resource management stages when transactions costs become important (Hanna 1995). These are during the description of the resource use context, regulatory design and implementation and enforcement of agreed rules. In the context of community based resource management of irrigation water, these costs are incurred in the form of negotiation, monitoring of activities related to institutional design, maintenance of the organization and enforcement of rights over the water.

We now turn to some of the empirical findings in the literature on transaction costs, which suggests that these costs can be quite varied. Mburu et al., (2003) studied landowners' transaction costs arising from collaborative wildlife management in Kenya and recorded that these costs was relatively low. Kuperan et al.'s (1998) study in the Phillippines found that monitoring accounted for more than 50 per cent of the total costs of co-management. Sumalde and Pedroso et al., (2001), in their study of a community-based coastal management program in Philippines found that transaction costs accounted for 37 per cent of the total costs. The share of transaction cost in the implementation phase was 74per cent.

There are two studies based in Nepal that are relevant. Adhikari and Lovett's (2006) study on community forestry in Nepal found transaction costs to be a major component of resource management costs. The average poor household incurred Nrs. 1265 in transaction costs annually while rich households incurred an average of Nrs 2312 per year. Osanami and Joshi's (2005) study of two irrigation systems within Kathmandu Valley shows the importance of conveyance cost and congestion cost for irrigation canal maintenance activity. When conveyance cost is high, all farmers recognize the importance of collective works for maintenance of irrigation canal and pay fee regularly. But when upstream farmers are reluctant to cooperate with downstream farmers congestion costs become important and farmers pay more in waiting, negotiating and watching the water.

While these studies provide estimates of transaction cost we found that there are no studies analysing transaction costs in FMIS. This study is an attempt to fill this gap in literature.

3. Study Area and Methodology

We took three districts (Kathmandu, Lalitpur and Bhaktapur)[1] in the Kathmandu valley for our study because the Valley is famous for its agricultural production. The total population of the Kathmandu valley is about 1.7 million of which 60 per cent reside within the urban centers while the remaining 40 per cent reside in the countryside (CBS, 2001). Irrigation canals exist only in the villages of these districts. The total cultivable area in the three districts is about 12,800 ha, 11,069 ha and 7097 ha respectively. The major cereal crops in the valley are paddy, wheat, maize and millet. Potato, oilseeds and vegetables are the major cash crops. Among these crops paddy, wheat and potato need irrigation water. Irrigation water is necessarily mostly for early paddy (which is paddy planted before the monsoons, i.e., in May), wheat and winter potato[2].

3.1 Data Collection

When the existing institution is transformed to a new one, changes usually take place in the transaction cost structure as well. Co-management has the potential to increase the ex-ante transaction costs while achieving gains from ex-post transactions (Kuperan et. al, 1998).

Nepal is divided into 75 districts which are further divided into Village Development Committees (VDCs) and Municipalities for purposes of local government. There are 3914 VDCs and 58 Municipalities including one metropolitan and four sub-metropolitan cities. The VDCs and municipalities are further sub-divided into smaller units called the wards. There are 9 wards in each VDC while the number of wards in a municipality ranges from 10 to 35. The survey for this study was conducted during the winter of 2007. As a first step, we listed and categorized all the irrigation systems within the three districts of the Kathmandu valley according to the number of Village Development Committees (VDCs) they cover, i.e., large (3 VDC and above), medium (2 VDCs) and small (1 VDC). There are altogether 415 systems in the Kathmandu valley among which 51 are large, 122 medium and 242 small. Primary data collection involved both system level data as well as household level data using questionnaires.[3]

We selected twenty systems from each category randomly (see Table 1 for the household selection strategy). In the large system, we divided the farmers into three groups—head, middle and tail. Farmers in the medium-sized systems were grouped into two—head and tail—while we considered all farmers in the small system as head-end users. The sample included twenty canals from each category of irrigation systems (i.e., large, medium and small). The number of households surveyed was 180, 120 and 60 for the large, medium and small systems respectively.

[1] The study is confined only to the Kathmandu valley as field visits were possible only in the Kathmandu Valley due to the civil conflict prevalent during the study period

[2] After planting, normal rainfall provides sufficient water to paddy plants. The summer potato which is cultivated just after the harvesting of paddy does not need much water since the land is wet during this period. Only winter potato needs irrigation. In some parts of Kathmandu, however, farmers plant paddy in May, to enable them to cultivate potato twice after the paddy.

[3] The three questionnaires were used to collect data at (a) system level, b) sub-system (Head, Middle and Tail) level, and c) household level.

Canal infrastructure was categorized as good, medium and poor depending on the physical condition and leakage situation. However, for the purpose of the regression analysis, we reduced these three categories to two (for e.g., Yes_Infr) for availability of infrastructure Thus the variable infrastructure then becomes a dummy variable with value zero for poor quality and value one for good and medium quality infrastructure. While the survey collected socio-economic and institutional data, it mainly focused on transaction cost information. Those households that incurred less than NRs 150 ex-post transaction cost were categorized as Free-riders.[4]

3.2 Measuring Different Elements of Transaction Costs

Transaction costs are incurred at both the organization/system and household levels. System level transaction costs occur both at the ex-post and ex-ante stage (for organization formation). Meetings, registration and negotiation costs are ex-ante in nature as they arise prior to the formation of an organization. Ex-post cost, on the other hand, is the time cost for meetings, conflict resolution and communications (Bhattarai, 2007). We also calculated transaction costs at the household level where we include the cost for watching, waiting and negotiating cost as post organisation formation cost but incurred during irrigation management[see Table 2].

Transaction cost estimation involved a direct monetary measurement as well as an imputed one. The direct measure included payments to hired labor for waiting while the imputed costs included contributions in terms of time by members for various activities. To measure the imputed cost of time spent by individuals in organizational work, we valued the opportunity cost at the average wage rate[5]. The households in the Kathmandu valley have the option of gaining work outside their farm throughout the year. Thus, it is acceptable possible to use the labor wage rate in Kathmandu as a proxy to calculate the opportunity cost of time (Mburu, 2003).

Formation cost is a one-time fixed cost which is calculated on the basis of the time and resources devoted by farmers at the time of WUA formation. Hence, we used the lowest bank interest rate for lending (9 per cent) to estimate the annual transaction cost of formation.

We estimated the total annual transaction time by adding the expenses incurred by households at the system level as well as at the household level. In order to make these compatible, we divided the system level total annual transaction time by the total number of households within the system and added it to the household level transaction time. In order to avoid the problem of double counting, we did not add the general meeting time at the system level to the total transaction time since this is already accounted for in the household's transaction cost estimate. We converted every 7 hours into one working day to arrive at a day measure for time costs.

In the following section we provide a brief description of the household characteristics, the physical condition of the canal, institutions and government assistance. This is followed by a discussion of the relative importance of transaction days in comparison to the total human labor requirement in crop production.

4. Description of Findings

Agriculture was the pre-dominant occupation for at least one member of every household interviewed The average family size was 6, the male-female ratio was near equal and about half the household heads were illiterate (see Table 3).

4.1 Physical Condition of the Canal and External Support

We found most irrigation systems in this area were constructed by the ancestors of the present users. Only a few (3-4) had been constructed using direct bilateral assistance. The source of water for most of the canals was rivers and streams. The average irrigated area is the highest in the large systems (at 151 ha) and lowest in the small systems (at 15 ha). The average length of the canal was 4.2 km for the large systems and 2.2 km for the small canals.

[4] The choice of Nrs 150 as a Free-riding threshold was arbitrary but the regression results were robust to changes within a range of Nrs 50.

[5] For the purpose of estimating the opportunity cost, we used the average wage rate of the peak and slack seasons.

Taking into consideration various parameters like the use of concrete in the canal, the quality of lining of the canal, leakage in the canal, etc., we classified canals into three categories: good, fair and poor. On the basis of this classification, we found most of the canals to be in poor condition: that is, either there were leakages in the canals due to absence of proper lining or they were not able to consolidate water from the source due to lack of a proper dam structure at the intake point of the canal. According to our findings, approximately 63 per cent of the households were using canals with poor infrastructure while only 5 per cent of the surveyed households were using canals with good infrastructure. The remaining households depended on canals with medium quality (or average) infrastructure.

Among the surveyed irrigation systems, 50 per cent had been rehabilitated during the last 30 years. Among these rehabilitated systems, about two thirds had received partial support from the government while only 10 per cent had been repaired by the user farmers themselves. The remaining systems had been repaired by the users with partial support from the government, the NGOs or the INGOs.

During our survey, we found two types of irrigation systems: those with formal registration and those without formal registration. Most of the registered institutions had been formed after 1990 while the motivating factor to organize and to register the institution in most cases appeared to be the possibility of receiving external assistance to repair the canal. The per centage of households having registered WUAs was highest among the large systems category compared to medium and small system (see Figure 1).

Although WUAs registered with government agencies had a higher likelihood of receiving financial assistance for maintenance purposes (the correlation between Support and registered WUAs was 0.7, which was significant at .01 per cent), 61 per cent of the systems had not managed to register their WUA and a similar number of WUAs did not receive support. Only 26 per cent of the households that were with a registered WUA failed to receive any support (see Figure 2).

Transaction Cost, as discussed previously, refers to the time and money spent by farmers related to the formation and continuation of WUA. Farmers incur post-formation expenses in terms of time put into supervision of irrigation facilities and ensuring that water flows to their fields. This is borne out by the significant differences in ex-ante transaction costs per hectare that farmers spent in forming the WUA (see Table 4).

Those who received external support also had good or medium infrastructure. Those who had a high ex-ante transaction cost also had a high ex-post transaction cost but, not surprisingly, they also had a higher agricultural output. However, being located downstream of the canal does not seem to be correlated with support. Instead, as expected, it is correlated with both good (or medium) infrastructure and ex-post transaction cost. One possible explanation for this is that those who are located downstream are likely to spend more time and effort in order to ensure that irrigation water reaches their fields. It will do so only if the proper infrastructure exists and if the households are ready to commit time to ensure that it does so. Interestingly, systems that had registered WUA and good infrastructure also had more reliable irrigation. But if the ex-post transaction cost was low (i.e., if farmers exerted themselves less in ensuring the flow of water) or if the farmers were located downstream, they had less reliable irrigation (see Table 5).

With regard to the role played by “support”, there was a significant difference in the ex-post transaction cost between those who received support and those who did not, irrespective of the type of system. However, while farmers in small systems seemed to have a lower ex-post transaction cost when they received support, those in medium and large systems had a larger ex-post transaction cost when they received support (see Table 6).

Interestingly, while farmers in the large systems had a significantly higher average output (that is, the total value per hectare), the output in the small systems was significantly lower than in the middle sized systems (see Table 7). When the farms were disaggregated by location, we found that in the case of large systems the tail-end showed a significantly lower output compared to the group average. For the rest of the farmers, the location did not seem to make a significant difference in terms of average output.

Farmers located in the middle area of large systems reported the highest output per hectare followed by the head-enders. The next highest output was reported by the tail-enders in the middle sized systems, who were in turn closely followed by the head-enders in mid-sized systems. The tail-end farms in both large and middle system reported a higher output than the average in the small-sized systems. Hence, we could conclude that farmers are better off (on average) as part of a large and middle systems than as part of a small system (see Table 7).

While approximately one third (31 per cent) of the total surveyed households were members of at least one other organization, only 14 per cent households of the total surveyed were members of water user associations (WUAs). Even among the registered WUAs, only 24 per cent of households were members of WUAs. Of the tail-end farmers, only 14 per cent were members of the WUAs while of all members of WUA, only 34 per cent were tail-end users.

4.2 Transaction Cost and Production

We can classify the transaction cost into two broad categories, ex-ante cost and ex-post cost, which can in turn be segregated into five broad activities: (i) watching, waiting and negotiating, (ii) meeting, (iii) conflict resolution, (iv) communication, and (v) formation cost. Among the above, while the "watching, waiting and negotiating cost" and the "conflict resolution" costs are ex-post costs, communication cost and formation cost are ex-ante transaction costs. Meeting costs, on the other hand, depending on the nature of the meeting, could be either ex-ante or ex-post. The ex-ante transaction cost on average is very low (NRs 6 per year per household) in comparison with the ex-post transaction cost (which is NRs 326 per year per household). Of the costs listed above, "watching, waiting and negotiating" constitute approximately 92 per cent of the total transaction cost while the time spent in meetings takes up only around 7 per cent of the total transaction cost. The remaining amount is taken up by the "conflict resolution, formation and communication costs" (see Figure 3). It is interesting that ex-post transaction costs are significantly higher for downstream farmers (about Nrs 4000) than the upstream farmers (about Nrs 2300) (see Table 8).

We did not collect detailed production costs during our survey. However, for purposes of comparison, we used the government of Nepal estimates of total human labor requirement for the cultivation of paddy (181 days), wheat (141 days) and potato (235 days). (Government of Nepal, 2006/2007).

The share of transaction time compared to the total human labor required for the production of crops on average, was 4 per cent for upstream and 6 per cent for downstream households. The transaction time for winter crops is three times higher than that for summer crops. This is mainly because the summer crop has the benefit of the monsoon rains and thus is less dependent on canal water. In contrast, farmers rely on canal water to irrigate the winter crop and thus have to devote more time for watching, waiting and negotiating. However, if we compare the transaction cost with the total value of output, it is only about one per cent of the total value of output (see Figure 4 and 5).

There are no other studies on the Transaction Costs in FMIS and hence it is hard to say whether our results are high or low. The findings of the present study are however consistent with those of Mburu et al. (2003) who studied collaborative wildlife management in Kenya. The findings of our study also reveal that the transaction cost in FMIS is relatively low compared to community forestry in Nepal. Adhikari et al. (2006), for instance, found that the annual transaction cost for a household in community forestry ranges between 9-14 per cent of the total cost which is much higher than those of this study where it was just 4-6 per cent of the total labor cost and just 1 per cent of the total production cost.

In the next section we set up our econometric model in order to test for the significance of factors influencing the total value of output (per hectare) and the role played by the transaction cost among other factors.

4.3 Econometric Model and Its Results

The critical factor that determines the productivity of farms in the non-monsoon period is the availability of irrigation water at the farm level, which is determined in turn by the existence of canals and their maintenance and operation status. Transaction costs influence both the maintenance and operation of irrigation canals (although the actual cost of maintenance is not part of the transaction cost). There is high uncertainty in the water flow of irrigation canals and this poses a challenge to efficient management, which in turn results in transaction costs. The productivity of land also depends upon the physical characteristics of the canal system as well as the location of the cultivated farm vis-à-vis the source of the canal.

4.3.1 The Model

We set up a regression model to understand the effect of farm locations as well as other variables on value of farm output. Since this study focuses on transaction costs, we did not attempt to model a regular production function. We examine the impact on production of factors like social cohesion (reflected in existence of dispute and a dominant caste), farm location, infrastructure quality, reliability of irrigation, free-riding, transaction cost, external support. We hypothesise that:

1. Total value of output per hectare= f (Dispute, Dominant Caste, Location of field, Reliability of Irrigation, External support, Free Riding, Transaction Cost)

These variables are expected to impact on farm revenues in different ways. The expected direction of their impact is presented in Table 9. We anticipate that a dispute in the system would adversely affect revenues. However, if the farmer belongs to a dominant caste, it may be possible for him to have better access to water for irrigation. The presence of better infrastructure is helpful but we expect this effect to be captured by the reliability of irrigation water – a better outcome is inevitable with a more reliable water supply. In terms of location, we expect those in the tail-end to have a higher transaction cost but the impact on production is not certain. If there are free-riders, they would have a higher net revenues as they take advantage of the semi-public goods nature of irrigation systems without incurring a cost for their use. However, even those who contribute find a positive impact on their revenues. If a group of farmers exerts themselves to form an organization, then they are likely to have gained support for the maintenance of infrastructure. And if they continue to exert themselves to ensure supply of water, then their output would inevitably increase. The transaction cost also contributes positively to an increase in output as these are incurred to ensure the reliability of irrigation water in the field.

In order to estimate the impact of the variables that affect the total value of output per hectare, we estimate the linear econometric model using the OLS method:

2. $$totval\_Ha = \beta_0 + \beta_1\, dispute + \beta_2\, dom\_caste + \beta_3\, dumlh + \beta_4\, dumlm + \beta_5\, dumlt + \beta_6\, dummedh + \beta_7\, dummt + \beta_8\, perl\_irrif + \beta_9\, free\_ride + \beta_{10}\, exposttc\_Ha + \beta_{11}\, exantetc\_Ha + \beta_{12}\, sqexposttc\_Ha$$

The estimated values of parameters are presented in Table 10.

4.3.2 Regression Results

We find that reliability of irrigation system have a positive impact on the total value of output per hectare, as expected. Similarly better quality of irrigation infrastructure has a significant positive impact. Free riders have a higher farm revenue as they do not bear any transaction costs towards WUA. This also provides evidence that it pays some farmers to "cheat" when they free-ride on the contribution made by the others to provide a public good. This, as the literature suggests, is the classic dilemma of the commons.

Transaction cost contribution to WUA functioning results in a positive impact on production. It is expected that a small expense incurred in various activities that ensure the flow of water, would have a multiplier effect on farm output. However, the negative coefficient on the squared term for transaction cost indicates that the benefits from greater transaction cost increase at a decreasing rate. Beyond a threshold, increased transaction costs alone will not lead to higher production.

The qualitative variables like tail-end of medium irrigation schemes, "Dispute" and "Dominant caste," even though not individually significant, are jointly significant. The other locational dummies are not significant indicating that when controlled for other factors, production is not influenced by location. These results are in conformity with our expectations.

We also calculated robust standard errors but since they were found to have similar values we do not present them here. The overall goodness of fit (adjusted-R square) is 0.3033 which is in an acceptable range and the joint test of hypothesis (F-test) is also significant. All the signs of the variables confirm to expectations as stated in the Table 9.

In the last section of this paper we summarise our discussion and recommend a possible set of policy interventions.

5. Conclusions and Policy Implications

This study attempted to shed light on transaction costs in the irrigation sector in Kathmandu valley of Nepal. We recorded the size and major components of transaction costs in FMIS. Our findings suggest that Transaction costs in FMIS are low in comparison to other sectors of the rural economy such as community forestry.

Did availability of irrigation make a difference ? Even though we surveyed only farmers who were part of irrigation systems, unreliable irrigation is a proxy for unirrigated agriculture. Our regression analysis suggests that the difference in average output between farmers with and without reliable irrigation was on average about NRs 64,000 per hectare after controlling for various institutional and locational factors. In comparison with this, the transaction cost of about Rs 3400 per hectare incurred by the farmers is minimal. This justifies farmer behavior in undertaking transaction costs to ensure reliable water supply for irrigation. Evidently downstream farmers spent significantly more in ex-post transaction costs than upstream farmers.

Even though transaction costs are low, they seem to make a positive and significant difference to farm revenues. But, it does pay to “cheat” as free riders in the system report higher revenues on average. If there is a way to curb free-riding, it may increase production further. If the proportion of free-riders is large, the reliability of irrigation may fall drastically.

Quality of infrastructure has a significant positive impact on the value of output per hectare. Infrastructure funding, however, is dependent on ex-ante transaction efforts to register the WUA and access aid from the government or donor agencies. As the results from our study show, transaction activities do not cost much but they do matter for collective action as well as for increases in farm output.

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References

Adhikari, B; Lovett, JC (2006) 'Transaction costs and community–based natural resource management in Nepal', *Journal of Environmental Management* 78: 5-15

APROSC (1978) 'Irrigation impact evaluation study: *Manusmara* irrigation project', Agricultural Projects Services Centre, Kathmandu, Nepal

Birner, R; Wittmer, H (2000) 'Co-management of natural resources: a transaction cost economics approach to determine the 'Efficient Boundaries of the State'. Paper presented at the Annual Conference of the International Society of the New Institutional Economics (ISNIE) in Tuebingen, Germany

CBS (2001) Population Census 2001 Selected Economic Activity Tables, Nepal Government, National Planning Commission Secretariat, Central Bureau of Statistics

Dulal, S; Pradhan, P (2002) 'Report on the inventory of irrigation systems in Kathmandu district, Nepal', Farmer Managed Irrigation System Promotion Trust Kathmandu, Nepal

Fenoaltea, S (1984) Slavery and Supervision in Comparative Perspectives: a model. *Journal of Economic History* 44, 635-668

Field, B; Olewiler, N (1995) *Environmental Economics* 1st. Canadian ed. USA: McGraw Hill and Ryerson

Fukuyama, F (1995) *Trust: The Social Virtues and the Creation of Prosperity*, Free Press: New York

Hanna, S (1995) 'Efficiency of user participation in natural resource management', in Hanna, S., Manasinghe, M. (Eds) *Property Rights and the Environment, Social and Ecological Issues*. Beijer Institute of Ecological Economics, Stockholm and the World Bank, Washington, DC, pp 59-67

Holloway, G; Nicholson, C; Delgado, C; Ehui, S (2000) 'Agro industrialization through institutional innovation: transaction costs, cooperatives and milk-market development in the east African highlands', *Agricultural Economics* 23, 279-288

Ministry of Agriculture, Government of Nepal (2006/2007) 'Costs of production and marketing margin per hectare of some important cereal crops, Nepal', Market Research and Statistics Management Program, Harihar Bhawan Lalitpur.

Kuperan, K; Mustapha, N; Abdullah, R; Pomeroy, RS; Genio, E; Salamanca, A (1998) 'Measuring transaction costs of fisheries co-management', Paper Presented at the Seventh Biennial Conference of the International Association for the Study of Common Property, Vancouver, Canada. Available at: http://www.indiana.edu/-issap/Drafts/Kuperan.pdf [Accessed on: 2007]

Lam, WF (1998) *'Governing Irrigation Systems in Nepal,'* Oakland, CA: Institute for Contemporary Studies

Mburu, J; Birner, R; Zeller, M (2003) 'Relative importance and determinants of landowners' transaction costs in collaborative wildlife management in Kenya: an empirical analysis', *Ecological Economics* 45: 59-73

North, DC (1990) *'Institutions, Institutional Change and Economic Performance,'* Cambridge University Press: Cambridge

NPC (2007) 'Interim Plan 2007/8–2009/10, Government of Nepal', National Planning Commission, Nepal

Osanami, Fumio; Joshi, NN (2005) 'Farmer's Incentives to Participate in Irrigation Activities: Findings of case studies in Kathmandu Valley', in Prachanda Pradhan and Upendra Gautam (eds.) Farmer Managed Irrigation Systems and Governance Alternatives: Proceedings of the third international seminar held on 9-10 September 2004, Kathmandu, Nepal, Farmer Managed Irrigation Systems Promotion Trust, Kathmandu Nepal

Ostrom, E (1990) *'Governing the Commons: The Evolution of Institutions for Collective Action,'* Cambridge: Cambridge University Press.

Ostrom, E (1994) 'Constituting Social Capital and Collective Action', *Journal of Theoretical Politics* 6 (4):527-562

Pradhan, P (2002) 'Eroding social capital through incompatible legal and institutional regimes: experience from irrigation systems in Nepal', Unpublished Paper Presented at the Workshop in Political Theory and Policy Analysis, Indiana, USA

Shivakoti, GP; Ostrom, E (eds.) (2002) *Improving Irrigation Governance and Management in Nepal,* Oakland, CA: Institute for Contemporary Studies

Sumalde, ZM; Pedroso, SL (2001) 'Transaction costs of community-based coastal resource management program in San Miguel Bay, Philippines', Economy and Environment Program for South East Asia (EEPSEA) Research Report, Manila Philippines.

Uphoff, N; Wijayaratna, CM (2000) 'Demonstrated benefits from social capital: the productivity of farmer organizations in Gal Oya', Sri Lanka, *World Development,* 28:1875-1890

WECS (1982) 'Performance Review of Public Sector Intensive Irrigation Based Agricultural Development Projects', Water Resource and Energy Commission, GoN Kathmandu, Nepal

Williamson, OE (1991) 'Comparative Economic Organization the analysis of discrete structural alternatives', *Administrative Science Quarterly* 36 (2) 269-296

Tables

Table 1: Selection of System

Systems	Systems Covering Village	Total Systems within Kathmandu Valley	No. of Systems Selected Randomly	Households Selected Randomly
Small	1	242	20	60 (3 from each system)
Medium	2	122	20	120 (3 from head and 3 from tail of each system)
Large	3 and above	51	20	180 (3 from head, 3 from middle and 3 from tail-end users)
Total		**415**	**60**	**360**

Table 2: Methods of Estimating Annual Transaction Costs

Transaction	Nature of Transactions/ Elements of Transaction	Nature of Cost	Approach	Cost Estimation
Formation of Organization	Meetings/dealing with stake holders/	Time for meetings	Value of time Wage rate*time	Interest rate as annual cost
Formation of Organization	Dealing with government offices	Travel cost, registration cost, statute preparation cost	Monetary expenditure	Interest rate as annual cost
Ensuring the implementation of decisions	Meetings/ dealing with agents/ communication/conflict resolution	Time for meetings	Wage rate*time	Opportunity cost
Protecting and negotiating	Watching, Waiting and Negotiating	Time	Wage rate*time	Opportunity cost

Table 3: Demographic Features of Households

Household Parameter	No of Households	Per cent
Head of the Household		
Male	311	86
Education (Head of HH)		
No Formal Education	183	51
Grade 1-5	46	13
Grade 6-10	94	26
Grade 11-14 passed	33	9
Master Completed	2	1
Main Occupation (Head of HH)		
Agriculture	238	66
Salaried Employed	47	13
Private Business	12	4
Aged	50	14
Pension	5	1
Wage Worker	4	1
Other	4	1
Member of Any Organization	111	31
Member of WUA	50	14
Total Number of Household	**n =360**	**100**

Table 4: Difference in Ex-ante Transaction Cost (per hectare) with and without Support (T-test with Unequal Variances)

Variables	Observations	Mean	t-value [Mean (without support) –Mean (With support)]	Satterth-waite's Degrees of freedom	H0:	Ha:
Without support (No)	212	30.70	**-2.86**	**138.526**	Diff =0	**Diff< 0 ; Pr (T>t) = 0.0024**
With support (Yes)	137	157.37				**Diff = 0; Pr (T>t) = 0.0048**
Combined	349	80.43				
Difference		-126.67				**Diff >0; Pr (T>t)= 0.9976**

Table 5: Correlation Matrix (Pairwise)

	support	totva~Ha	type_org	exante~Ha	expost~Ha	yes_infr	downst~m	prel_i~f
support	1.0000							
totval_Ha	-0.0069	1.0000						
type_of_org	0.7004*	0.0284	1.0000					
exantetc_Ha	0.1868*	0.2872*	0.1637*	1.0000				
exposttc_Ha	0.1041*	0.3995*	0.0190	0.6778*	1.0000			
yes_infr	0.4391*	0.1215*	0.4890*	0.0347	-0.0072	1.0000		
downstream	0.0694	0.0459	0.0457	0.0400	0.1380*	0.1582*	1.0000	
prel_irrif	0.0328	0.0821	0.1238*	-0.0760	-0.1736*	0.1088*	-0.2223*	1.0000

(Significant at 10%, N=349)

Table 6: Difference of Means in Ex-post TC per Ha (t-test with Unequal Variances)

Type of the System	Support	No Support	Combined	t-value Diff = mean(no) - mean(yes) Ho: diff = 0	Satterthwaite's degrees of freedom	P-Value	Alternate Hypothesis
Large	4479	3142	3743 (N=178)	-1.3429	106.017	.0911	Ha: diff < 0
Medium	4067	2937	3357 (N=113)	-1.5549	90.9057	.0617	Ha: diff < 0
Small	1038	2101	1826 (N=58)	1.4471	48.162	.0772	Ha: diff > 0

Table 7: Difference of Means in TotVal_Ha (t-test) for Different System Types with Unequal Variances

	TypeSys 1	TypeSys 2	TypeSys 3	All Systems
TotVal_Ha	2,30,123	1,89,409	1,60,885	2,05,434
N	178	113	58	349
Difference of Means	Ha: Diff =< 0	Ha: Diff == 0	Ha: Diff > 0	
Head	2,37,165	1,82,929	1,60,885	
Middle	2,73,507	–	–	
Tail	1,79,934*	1,96,007	–	

Table 8: Differences in Ex-post Transaction Cost per hectare (with Unequal Variances)

Variables	Observations	Mean	t-value [Mean (Upstream) –Mean (Downstream)]	Satterthwaite's Degrees of freedom	H0:	Ha:
upstream	173	2572.6	-2.61	279.009	Diff=0	**Diff < 0; Pr(T<t) =0.0048** **Diff=0 ; Pr(T>t) = 0.0096** **Diff >0; Pr (T>t) = 0.9952**
downstream	176	4014.6				
Combined	349	3299.8				
Difference		-1442.0				

Table 9: Definitions of and Expected Signs

Factor Context	Variable Name	Definition of Variable (Type: Continuous = C Dummy = D)	Expected Impact on Productivity	Reason
Dependent Variable	Totval_Ha	Total Output per hectare in (NRs)		
Explanatory Variables	Dispute	Existence of dispute within the system (D)	-ve	More dispute within the system the reliability of water flow will be low and hence low productivity in the land
	Dom_caste	Dominant caste (Bramhin and Kshetry) (D)	+ ve	Existence of dominant caste may manage the resource and facility in their favor and hence positive impact on production.
	Dumlh	Dummy for large head households	+ve	Positive impact on output as more irrigation facility will be available.
	dumlm	Dummy for large middle households	+ve	Positive impact on output as sufficient irrigation facility will be available
	dumlt	Dummy for large tail households	-ve	Negative impact on output as less irrigation water will be available in the tail end.
	dummedh	Dummy for medium head households	+ve	Positive impact on output as more irrigation facility will be available.
	dummt	Dummy for medium tail households	-ve	Negative impact on output as less irrigation water will be available in the tail end.
	yes_infra	Infrastructure quality (D) 1 for meduum and good infrastructure and 0 for poor infrastructure	+ve	Positive Impact as better infrastructure improves the reliability of irrigation.
	prel_irrif	Reliability of irrigation facility (D)	+ve	More reliable the irrigation facility more production on the land.
	free_ride	Free riders (households having less than NRs 150 expost transaction cost)(D)	+ve	Free riders have positive impact on output as they have more net benefit.
	exposttc_Ha	Per hectare transaction cost incurred after the formation of organization (C)	+ve	More time and effort for the collection of water and improvement in the reliability of water availability for irrigation in the field more will be the production.
	exantetc_Ha	Per hectare transaction cost during the process of formation of organization (C)	+ve	More time and effort for the institutional development for the smooth and regular flow of water more will be the output in the field.
	sqexpost_Ha	Square of the expost transaction cost per hectare (c)	-ve	However, use of increasing amount of transaction cost results decreasing rate of output gains.

Table 10: Summary Statistics

Variable	N	Mean	SD	Min	Max
totval_Ha	349	2.05e+05	2.53e+05	27600.00	2.81e+06
Dispute	349	0.30	0.46	0.00	1.00
dom_caste	349	0.71	0.46	0.00	1.00
dumlh	349	0.17	0.37	0.00	1.00
dumlm	349	0.17	0.38	0.00	1.00
dumlt	349	0.17	0.38	0.00	1.00
dummedh	349	0.16	0.37	0.00	1.00
dummt	349	0.16	0.37	0.00	1.00
prel_irrif	349	0.78	0.42	0.00	1.00
free_ride	349	0.30	0.46	0.00	1.00
exposttc_Ha	349	3299.82	5230.99	0.00	67500.00
exantetc_Ha	349	80.42	331.63	0.00	5864.05
sqexpost_Ha	349	3.82e+07	2.55e+08	0.00	4.56e+09

Table 11: Regression Results (Dependent Variable: Totval_Ha)

Explanatory Variables	Coefficient	t
Dispute	-43021.9	-1.57
dom_caste	30993.39	1.23
Dumlh	6041.323	0.15
Dumlm	30460.02	0.74
Dumlt	-18247.74	-0.44
Dummedh	-60721.12	-1.51
Dummt	-18273.09	-0.45
prel_irrif	63939.38**	2.20
Support	-89161.5***	-3.30
yes_infr	59280.18 **	2.17
free_ride	155474.4***	5.64
exposttc_Ha	45.41855 ***	9.81
exantetc_Ha	421.8475***	4.55
sqexpost_Ha	-.0009478***	-5.82
_cons	-25387.06	-0.62

** Significant at 5 % level of significance *** Significant at 1 % level of significance

Figures

Figure 1: Proportion of Households with Registered Organizations (by Type of System)

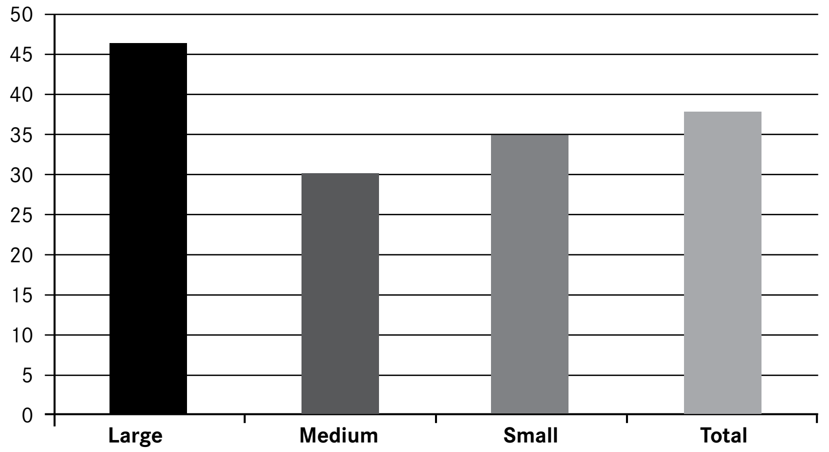


Figure 2: Households with Registered Organizations and External Support

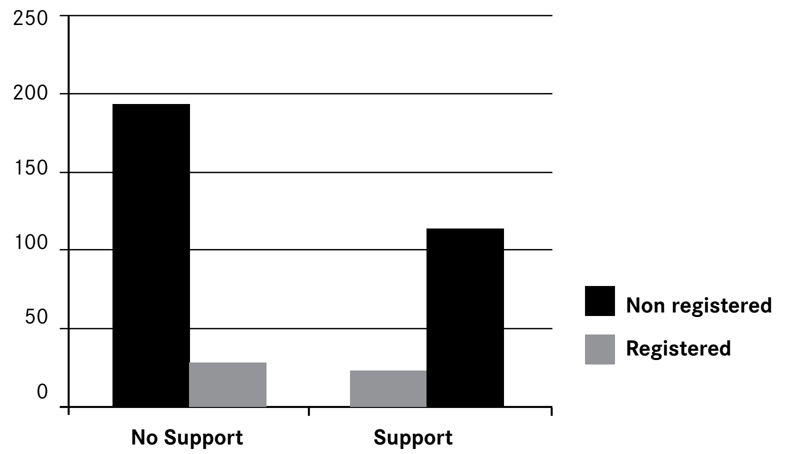


Figure 3: Different Category of Transaction Cost (in hours)

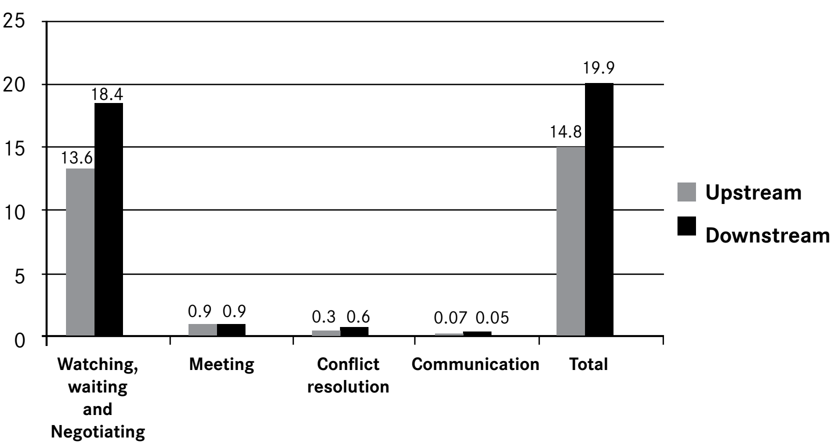


Figure 4: Transaction Time, Repair and Maintenance Time and Total Time for the Production of Crops per Household

(in man days)

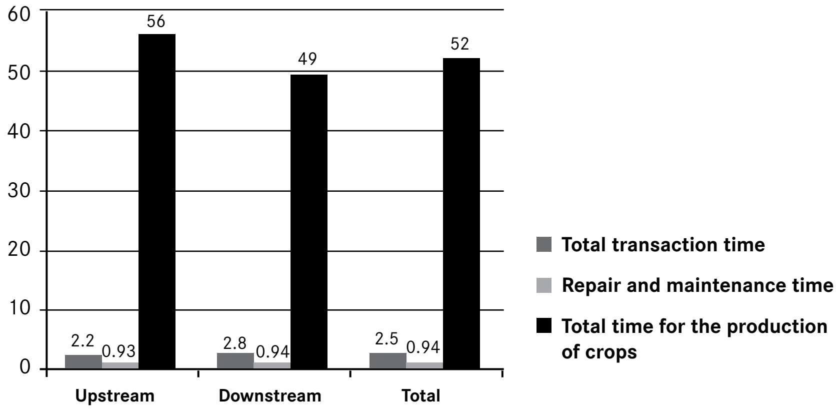
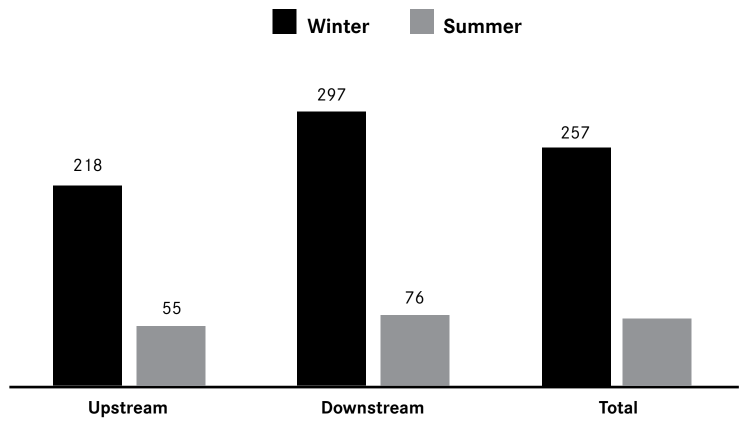


Figure 5: Transaction Cost (in NRs) by Season



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