CHAPTER 5

KRISHNAPUR: SCARCE WATER

Photograph by Robert Yoder.

The Krishnapur Tole cluster within the village of Karre Khola in Surkhet District was chosen as a case study due to the unique MUS situation that arose from the area's incredible water scarcity. Information in this case study came predominantly from personal interviews of nine out of the 16 households and small-group interviews from the whole cluster in October 2006. Of the nine households interviewed, three were from each part of the MUS system—head, middle, and end, and within each group of three were one poor, one middle-income, and one wealthy household. Additional information was obtained from the detailed survey design report conducted by SIMI staff prior to MUS construction.

SITUATION ANALYSIS

COMMUNITY SETTING

Location and Climate

Karre Khola village sits between two streams, the Karre Khola on the east and the smaller Bhandari Khola on the west (see Figure 5.1) that join at the lower end of the valley. The village, named after the larger stream, is northeast of Surkhet municipality (Birendranagar) at an elevation of about 760 m. The village has 356 households spread in a narrow band along a one-km stretch of road leading from the valley up the hill to Ratu VDC. A six-km gravel road links the village to both Birendranagar and the road leading to the Terai in the south of Nepal. However, there is a more direct foot trail that takes only one hour to the municipality, so most travel and transport to and from Karre Khola village is by foot.

The Karre Khola stream has a steep uniform gradient (80 m drop in 1,000 m) near the village with nearly vertical banks cut 10–20 m into unconsolidated rocky soil. Although there are perennial springs that feed the stream in some areas, it is not large even in the monsoon season and has very little water in the dry season. This leads the entire Karre Khola valley to be very water scarce in the dry season, from about February until monsoon rains start in June. Table 1.2 in chapter 1 shows the rainfall patterns, temperature ranges, and evapotranspiration rates for Krishnapur.

A 76-year-old resident of the village, Mr. Tek Bahadur Mager, who has lived all his life in the area, described how the heavily forested valley had very few permanent residents when he was young. Since malaria was endemic in the valley, most households made their permanent houses above 1,000 m, the upper elevation range of the Anopheles mosquito, on hills surrounding the valley. They made the long walk (one or more hours each way) to their farms in the valley to cultivate rice and other crops and tend to cattle. Many kept temporary huts near their fields where they could stay overnight when necessary. As malaria was reduced in the period 1950–1970,[1] many families with fields in the valley moved down from the higher villages, and Karre Khola became more established.

Population/Demographics

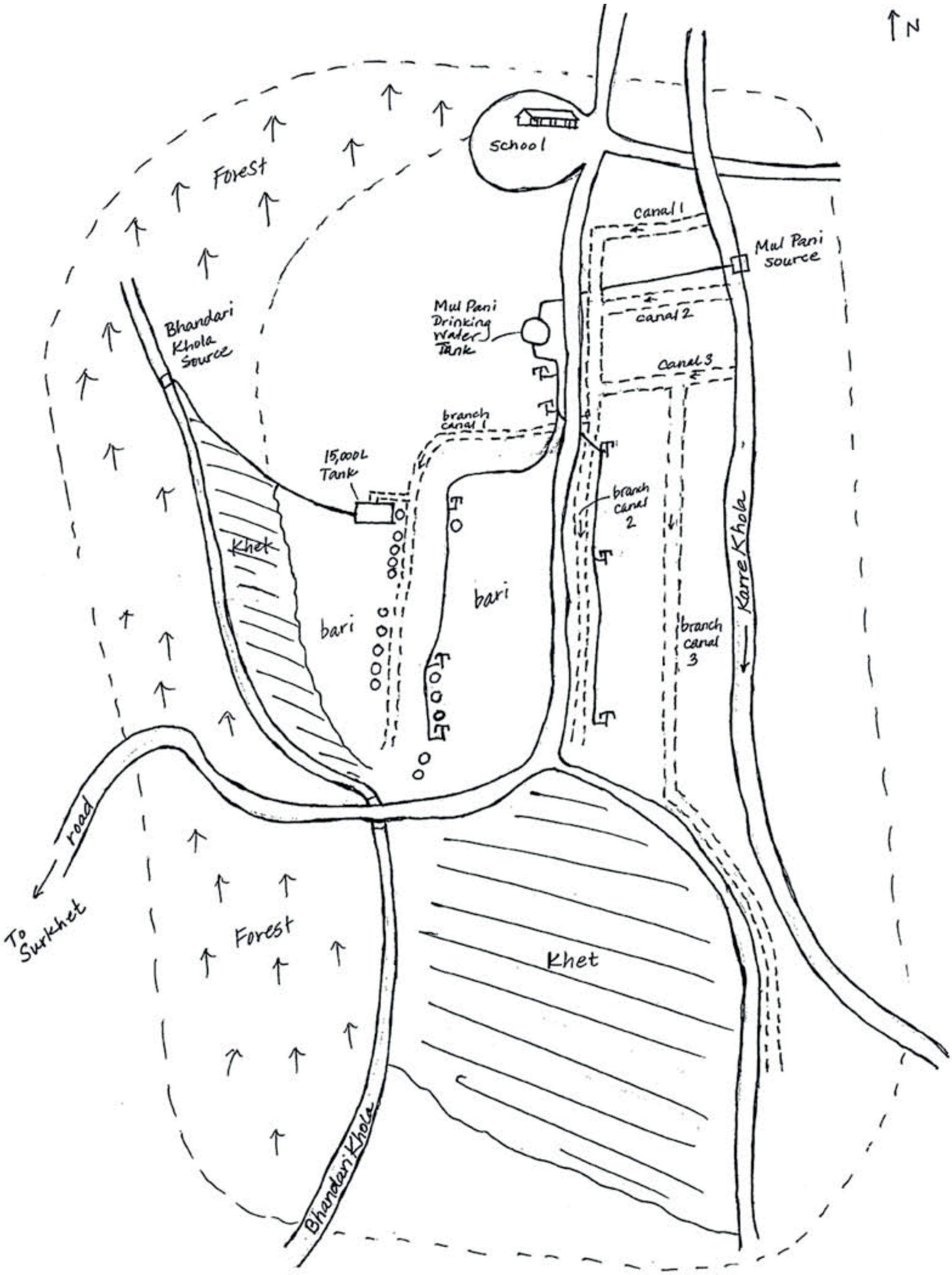
The whole Karre Khola village has 871 males and 1,447 females, totaling a population of 2,318. The village is a mixture of Magar, Brahman, Cheetri, Kami, and Damai ethnic groups within the Hindu religion. In addition to village members who shifted residence over time from high on the nearby hill to the valley, many others have migrated in from nearby districts of Dailakh and Jumla over time. Krishnapur Tole is one neighborhood within the Karre Khola village which lies along the westernmost branch of the three-branch Karre Khola irrigation system described below (branch canal 1 shown in Figure 5.1). The 16 households in Krishnapur Tole—47 males and 49 females, for a population of 96—reflect the same demographic mixture as the larger village and have an average family size of six people. The literacy rate among the household sample is fairly high, about 70 percent. Only individuals over 50 are illiterate. Moreover, secondary-school attendance is high because the village has a secondary school, eliminating the need for children to leave the village for education.

Socioeconomic and Food-Security Situation

The major income-generating activities for residents of Krishnapur Tole are service work, such as employment by the government, an NGO, and private business employment, trade, and agriculture, with an annual gross income of sampled households of NPR 8,900–NPR 105,200 ($127–$1,503) prior to the MUS project. Four of the nine surveyed households had income from service work, comprising 31–100 percent of their total income with agriculture,[2] making up the remaining portion for two of them and trade forming the remainder for one household. Three of the nine surveyed households made a substantial amount (61–69 percent) of their income from trade in cottage industries like weaving local *radi*[3] and *pakhi* (carpet). For two of the three, the remaining portion of their income came from agriculture. The third household is the only one that received income from both services and trade and did not have agricultural sales. The remaining three of the nine households received 100 percent of their income from agriculture, largely from sales of goats, ghee, and milk. The annual gross income of sampled households is NPR 9,100–NPR 106,375 ($126–$1,477) per year. Unlike Chhatiwan and Senapuk, none of the households in Krishnapur receive remittances or pensions.

Household expenditure among the nine sampled households is NPR 8,200–NPR 52,000 ($114–$722) per year. Household expenditure for social and religious obligations (for example, marriages, Dashain festival, and funerals) is the largest financial outlay, averaging about 30 percent. This is followed

Figure 5.1 Karre Khola village schematic



Courtesy of Monique Mikhail.

by food purchase, education, and healthcare (doctor visits and medicine). Some years households have a deficit budget with insufficient money even for food or social activities such as marriages or religious ceremonies. In these instances, the households are forced to take out loans from a local money-lender or from a community group. Local NGOs have been actively working in the area with communities like Krishnapur Tole to organize a range of activities: women's savings groups, vegetable production groups, and forest-management groups being the most common. Many of these groups have savings schemes where members contribute a small amount into their savings account each month. The savings pool is then used as a revolving fund for short-term loans with an interest rate much lower than other locally available options (18 percent vs. the local private-lender rate of 24 percent or more).

The average landholding of this village is about 0.5 ha, 80 percent khet and 20 percent bari. The khet land is some distance down the valley from the village settlement, whereas bari land is located next to the houses. In the sampled households, five out of the nine can grow enough grain to meet their household needs all year. The remaining four households had a four- to five-month period during the year when they did not have sufficient grain and used their cash income to purchase necessary foodstuffs or exchanged labor for food.

Pre-project Agriculture

Cereal production for household consumption was the primary crop cultivation before the MUS project (see Cropping Patterns in chapter 1). Only one household of Krishnapur Tole was able to grow enough potato, onion, chili, and garlic for sale at commercial markets prior to the project. The remaining farmers grew a few traditional rain-fed vegetables for home consumption. Most farmers have similar soil types and use fertilizer, pesticides, manure, and compost as inputs for their crops. Prior to MUS implementation, seed varieties used were predominantly local.

The cluster of Krishnapur Tole has buffaloes, cows, and goats, with an average of five animals per household. Livestock provide families with meat, milk, and income. As mentioned above, sales of livestock and livestock products are a significant source of income for Krishnapur farmers: three of the nine sampled households sold live goats, two sold milk, and two sold ghee in the year MUS was constructed. Income from goat sales was NPR 4,000–NPR 40,000 ($57–$571) whereas milk sales were around NPR 10,000 ($143), and ghee sales were NPR 700–NPR 5,000 ($10–$71).

INITIATION OF THE MUS SCHEME IN KRISHNAPUR

In mid-2003 SIMI project staff based in Birendranagar selected three VDCs in the area for potential MUS projects and contacted a local NGO, the Social Awareness Campaign (SAC), to find out more about the villages there. SAC had a well-established connection with the Karre Khola VDC through their prior work on a goat-exchange program and shared their village level data with SIMI. Upon reviewing SAC's data, Krishnapur Tole cluster in Karre Khola village emerged as a potential group to work with. SAC had previously helped the 16-household cluster within this farming village to form a production group and register with the DADO as the Narayan Hari Farmers Group. The group of farmers wanted to form a production group because they shared one branch of a previously existing three-branch irrigation system and wished to work together to increase their production.

Although by 2003 SAC was no longer working with Krishnapur Tole, another local NGO, the Environment Development Society (EDS), had become closely associated with the group. SIMI staff met with EDS and asked them to facilitate an introduction with Krishnapur Tole. SIMI held a meeting with the residents of Krishnapur Tole and discussed their water situation to determine what type of system might work best for them.

WATER ACCESS PRIOR TO PROJECT IMPLEMENTATION

Prior to 2001 there was no piped drinking water system in the Karre Khola village. Water had to be carried from springs, many of which are seasonal, forcing villagers to make an hour long journey in the dry season to obtain water from one of the perennial springs along the Karre Khola streambed. Some had to make this journey twice per day to get enough water to fulfill their domestic needs.

In 2001 the government's Rural Water Supply Program worked with the Karre Khola villagers to construct the Mul Pani drinking water System. The system, which serves the entire Karre Khola village, comprises a covered collecting tank at one of the larger springs near the Karre Khola streambed and a gravity pipeline to deliver water to a 25,000-liter storage tank (Figure 5.2) at the upper end of the village. drinking water is piped from the storage tank to 26 village tapstands and one private connection, which resulted from a negotiation for land to build the storage tank. Three of the village tapstands and the private connection are located in the residential area of the Krishnapur Tole cluster. The households sharing each tapstand collectively pay NPR 30 ($0.42) per month for system operation and maintenance.

The system design is such that once the domestic storage tank is full, any additional water is directed through an overflow pipe directly into the distribution system. During the rainy season, the domestic water-storage tank fills at night, and each morning the tank valve is opened for two hours, during which the community can get water from the tapstands to suffice all of their domestic needs. During this peak-flow season, the storage tank will again fill after the two-hour morning usage and overflow directly to the tapstands, allowing households to get additional water in the afternoon.

Figure 5.2 25,000 liter Mul Pani drinking water tank

Photograph by Ryan Yoder.

However, during the dryer times of year the delivery from the spring is greatly reduced and the storage tank does not fill. At these times there is only enough water to fill the taps for about an hour per day, giving barely enough water just for drinking. Long lines form at the taps. and there is often conflict over water access. Residents are not allowed to bathe, do laundry, or water their livestock at the tap during this period, and instead they must walk to the Karre Khola river for those activities.

Unlike the domestic water situation, irrigation infrastructure had existed in Karre Khola for almost a century. In the period from about 1910 to 1915, farmers in the valley worked together to divert the Karre Khola water from the streambed to their fields. The farmers' primary objective was to irrigate their khet located below the village, as this is where they cultivated rice, their staple grain. Three small canals were built with intakes about 100–200 m apart along the Karre Khola to capture water from different springs. It is the springs along the stream that recharge the stream flow and make it possible to extract water at multiple locations. The three canals then combine into one channel for some distance through the village, after which they diverge to serve separate areas of khet fields (see Figure 5.1). The Karre Khola stream is also used for irrigation by other villages both above and below Karre Khola village.

The Karre Khola farmer-managed irrigation system is carefully administered by the Mulpani Belkulo Water Users Committee. Each year the farmer leaders of the committee call a mass meeting, which all irrigators are requested to attend. In addition to electing leaders and standing committee members to manage the system, they discuss the rules for operation and maintenance and the roles and responsibilities of elected officers, committee members, and hired staff. The elected canal committee then meets periodically to discuss and determine operation and maintenance tasks.

Water from the irrigation system is allocated to the khet fields on the basis of land area: one hour of water from one of the branch canals allocated for every 667 m^2 in the rainy season and two hours for every 667 m^2 in the dry season. While volume of water in the canal system is sufficient to provide equal and continuous flow to each of the three branches during the rainy season, there is not enough flow for each farmer along each branch to take water simultaneously. Therefore, water distribution is rotated within each of the three branches, sometimes leading to disputes among farmers. Equal discharge for continuous flow in each of the three branch canals is accomplished by adjusting the gates where the canals are divided, and distribution of the water to each rotational group is monitored by a *chokidhar* (watchman)—a hired employee given authority to enforce distribution decisions.[4] The chokidhar is responsible for determining need and allocation. For example, if farmers in one area are harvesting their crops, the water to their area may be cut off to allow water for farmers who are still cultivating. Within each rotational group the farmers themselves are responsible for monitoring the length of each person's turn to receive water, but they can appeal to the chokidhar if there are disputes. When the discharge is low in the dry season, water distribution is rotated from one branch to the next instead of having continuous flow in each branch.

In 2001 the Mulpani Belkulo Water Users Committee appealed to the DoI for assistance in strengthening their system to retain a greater amount of water. Between 2001 and 2003 the DoI improved the diversions from the stream with gabion structures and lined the main and branch canals, using cement masonry (shown in Plate 12), resulting in less water loss at the diversions and through seepage.

PROJECT PLANNING AND IMPLEMENTATION

SYSTEM DESIGN AND CONSTRUCTION

Shortly after completion of the 2001–2003 canal lining project by the DoI, SIMI approached the Krishnapur Tole cluster to see if they would be interested in working on a project together. SIMI was impressed with the experience of the group in water management. As a subunit of the larger Karre Khola irrigation system, members of the Krishnapur Tole cluster had a long history of working together to manage the distribution of water from their sub branch and represent their interests to the larger-system members. At the initial meeting with the group, SIMI explained their microirrigation work,

Figure 5.3a 15,000 liter MUS storage tank

Photograph by Ryan Yoder.

Figure 5.3b MUS settling tank

Photograph by Ryan Yoder.

and the group mentioned the recently completed lining of the canal. Due to the canal lining, the Krishnapur Tole water delivery turn from branch canal 1 would be increased by 16 hours during the dry season. Since the branch canal leading to the khet fields passes through or near to the bari land on its way downhill, they were interested in SIMI's proposition to use this extra water for vegetable cultivation on their bari land.

Krishnapur Tole farmers had been formed and registered with DADO as the Narayan Hari Farmers Group prior to SIMI involvement and were responsible mostly for water distribution from their outlet from the branch canal 1 and for production marketing. Once the partnership with SIMI was made, the group reelected members to their seven-member (with two female members) committee and changed their name to the Krishnapur Off-season Vegetable Group (KOVG). In addition to their traditional vegetable production function, the KOVG set up a community bank to support village development projects and became responsible for planning and construction of the new water-distribution system.

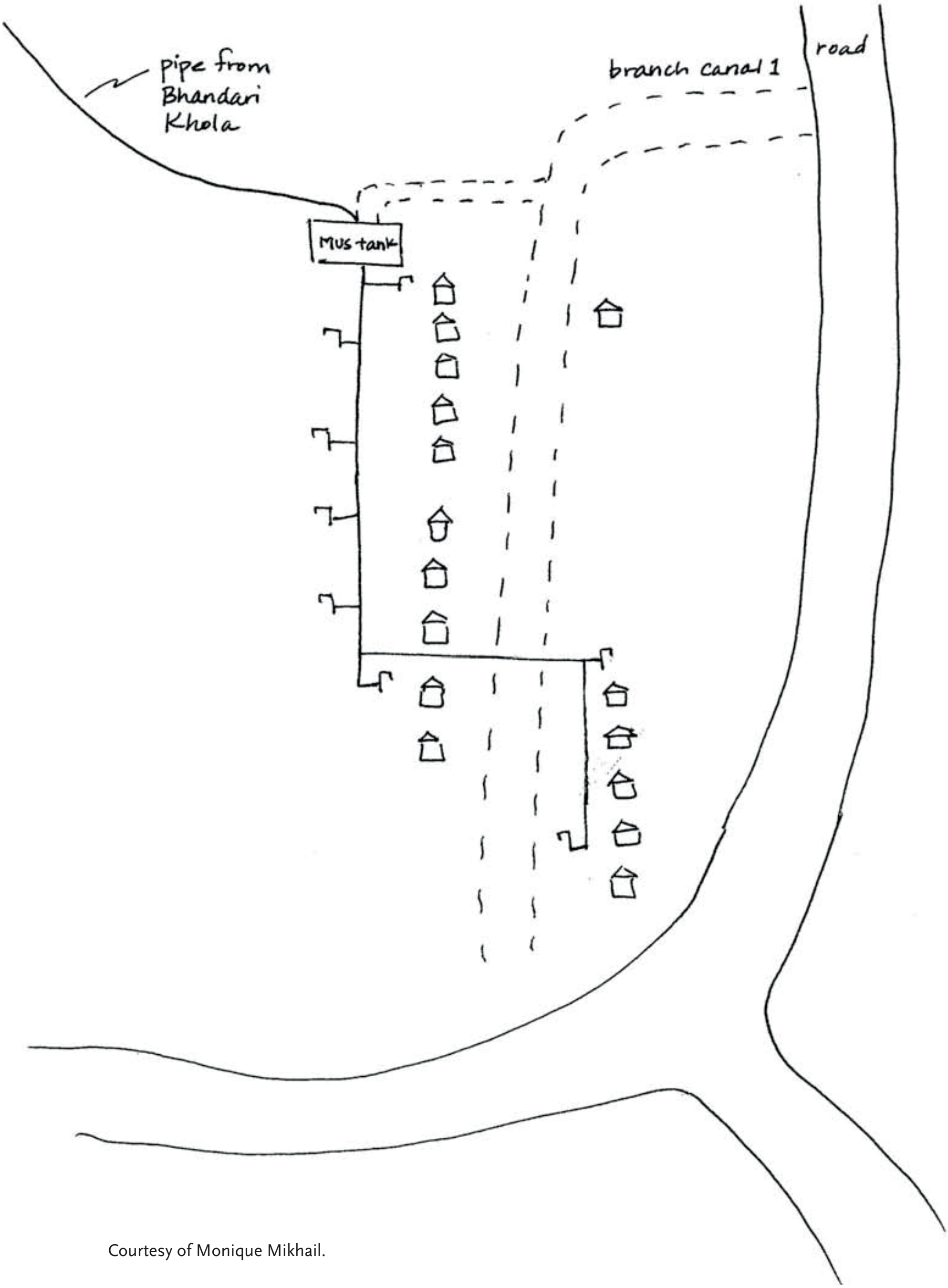
In order to better deliver the extra canal water, a 15,000-liter storage tank (Figure 5.3a) was constructed at the upper end of the Krishnapur area that could be filled by gravity flow from their branch canal 1 outlet. A settling tank (Figure 5.3b) was built for the water to flow through on the way to the storage tank. The settling tank removes sand and silt that could block microirrigation-system emitters. Eight irrigation offtakes were built near the households' bari land, and for the first growing season water was delivered from this storage tank directly to the offtakes (see figure 5.4). Households purchased one of the seven available microirrigation kits described in Table 2.1 of System Components in chapter 2.

The extra 16 hours of water distribution was originally planned to be delivered every seven days, but due to low flows in the Karre Khola in the first dry season of operation, the time between deliveries of water had to be lengthened to serve all the fields in the canal system. Thus, the KOVG found that they were only getting their extra water every 10 to 14 days. Since vegetables require more frequent irrigation, more water storage was needed for better control.

Two options were considered for increasing the water storage. The first option was to increase the size of the tank receiving water from branch canal 1, which would make the volume of water delivered to each homestead a collective-action decision. In SIMI's experience, controlling the delivery as a group works well when the supply is adequate for frequent delivery to each farmer with all farmers on the same irrigation schedule. However, Krishnapur farmers grow different crops requiring various amounts of water at different times, making it difficult for a unified water-delivery system from one tank to meet their needs.

The second option was to build additional storage at each homestead where each household could decide independently how to allocate the water among competing needs. Although the Krishnapur project had originally

Figure 5.4 Krishnapur Tole schematic



Courtesy of Monique Mikhail.

been conceptualized solely as an irrigation project due to the quality of the canal water, the SIMI team was constructing other MUS projects at the time and realized that the Krishnapur system could become a MUS system and provide all water needs except for drinking. With homestead storage it would be possible to achieve equal water delivery to each household, providing the farmers with irrigation-scheduling flexibility and at the same time creating easy access to water for all domestic needs other than drinking.[5] The use of homestead storage water for bathing, clothes washing, and livestock watering would reduce the need for the long walk to the stream for those tasks and reduce the water collection from the Mul Pani drinking water system taps for toilet flushing, hand washing, dish washing, etc.[6] It would also take pressure off of the Mul Pani drinking water System by shifting most of Krishnapur's domestic water-use demand away from that system. When SIMI explained to the KOVG the possibilities of the homestead storage option, the group members decided it was worth the extra cost because it gave them much more flexibility for using their water and provided domestic water near the home.

To create this homestead storage, all but one participating household (that has bari in Krishnapur Tole but its home elsewhere) built either a 1,000- or 1,500-liter modified Thai Jar storage tank next to their offtake (Figure5.5 and Plate 13) so they could easily fill the tank from the offtake. They use the water in their storage tank to fill the drip irrigation header tank to irrigate their vegetable plots (see Plate 14) and for domestic uses other than drinking.

The homestead storage serves several purposes. It allows the men and women in each of the benefiting households to capture any overflow from the primary storage tank in periods of excess water flow in the first few months after the rainy season. It also improves equitable distribution during the driest time of the year when every drop of water is precious. The primary purpose, however, is to give each household flexibility in how they use their limited water supply. They can individually determine how much they wish to allocate for productive versus domestic uses and vary it without time-consuming group negotiations. It also gives them flexibility in the timing and application rate for irrigating their vegetable plots in a situation where frequency of water need for vegetable plots is greater than frequency of water supply delivery down branch canal 1.

Although most households fill their homestead storage from the canal system for productive use and domestic needs, there are a couple of households that chose to use their resources differently. The household that owned the land where the Mul Pani drinking water System tank was constructed had been given a direct household connection to the distribution network as compensation for the land. This household decided to use its Thai Jar storage tank for domestic water only and connected it to the Mul Pani drinking water network instead of the MUS network. Except for the driest few months,

Figure 5.5 Farmer displaying his homestead storage and nearby offtake

Photograph by Ryan Yoder.

this 1,500-liter tank fills during the daily community-wide domestic water release and reduces the household's waiting time at the public tap. Another household fills its storage tank from the Mul Pani drinking water tap located near its house and uses it for all domestic purposes. For irrigation, this household waits until all other users have filled their tanks from the nearest MUS offtake and then connects a hose to the offtake directly to the drip irrigation "header" tank to fill it, supplementing with storage water if necessary.

Water is delivered to the homestead storage tanks by releasing it from the main tank at intervals decided by the KOVG, enabling each offtake to receive water simultaneously. Since there is a considerable slope from the main tank down through the Krishnapur Tole area, flow regulators were installed and adjusted to provide the same flow rate at each offtake. Each offtake is shared by two households, which take turns filling up their storage tanks, ensuring equal quantities of water to each household.

Even after construction of homestead storage, Krishnapur Tole had problems during the period of extreme water scarcity from about April to mid-June. Therefore, Krishnapur Tole lobbied SIMI to augment the canal-water supply as part of the MUS project. The Krishnapur cluster found a small spring about 400 m away in the Bhandari Khola stream on the western side of Krishnapur (see Figure 5.1) that was not yet utilized by another community. They registered use of the new source with the VDC to secure the formal rights to its use. Although the water from this spring was clean enough for drinking, there were a couple of reasons it was not combined with the Mul Pani drinking water system. First, it was unfeasible because the new source was at a lower elevation than the Mul Pani storage tank and would require either a pump or new tank. Secondly, the Krishnapur Tole cluster was both at the end of the Mul Pani system and already demanding less domestic water from it than other Karre Khola villagers due to their homestead storage. Since they were mobilizing the resources for developing and delivering the spring water, they could use the extra water just for their cluster. Hence, SIMI and the KOVG tapped the spring and piped the water by gravity to the main MUS storage tank.

With the additional water, the MUS system had enough to supply all of the nondrinking domestic needs and the productive needs of Krishnapur Tole cluster even in the dry season. Construction of the whole MUS system including main tank, offtakes, homestead storage, and the piped spring enhancement took 11 months. And although all households contributed an equal amount of labor for system construction, women were the major contributors, supplying two-thirds of the total labor.

SYSTEM OPERATION

After construction of the MUS system was completed, the KOVG transitioned into the Water Users Committee (WUC) and reelected nine members, five of them female. The number of female members was increased because it was largely the women who were responsible for vegetable cultivation with the microirrigation kits, and SIMI had encouraged them to have more female representation. The WUC is now responsible for operation (including allocation and distribution decisions) and maintenance of the MUS system. The WUC chairperson operates the MUS distribution system to the offtakes and ensures that each household receives an equal amount. Although he is not paid for this responsibility, his house is near to the water tank, making it more convenient for him to function as overseer.

Because the primary water supply for the Krishnapur WUC is from the existing irrigation system, families are still required to pay annual user fees for that water, costing NPR 739 ($10) per hectare for irrigating khet and NPR

370 ($5) per hectare for irrigating bari. The Krishnapur WUC collects these user fees and gives them to the Mulpani Belkulo Water Users Committee. Krishnapur Tole members also contribute maintenance labor to the Karre Khola surface-irrigation system.

The Krishnapur WUC also collects NPR 10 ($0.14) per month per household for a savings fund. This WUC fund is used for repair and maintenance of the Krishnapur Tole MUS system as well as community lending.

SYSTEM COST

The individual households of Krishnapur Tole cluster ended up contributing more financially than other communities constructing MUS schemes. Households in other communities with MUS schemes contributed labor, local materials, and sometimes additional cash for their systems as well as purchasing their own microirrigation kits. But Krishnapur Tole members ended up shouldering most of the cost of building homestead storage in addition to these other costs. SIMI hired a skilled mason to construct the storage tanks, costing about NPR 800 per household for his wages, and each household covered the remaining NPR 3,200 ($46) of the NPR 4,000 ($57) per Thai jar storage tank. The total cost of the project was NPR 90,787 ($1,260), not including the individual-homestead storage tank costs. SIMI paid for the construction material, skilled labor, and flexible pipe for each offtake (total length of pipe for the whole Krishnapur cluster was 160 m costing NPR 1,920, $27). The KOVG provided all local materials and unskilled labor valued at about NPR 26,000 ($361, $22.50 per household) or 25 percent of the total cost. When the costs of the microirrigation equipment and Thai jars are included, the Krishnapur cluster's share of the total cost comes close to 40 percent.

CAPACITY BUILDING

Although members of Krishnapur Tole had been part of an organized canal-irrigation system for a long time, that system was designed for just cereal production. Krishnapur Tole members had little knowledge of vegetable cultivation and only basic knowledge of water resource management. As mentioned in the "Training" section of Chapter 2, there were many training sessions that SIMI staff led as part of the MUS project. For Krishnapur Tole, SIMI staff led training sessions including: water tank safety; management of water; pipe assembling and maintenance; water distribution; vegetable production practices, such as, crop timing, seedbed preparation, postharvest handling; plastic house construction; and pesticide safety. Training targeted for women focused on production cycles, postharvest handling, and agroprocessing techniques, and developing sustainable rural institutions.

Figure 5.6 Vegetable collection center

Photograph by Ryan Yoder.

MARKETING

Since the WUC had started out as a farmers' production group organized by SAC several years back, they had already worked together for some time on marketing. SIMI helped the Krishnapur members build on this experience by establishing a marketing connection between Krishnapur and other production groups in Surkhet as well as production groups in three other districts—Jarbuta, Sradkhani, and Ratu. A formal coalition marketing committee and collection center were set up in Jarbuta (Figure 5.6) in 2005. At high-production times, vegetables are collected at the center every 15 days and sold in the market in Birendranagar. At low-production times, the farmers have the option of taking their produce to a weekly bazaar in Birendranagar that was started in December 2006 or selling it to traders who come to the village on the way to the bazaar.

OUTCOMES

Just as in Chhatiwan and Senapuk, with the introduction of vegetable growing, vegetable sales have become another means of obtaining cash income for Krishnapur's farmers. While cereal production before and after MUS implementation was the same for Krishnapur Tole farmers, the types of vegetables grown, the area under cultivation, and even the yield of traditional vegetables all expanded (see Table 5.1 for details of the change).

Nearly 90 percent of the households in Krishnapur Tole now grow vegetables all year round, increasing their vegetable production area per house-

Table 5.1: Production volume and value of different crops pre- and post-project for nine Krishnapur households over one season

	Vegetable	Pre-Project Production (kg)	Post-Project Production (kg)	Increase in Production	Average Sale Price (NPR/kg)	Gross Sales Production of Increased (NPR)	Gross Sales of Increased Production ($)
New crops	Cauliflower	0	472	472	17.25	8,142.00	116.31
	Bitter gourd	0	248	248	23.78	5,897.44	84.25
	Cabbage	0	220	220	7.14	1,570.80	22.44
	Tomato	0	137	137	12	1,644.00	23.49
	Brinjal (eggplant)	0	65	65	15	975.00	13.93
	Pole bean	0	41	41	24.26	994.66	14.21
	Pumpkin	0	15	15	0	0.00	0.00
	Cucumber	0	14	14	0	0.00	0.00
Traditional crops	Radish	0	5	5	0	0.00	0.00
	Onion	150	440	290	11.35	3,291.50	47.02
	Chili	40	147	107	21.06	2,253.42	32.19
	Garlic	101	119	18	21.81	392.58	5.61
	Potato	95	110	15	17.42	261.30	3.73
Total		386	2,033	1,647		25,422.70	363.18

Source: This table is based on recall data during interviews with nine of the sixteen households. Sales where produce was weighed and paid for are likely quite accurate, but home consumption and sharing of produce with family/neighbors was difficult for individuals to remember.

hold from 100 m^2 before the project to 260 m^2 afterward. Through SIMI trainings, farmers have shifted to using all hybrid seed varieties except for the more traditional crops of potato, onion, and garlic. However, improvements in their cultivation have also caused yields of traditional crops to increase. Newly introduced vegetables grown from greatest to least quantity are cauliflower, bitter gourd, cabbage, tomato, *brinjal* (eggplant), pole bean, pumpkin, cucumber, and radish. Considering only the new vegetables cultivated in the first post-project season (the rainy season), the production of vegetables increased by 135 kg/household. Table 5.1 shows the change in vegetable production before and after MUS project implementation for one crop season.

According to the production of the nine interviewed farmers, the average income per household from vegetable sales in only one season post-project was NPR 2,825 ($40.35). For two of the three households who receive 100 percent of their income from agriculture, vegetable production jumped from zero to 13 percent and 25 percent of their income. For the remaining seven households, income from vegetable sales ranged from 1 to 9 percent of their total income. Unfortunately, the monsoon season the first year after the MUS system was completed was unusually severe, and the farmers were unable to save a large portion of a number of their crops including cauliflower, cabbage, and tomatoes. Other crops suffered as well, leading to lower-than-anticipated yields for all crops. Exacerbating this crop damage, poultry roaming in the cluster became a source of damage for the vegetables. Due to these problems, two of the nine households had a deficit budget that year. It is anticipated that were it not for the intense rains, yields, and income would have been much higher.

The increase in vegetable production also had a positive impact on health. Consumption of fresh vegetables increased along with food security. In fact, households consumed a large percentage of their vegetable produce with poor, middle-income, and wealthy households consuming at 47%, 38%, and 33% respectively. As might be expected, poorer households consumed a higher percentage of their produce. This means that households saved on average NPR 932–NPR 1,328 ($13–$19) from consuming their own vegetables. As mentioned above, four of the nine interviewed households were food insecure for four to five months per year. These households indicated that they have gained an additional three months of food sufficiency from consumption and sales of their vegetables, greatly reducing their food insecurity. Wealthier households have the resources to purchase vegetables in the market to augment their production and enable them to enjoy a greater variety of produce consumption.

Additional health benefits came from the increased domestic water available at the household for sanitation. Prior to MUS implementation, seven households in the Krishnapur Tole cluster had latrines, but after MUS implementation, seven more households built latrines with support from a local organization. They were able to build the latrines because of the additional water they had received through MUS. In the next few years, a municipal drinking water project funded by the ADB will be providing all VDCs from the source to Birendranagar with drinking water.[7] Karre Khola will be among the communities served by this project. The benefits of this additional domestic water as the population grows will be invaluable.

Regrettably, the production of vegetables has led to the cessation of poultry raising in the cluster. Prior to the MUS project, Krishnapur farmers raised some poultry, but because they caused significant vegetable damage, the households got rid of them. This has resulted in a loss of income as well as nutrition from meat and egg consumption. Unlike poultry, goats and cattle are kept in the house or in a goat shed to keep them away from the vegetables.

As in the other cases, another benefit from MUS installation is the reduction of time spent collecting and carrying water in the dry season for domestic needs. The previous collection time of one hour twice per day for the 60-day dry season period adds up to 120 labor hours saved, equal to three 40-hour workweeks within a two-month period. At the local female labor rate, this equates to NPR 750 ($11) per household.

CONCLUSIONS AND LESSONS

Although there was economic benefit to Krishnapur Tole cluster from the MUS system, it was less pronounced than expected. This was largely due to damages to the vegetable crops from heavy rains and poultry. It would be an added cost for the Krishnapur farmers, but SIMI could assist them with the option of plastic houses under which to grow their vegetable crops to protect them from excessive rains. And the termination of poultry raising was an unnecessary result of the project and could have negative consequences on their overall nutrition and income. For future MUS systems, SIMI should include information about the potential impact of animals on vegetable production and ways to mitigate crop damage.

The unforeseen crop-damage setback reduced the potential positive impact of the MUS system for that first year, but it does highlight the limited stretch of any one project within the broader context of a community's water resource development. This case exemplifies the ability of a very-water-scarce community to integrate their own water resources management as water needs have changed over the nearly 100 years of agricultural development in the Karre Khola valley. The MUS project activities are part of a long series of actions that the Krishnapur Tole cluster has mobilized from internal and external resources. And since most of these activities have been developed for a single purpose, integration of water resource management has been almost entirely up to the villagers.

The first water-control development was for paddy production through canals, but as settlements emerged in the past 40 to 50 years, domestic and livestock water needs became dominant, and the cluster requested the Rural Water Supply Program build them a drinking water system. As irrigation supply from the canals became constrained, they requested support from the DoI to line the canals, increasing the water they obtained from them. Later, they worked with SIMI to design a scheme to use the extra water from the lined canals and built homestead storage for multiple water uses. And when they found that the water available through the canal was not quite enough for their needs, they extended the MUS system to add water from another spring in the Bhandari Khola. They continue to plan and lobby for development of additional sources of water to meet their multiple needs, particularly in the dry season. The future ADB project will add yet another layer to this series of water resource projects.

Another interesting lesson from Krishnapur is that when water is scarce, greater control over the resource is necessary. In order to increase their control over their water use, farmers first opted for water storage at the group level and then for greater flexibility added homestead storage. The use of homestead storage combined with the cluster storage tank is a different configuration than seen in all other MUS systems built in Nepal. When water is delivered to taps from a single tank, although everyone is entitled to the same amount of water, actual usage may not end up being equitable. In a water-scarce situation like Krishnapur, the use of on-site storage was an innovative way to cut down on community conflict and ensure equitable distribution. It also allowed individual households much greater flexibility of use, choosing how much to utilize for each purpose and when to irrigate.

Residents of Krishnapur Tole cluster definitely benefit from being part of the larger canal irrigation system of Karre Khola. Not only are they entitled to canal water through their operation and maintenance contribution, but they also had a history of water resource management that has enabled them to be more adept at finding available schemes to meet their water needs. It has also given them the experience of working together as a community to advocate for their needs to government bodies such as the DoI and the Rural Water Supply Program.

As in Senapuk, women provided more of the labor for construction but were less included in the construction committee, which points to the need for greater inclusion of women in decision-making activities. Positively, when the construction committee transitioned into the WUC once the system was built, a greater number of women were voted onto the committee than before.