LAND TENURE AND WATER RIGHTS FOR FARMERS MANAGED PERENNIAL SPATE IRRIGATION (KALAPANI) SYSTEM OF MITHANWAN WATERSHED, D.G. KHAN, PAKISTAN

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1. INTRODUCTION

1.1. System Description

The Sulaiman ranges on the western part of Pakistan's provinces of NWFP and Punjab contributes runoff for spate irrigation systems (Figure 1). The Mithanwan hill-torrent watershed of D.G. Khan is approximately 993 km^2 in area, of which, 729 km^2 are hilly and about 264 km^2 are Pachad lands (between the hills and the Indus river). The project area of the FAO and the WRRI-NARC lies in the Tribal Area of the D.G. Khan which is located in the upstream and administered by a Political Assistant under the control of the Deputy Commissioner, D.G. Khan (FAO 1995).

The main objective of the FAO project is the introduction of the concept of integrated watershed management with direct participation of the rural communities using a process oriented approach in an area of concentration - the Dholi Target Area. The WRRI-NARC is also implementing its Rod-Kohi System Development and Management Project in the same Target Area with an objective to alleviate poverty through participatory development and management of runoff farming system of area which is perennial and locally termed as *Kalapani* system. The *Kalapani* system of the Target Area depends on the underground flows which come out of the terrain like springs. The water is clear without any suspended sediments. These perennial flows are diverted through the streams which carry the monsoon hill-torrents and thus subject to damage by the monsoon floods.

In the Dholi Target Area, there are five *Mauzas* namely, *Irsind, Dholi, Kothi, Soharbun* and *Khand*. There are two perennial systems. One is very small and isolated and commands lands of the *Irsind Mauza*, whereas the other system is large and contiguous which provides water to four major *Mauzas Dholi, Kothi, Soharbun* and *Khand*. *Dholi* is located at the head, whereas *Khand* is located at the tail. Both the systems were selected for study to represent the variations in land tenure and water rights as a function of system size (Figure 2).

1.1.1. Small-scale Isolated *Kalapani* System

The *Kalapani* (perennial water) system of the *Mauza Irsind*, at the point of issue from the hills of the Mithanwan torrent at *Khuldan*, receives perennial flows from about 25 springs. The discharge of these springs turns into streamflow and after a distance of about 7 kms enters into a wide section at *Khuldan*. At this point, farmers of the *Irsind* command have diverted water through loose stone diversion structures to allow diversion of water into three independent water channels. The capacity of these three channels vary and the

flow ranges between 14-28 litres per second. The highest flow is in the channel serving the Irsind tail-end system and provides water to a sub-command of around 32.2 hectares. The discharge of the channel serving the middle-reaches of the system provides a discharge of 14 litres per second to the *Rahndan* sub-command. This channel is not operating at the moment due to heavy breaches as all the households have left the area due to dispute with the community. The discharge available to the channel serving the head-reaches at the *Thakdaf* sub-command is around 20 litres per second. The area of the *Rahndan* and the *Thakdaf* sub-commands is around 1.6 and 3.0 hectares, respectively (Figure 3). The length of the three channels serving the *Thakdaf*, the *Rahndan* and the *Irsind* sub-commands is around 376, 398 and 896 meters, respectively (Figure 3).

The torrent flood water during heavy rainfall affects the *Kalapani* system, especially, in the monsoon season when the system is damaged 10-12 times. The damages during the winter season are less due to less frequent and low flows torrents. In the past, farmers used to farm lands only during the *Rabi* season. However, since the last 3 years, they have started cultivating crops during the *Kharif* season. Wheat and oats are grown in the *Rabi* season, whereas millets, cotton and some vegetables are grown in the *Kharif* season.

The channels of the *Irsind* middle- and tail-end reaches are built on steep and rugged mountainous topography, where the channels are subject to damage due to landslide and bank-erosion of the *Siri*-nullah. The channel erosion is very common and therefore farmers have constructed aqueducts at four places. These channels are subject to damage at every rainfall and six persons were died in the process of repair and maintenance. The channel which provides water to the *Thakdaf* sub-command is relatively stable and is not much affected due to erosion or landslide.

The land to which perennial flow is applied also termed as *Kalapani*. The discharge of springs is reduced during the May-June period and it varies considerably due to the temporal variability of rainfall.

In summary, the small-scale *Kalapani* system can be regarded as a case where potential for expansion of command area is limited. Thus the system can be viewed as an example with adequate availability of water. Actually, water is in excess and therefore no rotation is practiced at the diversion structure which provides water to three channels serving three sub-commands. However, a rotation is practiced for the sub-commands to provide water to the water users. Therefore, system is described as continuous flow, non-rotational channel diversions, rotational for distribution to users, and water rights based on prior appropriation.

1.1.2. Large-scale Contiguous *Kalapani* System

The perennial flow, large-scale and contiguous *Kalapani* system of the *Dholi* Target

Area is comprised of four major sub-commands of *Dholi, Kothi, Soharbun* and *Khand* and it originates from the flows of several springs concentrated at a place named *Bazdee* in the *Sulaiman* ranges. Initially, the main water channel was constructed by the *Pathans* who were expelled by the Balochs in the 16th century. The streamflow adopts its route in an ephemeral stream named as *Siri* nullah and diverted to the command area at a point called *Bandha*. Locally, *Bandha* is a term used for diversion structure. At this point, the farmers of the four sub-commands have jointly constructed a loose stone diversion structure. The water is diverted through a channel along the contours of the steep terrain for gravity-flow irrigation. The diversion structure is normally damaged or completely washed away during flash floods of the monsoon season (July-August). In addition, the channel erosion of the *Siri* nullah and upstream runoff from adjacent slopes very often damaged the channel and the supply of water is interrupted. However, the damages are less common during the *Rabi* season because of lesser rains and low flood flows. The estimated command area of small- and large-scale systems selected for the study are presented in Table 1.

The community used to reconstruct the diversion structure and repair the water channel before the beginning of the *Rabi* season for growing of wheat. However, for the last three years, they have also started growing cotton and vegetables during the *Kharif* season. Due to increased cropping intensity, the farmers are now maintaining the channel more frequently. The labour is shared among the water users based on water allocation. The repair and maintenance of channel is distributed into four phases. One phase is completed in a day and normally the whole of the work is completed in four days. Every day, a goat or sheep is slaughtered and a feast is arranged for the field party through mutual contribution. Contrary to the *Irsind* small-scale system, the damages to the water channel because of channel erosion and upstream runoff from adjacent terrain are less, and thus the maintenance is less risky.

The *Dholi* sub-command is located at the head of the large-scale *Kalapani* system while the *Kothi* and *Soharbun* sub-commands in the middle and the *Khand* sub-command at the tail (Figure 2). From the end of the *Dholi* sub-command, the water channel is extended downward along and within the *Siri* nullah bed and divided into two branch channels. One of the branch channel irrigates the *Kothi* sub-command while the other branch channel supplies water to the *Soharbun* and the *Khand* sub-commands. So each sub-command in turn is having its conveyance system providing water to the command area with fields located at head, middle and tail reaches. Therefore, each sub-command can be considered as a sub-system.

The water losses in the channel are very high due to seepage, overspills and deferred maintenance. In addition, the perennial water flow is interrupted during the flash

floods in the *Siri* nullah and the irrigation supply is discontinued.

In summary, the large-scale continuous flow system is being operated under a rotation of 9 days interval for the four sub-commands. The water user can get his turn after a period of 9 days. The rotation is practiced as there has been many fold expansion of the command area during the last 3 decades. Still there is a potential for further expansion of the command area. Thus the system can be described as continuous flow, rotational and water rights based on prior-appropriation to provide water for deficit or incomplete irrigation. The unit discharge available during the dry period is around 22 litres/100 ha which is in line with the allowance of the irrigated areas of perennial canal commands in the Punjab province.

1.2. Study Area

The study area represents the largest *Kalapani* system of the Mithanwan Watershed located in D.G. Khan tehsil of the Punjab province of Pakistan. It is part of the Sulaiman ranges with latitude of 30b 00' north and longitude of 70b 07' east and located at about 70 kilometers from the D.G. Khan city. It is connected to D.G. Khan-Quetta Trunk road through a 10 km long unmetalled hilly road (Figure 1). The area predominantly consists of mountain ranges running in the north-east and south-west directions. Within these mountains, there is a valley of scattered commands served by the *Kalapani* system. The valley comprises of four *Mauzas* and sub-commands *Dholi, Kothi, Soharbun* and *Khand* which are part of the contiguous large-scale system.

The small-scale isolated system of the *Mauza Irsind* is an independent *Kalapani* system covering about 36.8 hectares of the command area. This system is isolated and not part of the main contiguous *Kalapani* system of the *Siri* nullah. Furthermore, this system is located at the head of the main irrigation system.

The average annual rainfall of the Target Area is around 447 mm. About 71% of the annual rainfall is received during the *Kharif* season (May-September). The *Rabi* season rainfall is around 130 mm and out of which 85 mm which is around 65% is received during March and April (Table 2). Thus crop production is mainly dependent on irrigation.

The mean pan evaporation during the *Rabi* and the *Kharif* seasons is 765 and 1168 mm, respectively. The climate is arid during the *Rabi* season, and semi-arid during the *Kharif* season. Thus irrigation is essential to meet crop evapotranspiration requirements.

1.3. Purpose of the Study

Land tenure and water rights have been identified as key factors in management of *Kalapani* irrigation system. Even though there are rules and regulations to assign water, coordination among farmers to divert water and repair damaged channels is essential. There is little or no time for verification of waterways or try to divert water according to the

agreed water rights. Tribal traditions determine different perceptions and attitudes towards natural resource management. Thus water management in *Kalapani* perennial flow systems of *Sailaba* agriculture is both technically and socially complex. The purpose of this research is to enhance the understanding of interactions of: a) land tenure and water rights with; b) agriculture and resource management systems of the *Sailaba* agriculture in D.G. Khan. The research study is an effort to build upon recent findings (Steenburger 1997) and the on-going field research of the Rod-Kohi System Development and Management project which requires information on land tenure and water rights for transfer of research results for use in the forthcoming development projects.

2. FINDINGS OF THE STUDY

2.1. People and Social System

2.1.1. Tribal System

People of the area belong to two *Baloch* Tribes: *Leghari*; and *Buzdar*. According to the Gazetteer of the D.G. Khan (1898), the *Leghari* tribe migrated from Barkhan Tehsil of district Loralai, Balochistan. After ousting the *Ahmadani* tribe from the area in the time of Mughal Emperor Humayun (16th century), they settled in this hilly tract with their head office at *Choti Zerin*. The tribal head was bestowed with the title of *Nawab* by the British Government at that time. *Hajbanis* are the offshoot of *Leghari* Tribe who occupied the area by ousting *Pathans* in 16th century. They are further differentiated into four sub-tribes (*Rahwani, Saskani, Kalani and Madrani*). The *Rahwani* are sub-divided into three clan groups i.e. *Shahlani, Chhalkani* and *Abdalani*. The sub-tribe *Madrani* has sold their lands and permanently shifted to Hyderabad in the Sindh province. The lineage of the *Hajbani* sub-tribe is presented in Figure 4.

The *Kaloi* are the offshoot of *Jalalani* sub-tribe of main *Buzdar* tribe who settled in this area at a later stage. They are further sub-divided into *Dodani, Chakrani, Blochhani, Qasmani* and *Bhawani*. *Dodani* are internally differentiated into *Alliani, Noorani, Kamalani* and *Jamalani*, while *Chakrani* are further sub-divided into *Sonani, Phehani* and *Nihalani*. *Sonani* are still residing in the area while *Phehani* and *Nihalani* have migrated to nearby *Sakhi Sarwar* town (about 20 km from the study area) but still having their lands in the area.

After selling their lands, *Qasmani* and *Bhawani* permanently shifted to Hyderabad (Sindh) and *Blochhani* possessed an adjacent area of *Rakhi Munh*. The family tree of *Kaloi* sub-tribe is presented in Figure 5.

Both the main sub-tribes were engaged in tribal rivalry for a long time during British rule in India. They left the area, which remained abandoned for a long time. After the resolution of conflict they again started agricultural practices. For the last 20-25 years, they

have further improved their relations and started making kinship by intermarriages.

The community of the area is still adhering to *Sardari* (Chieftain) system. Each sub-tribe has its own leader locally named as *Moqadem* who helps resolving daily issues of the community at the local level. Though the *Moqadem* is considered to be a notable person of the area and much regarded by the community but yet not given the authority to impose his verdicts rather he has to convince the people.

Contrary to the small-scale system of *Mauza Irsind*, the tribal system in rest of the area is not that strong particularly within *Hajbani* sub-tribe. The *Moqadem* of *Kaloi* sub-tribe is still having a better position among their community. This is an indication of weakening of the *Sardari* system with time and increased awareness.

The community of the small-scale isolated *Kalapani* system of the *Mauza Irsind* belongs to the *Leghari* Tribe. The main divisions of the *Leghari* tribe are *Alianis*, *Hadianis*, *Boghlanis* and *Haibatanis* (Figure 6). The community residing in settlements of the *Mauza Irsind* is the descendants of the *Hadiani* sub-tribe. The young generation is not much aware of their history. They are internally differentiated into *Ramadani*, *Bijarani*, *Smailani*, *Shahwani*, *Zanglani* and *Hajwani* sub-tribes. The names of the sub-tribes reflect their patrilineal kinship. The *Ramadani* and *Bijarani* sub-tribes originally belong to this area while the others are the settlers. *Shahwani* sub-tribe has permanently migrated to Sakhi Sarwar, a nearby town. However, they are still having their lands in the area which are being cultivated by the tenants.

2.1.2. Household System and Population

The people of the small-scale system are migratory in nature. Livestock and off-farm income are the main sources of livelihood, whereas agriculture serves as a secondary source of income. During the summer season, *Bijarani*, *Smailani*, *Zanglani* and *Hajwani* migrate to the Fort Munro in search of pasture for their livestock. The *Smailani* and *Ramadani* sub-tribes remain in the area throughout the year. However, some families of the *Ramadani* sub-tribe move down to the Sakhi Sarwar town for a period of about three months in the winter season.

The small-scale isolated *Kalapani* system of the *Mauza Irsind* consists of four main settlements namely *Irsind*, *Sarsand*, *Thakdaf* and *Rahndan*. Major part of the population resides in the *Irsind* settlement, while the others are less populated. The majority of population belongs to the *Ramadani* and Bijarani sub-tribes, whereas only few families are *Zanglani*. The details of settlements in terms of number of households and population are given in Table 3.

The people of the large-scale *Kalapani* system used to be migratory in nature. But since last 15-20 years they are settled. Livestock and off-farm income sources contribute

more to the livelihood than agriculture. The large-scale contiguous system comprises of four sub-commands (*Dholi, Kothi, Soharbun* and *Khand*). Majority of the population resides in settlements of the *Mauza Khand*. The population of the area is scattered into several distantly located hamlets called *Bastis*. Traditional joint family system is strictly observed in the area. The system is large and thus information regarding population could not be collected. However, about 40% people belong to the *Hajbani* sub-tribe while the rest 60% belong to the *Kaloi* sub-tribe. The *Kaloi* sub-tribe is larger as 55% households belong to this sub-tribe.

The family size varies considerably in the area. A survey of 88 farmers was conducted at the five sub-commands of the two selected systems which indicated that the family size ranges between 3-28 persons per household. About 68% families fall under family size of 12 persons or less (Table 4).

The population of the area is scattered. By tradition, the people like to live in clusters located in open area locally called *Bastis* to have sufficient pasture for grazing of livestock. The settlements vary in size and population. Normally, they live in huts usually made of straw, stones and mud. Very few families live in houses made of stone masonry.

Balochi is the main language of the area. *Siraiki* and upto some extent *Urdu* is also understood by the male population because of their interaction with urban population. The female population do not understand any language other than *Balochi* due to limited access to the urban areas.

2.1.3. Social Structure

The people of the area still follow *Sardari* system introduced by the British Government. Each faction has its own head at the local level known as *Moqadem*. Majority of the people are small landholders. They earn livelihood by cultivating their lands and raising livestock. Some of them also work as tenants or share croppers to further add to their livelihood. Only few families are landless and own few animals. The major livelihood of these families is from providing service to the community for grazing of their animals or as tenant.

All the sub-tribes make kinship with one another by family marriages. Traditionally, groom is responsible to pay to the bride's family an amount which ranges between Rs. 60,000 to Rs. 100,000. It varies depending upon the physique and appearance of the bride, and family status. The payment is made in cash or giving land to the bride's family. Nevertheless, it depends upon the financial condition of the groom's family. This payment is used by the bride's family to meet the marriage expenses.

The society is conservative and male-dominated. Females lead a very laborious life. Other than in-house activities like child care, cooking, washing, milking of livestock etc,

they are responsible for collection of fuelwood and fetching of water as well. They play a major role in harvesting of crops and husking of grains.

Male members of the family take care buying and selling of livestock, purchase of agricultural inputs and marketing of produce. Issues related to land and water distribution are settled by the males, as the decision power rests with them.

Other than livestock, wage labour and tenancy are the main source of family income. As the education level is very low, the people go to *Sakhi Sarwar* or D.G. Khan to work as unskilled labour like breaking of stones, construction of roads and houses, etc. Sometimes the individuals observe seasonal migration to Choti Bala (near Sakhi Sarwar) for tenancy as well.

The total population of the *Mauza Irsind* of the small-scale *Kalapani* system is around 611, out of which about 53% are males and 47% females. Only 30-35 persons are involved in labour work in other cities, whereas about 5 persons have gone abroad to earn their livelihood. The people are hardy and sturdious. It was not possible to have information regarding population of the *Mauzas* of the large *Kalapani* system, however, it is estimated that population of the large-scale *Kalapani* system is around 1350.

2.1.4. Education

The overall education in the area is very low. Out of four *Mauzas* of the large-scale system, three *Mauzas* (*Dholi, Kothi* and *Khand*) are having primary schools. But only one primary school at *Mauza Dholi* is functional while the others remain closed most of the time due to absence of teachers. In fact, no one likes to serve in such a remote area without road infrastructure. After the primary education, the boys have to go to the Sakhi Sarwar town or D.G. Khan to join secondary classes, while schooling for girls is non-existent.

The level of education is very low in the *Mauzas*. According to the initial PRAs, the literacy rate is also very low (FAO 1995). There are only 22 persons having education upto Matric level, whereas 31 persons are under Matric (Table 5). Therefore, only 2.5 percent population is having some level of school education.

2.1.5. Health

The health of local community particularly that of women is very poor. It is primarily due to mal-nutrition. For basic health care, the people have to travel to the nearby town Sakhi Sarwar located at a distance of around 35 km. But unfortunately, the facilities are insufficient and hospital is poorly equipped. Eventually, in case of serious health problems, the people have to rush to D.G. Khan at a distance of around 70 km.

Most of the health problems are due to lack of clean drinking water, improper housing and snake bites.

2.2. Farming Systems

2.2.1. Range and Livestock Production

Livestock rearing is a traditional practice in the area and contributes a lot to the economy of the local population. Almost every farmer in the area is having livestock. Herds of cattle graze freely and unattended in the communal land round the year. The flocks of sheep and goats are watched by the graziers only to avoid predation but not directed. As a result, the rangelands are over exploited with very little cover of palatable forage species. The vegetation cover is better after monsoon rains (August-September) but accute forage shortage occurs during the months of December and January. During this period, fodder trees like *Kikar* (Acacia nilotica), *Siris* (Albizia lebbek) and *Ber* (Zizyphus mauritiana) are lopped for the livestock. Forage deficit is severe in May and June.

Small ruminants form a higher proportion of the total herds in *Kalapani* system. Sheep out-number the goats considerably. Large ruminants form a smaller proportion of the herd.

Though the livestock is the major component of the economy of the area, yet there is a lack of basic veterinary facilities. As a result, the mortality rate in livestock is very high. In addition, stockwater ponds in the grazing areas are not common. Livestock has to travel a long way to have an access to the drinking water which results in loss of weight. The average number of livestock per household varies between 33-57 in various sub-commands of the *Kalapani* system (Table 6).

There are more number of small ruminants per household. The average number of small ruminants per household varies from 25 to 50 in the five sub-commands of the *Kalapani* system. The average number of large ruminants per household ranges between 4-9. In addition, each household has few poultry birds and number ranges between 4-10 (Table 6).

2.2.2. Crop Production System

The *Rabi* and *Kharif* seasons are prevailing in the area. Farmers normally grow wheat, berseem and onions during the *Rabi* season, whereas millets, sorghum and cotton are grown in the *Kharif* season. Prior to the interventions of the FAO and PARC projects, the farmers were mainly growing *Rabi* season crops as the water supply during the *Kharif* season is damaged due to either landslides or floods of hill-torrents. The distribution of cropping intensity and crop harvesting intensity is presented in Table 7.

The average cropping intensity in the small-scale system is around 153% with 94% in the *Rabi* season and 59% in the *Kharif* season. This shows that the cropping intensity is low in the *Kharif* season from that of the *Rabi* season mainly due to recent introduction of the *Kharif* season crops. The crop harvesting intensity is around 134%, with 82% in the *Rabi* season and 52% in the *Kharif* season. Thus 12% and 7% area in the *Rabi* and the *Kharif* seasons, respectively, could not be harvested due to problems related to water shortages, harvests for fodders or other damages.

The trends of cropping intensity distribution in the large-scale *Kalapani* system are very interesting. The percent of farmers having cropping intensity of 100% or less is 6,18,25 and 52 for *Dholi, Kothi, Soharbun* and *Khand* sub-systems representing head, upper-middle, lower-middle and tail-end reaches, respectively. This extreme variation in farmers having low cropping intensity can be easily related to the availability of water. Most of these farmers are also located at the tail of respective sub-command. Similarly, the percent farmers having cropping intensity of more than 151% is 47, 46, 42 and 13 for the head, upper-middle, lower-middle and tail sub-commands, respectively. This shows that tail sub-command is affected adversely due to shortage of water. Furthermore, farmers at the head and tail of the sub-command (*Khand*) also experience same problem. Thus, farmers located at the tail of the tail-sub-command are extremely affected by the system.

The cropping intensity of the large-scale system is dependent on the location of the sub-system from the diversion at source. Thus average cropping intensity at head, middle and tail reaches was estimated and it varies from 156 to 128% from head to tail reaches, respectively (Table 8). This shows that average cropping intensity is dependent on availability of water.

In the small-scale system, the cropping pattern is cotton-wheat, millets-wheat and sorghum-wheat. The average cropping intensity shows that most of the cultivated area is cropped during the *Rabi* season with wheat, as the fallow area is around 6%. However, in the *Kharif* season, about 41% area is fallow. There is a possibility that cropping intensity would further increase in future and will attain a level of close to 200%, if water is available during the *Kharif* season on sustainable basis.

The cropping patterns of the sub-systems of large-scale *Kalapani* system are complex and affected by the location of the sub-system from the source (Table 9). The low cropping intensity at lower-middle and tail-end sub-systems is due to the reason that farmers are practicing more a single cropping system with wheat in *Rabi* or cotton in *Kharif*. At the head reaches, about 90% farmers are practicing double cropping system, whereas at tail reaches only 54% farmers are practicing the double cropping system. There are two categories of double cropping systems. The first category includes: a) millets-wheat; and b) cotton-wheat. The second category includes: a) millets-wheat, onion, berseem; b) cotton-wheat, onions, berseem; c) cotton, millets, vegetables-wheat; and d) cotton, millets, vegetables-wheat, onions, berseem.

The variations in cropping pattern at head, middle and tail are due to variability in availability of water. Therefore, equity in water availability is a major concern in systems where water is in short supply. The inequity might be due to water rights, distribution rules and water conveyance losses.

2.2.3. Integrated Land Use

The people of the area were not exercising integrated land use concept. Small landholdings are the main hurdle for that. The naturally growing trees particularly on the field boundaries are protected only but not managed. Nevertheless, for the last three years they have started growing fruit orchards as well. But this approach still needs to be promoted.

Non-descript breeds of livestock are kept by almost every farmer. Apart from tractors, the bulls are still being used by some of the farmers for land preparation and cultivation. Because of free grazing, the people are not inclined towards growing of improved fodder varieties. However, a few farmers are now growing PARC introduced Mott grass (Pennisetum purpureum) along the water channels.

2.3. Land Tenure

2.3.1. Land Ownership

About 95% households are land owners in the *Kalapani* system, whereas only 5% households are either tenants or landless. The details of the landowners, tenants, and land owners cum tenants are presented in Table 10.

Regarding land tenure, two categories were identified: a) *Shamlat* land belongs to tribal communities meant for grazing, graveyards, mosques, etc; b) *Malkiat* land, which is privately owned land and ownership rights are recorded and updated in Revenue register. The rangelands and mountains fall under the community tenure. The farmers for individual tenures try to demarcate their lands with loose stone walls. The communal lands are primarily used for grazing of livestock.

In the small-scale *Kalapani* system, the *Ramadani* sub-tribe is the actual owner of the land, while the rest have purchased the land in the past. The individual tenures have been demarcated and settlement has been completed in 1970. However, the *Abraize* tenure, which is the mini-catchments adjoining the individual irrigated tenure is not yet demarcated and settled by the Revenue department but the ownership has been established by the community. The irrigated land area has been increasing since independence of Pakistan. In the first 2 decades, there was a minor increase of only 12%. The increase in the next 3 decades was very high and is about 85%.

Presently, the land ownership of the four sub-systems of the large-scale *Kalapani* system predominantly belong to the *Hajbani* and the *Kaloi* sub-tribes. The *Hajbani* sub-tribe is the original land owner of the area. The *Kalois* are the settlers and gradually purchased the lands from the *Hajbanis*. Almost all the *Madrani* sub-tribe an offshoot of the *Hajbanis* have already sold their lands to their fellow tribe and permanently shifted to Hyderabad (Sind) to earn their livelihood. Only one family of this sub-tribe is having 3

pieces of land in the *Dholi* sub-system. Similarly *Bhawani* and *Qasmani*, the clan groups of *Kaloi* sub-tribe have left the area permanently and their lands are under the control of existing *Kaloi* sub-tribe.

The Chief of the *Leghari* tribe and his family owns 1/5th of the irrigated lands of the *Kalapani* system. The ownership was established during the British rule in India. However, these lands are cultivated and managed by the *Kaloi* sub-tribe. The owners neither contributed in agricultural inputs nor get any share of the produce.

A few years ago, a family of *Jarani* sub-tribe (from Leghari tribe and presently residing at Fort Munro), has also purchased 3 pieces of land in the *Dholi* sub-system. Similarly, a family of *Smailani* sub-tribe from the *Irsind* command is also having one piece of land in the *Mauza Kothi*.

The ownership of both the sub-tribes is scattered in all the four sub-systems. There are 51 farmers having their lands in more than one sub-system. The *Aabraize* tenure is established by the community according to which the catchment area belongs to the owner of the field in which it drains. Nonetheless, the ownership is not yet settled by the Revenue Department. The *Hajbanis* and *Kalois* possess 59 and 41% of the irrigated land, respectively.

The irrigated area has been increasing since the creation of Pakistan. According to the results of the study, the irrigated area in the *Soharbun* and *Khand* sub-systems increased 3 times as these sub-systems were having the capacity of expansion. This expansion was more evident since the last two decades, when the settlement of new sub-system *Soharbun* took place.

The farmers of *Kothi* and *Khand* sub-systems used to exchange the possession of landholdings every year. According to which the lands of the *Kothi* sub-system were cultivated by farmers of the *Khand* sub-system for one year and vice versa. This rule remained under practice till 1980. After that one of the farmers approached the district administration against the switching-over of cultivation and as a result the issue was settled once for all and the rotation is no more practiced. However, still some of the farmers exchange their lands temporarily for cultivation due to accessibility. It becomes easier for the concerned farmers to manage the land. Nevertheless, this interchange does not affect their water rights.

2.3.2. Local Institutions

The *Dholi* Target Area of the Mithanwan watershed is located at a distance of about 8 km from the *Rakhi Munh*, at the D.G. Khan-Fort Munro road. The access to the area is difficult. The institutions in the area are as under:

- Village organizations for the five *Mauzas* were established during 1994. The community deposit their savings with the organization under the saving-credit

scheme which are used to provide short-term credit to the members. This is one of the active community institution in the area.

- The local traditional forum still used for conflict resolving is termed as *Muchi*, which is comprised of selected notables. This institution helps to resolve the minor conflicts and still functional even in the presence of the village organization. This means that village organization role is basically restricted towards credit-saving and agriculture related activities.
- *Biradari* is the institution which resolves the conflicts of minor nature among the clan groups of a sub-tribe or family level.
- Union Council was created by the Local Government in 1979 elections. It basically consists of several *Mauzas* and is supposed to solve the problems concerning health, drinking water, sanitation, etc at local level.
- *Jirgah* was composed of *Moqadems* (notables) of sub-tribes to settle the disputes of the local people. It had an authority to deal with major conflicts. This institution was abolished in 1971, and these disputes are now dealt with by the Border Military Police (BMP) or judiciary.

2.3.3. Inheritance System and Fragmentation

The land after death of the owner is divided equally to the male members of the family - only sons of the deceased have a right to get their share under the local inheritance rules. The daughters and wife do not possess any right of inheritance due to the traditions prevailing in the area. However, the community is fully aware of the legal aspects of the Pakistani law of inheritance, which also provides share to widow and daughters alongwith sons. The inheritance system demands division of land which results into further fragmentation.

The livestock contributes significantly in livelihood of various households. Thus distribution of livestock is also important in relation to the inheritance system. The male members of the family have equal rights for ownership of the livestock. The daughters and wife do not possess any right of ownership, except any animal if raised by them.

The landowner can also distribute the land among the male members during his life time but the same rule of distribution will prevail.

The most interesting convention of the inheritance system is that quality of land is also given due consideration while dividing the land. For example, in the sub-system command area, if a farmer owns two pieces of land and they can be categorized as productive or less productive fields based on availability of water and soil productivity. Normally, the field located at the head is considered as more productive compared to the field located at the tail. For example, if the owner has four sons, each of the field would be divided into four pieces so that each son owns one piece of productive land and one piece

of less productive land. This convention of land inheritance therefore, aggravates the problems of land fragmentation, if mutual agreement is not possible among the brothers.

The resource-poor landholders sometime give land (in lieu of cash) to the bride's family for getting married. This is a very common practice among the resource-poor families and they are forced to live rest of their life below normal subsistence. For example, Mr. Mohammad Bukhsh, who owned 0.40 ha of land before the marriage ended up with 0.05 ha after the marriage. This has deprived Mr. Bukhsh's son of having the land due to inheritance.

The act of adultery locally termed as *Kala Kali* is casually reported. If it happens, the woman is sold outside the tribal area by her family while the male's family has to pay penalty for this offence. The penalty is decided by the notables of the *Mauza* or one trustworthy representative of each side. The male may be deprived of his whole or part of the land alongwith whole or some share of his water rights and given to woman's family. The decision of the councillors is final and the land along with water rights becomes the property of woman's family. If some one does not abide by the decision, the punishment is even severe. The offender is not allowed to enter the tribal area and if he does so, he may be assassinated as an avenge by the woman's family.

Similar punishment is suggested for murder case. The issue is only settled by giving one girl in marriage to the murdered family by the murderer's family or cash or a piece of land or all the three as agreed upon.

The unirrigated area consisting of mountainous rangelands around the command area is recognised as *Shamlat*. Besides inhabitations and graveyards, the area is mainly used for livestock grazing. The *Hajbani* and the *Kaloi* sub-tribes have established their ownership on these lands. As a result communal land of *Mauzas Kothi, Soharbun* and major part of *Mauza Dholi* is under the control of the *Hajbani* sub-tribe. Similarly, communal lands of *Mauza Khand* and some part of *Mauza Dholi* are possessed by the *Kaloi* sub-tribe.

The ownership of communal lands is established among and within the sub-tribes. The area is measured by pacing and equally divided among the families of the respective sub-tribe. However, this division is not mentioned in government record. Despite all these theoretical divisions, the rangelands are mutually exploited by both the sub-tribes. Sometimes, *Jarani* and *Bhawani* sub-tribes (other offshoots of *Leghari* tribe) come down from Fort Munro to graze their livestock in winter. But they have to take the local community into confidence for the purpose.

The *Irsind* small-scale system consists of 275 bunded units of land which are located under three sub-commands of the *Irsind Kalapani* system. The details are presented in Table 11. There is a wide variability in number of bunded units owned by

different land owners. The maximum number of bunded units owned by a landholder is 15, whereas it is one as the smallest unit. The distribution of bunded units is presented in Table 12. About 52% of farmers own three or less bunded units, whereas about 30% farmers own bunded units ranging between 4-6. Only 18% farmers own bunded units of more than 6. The average bunded unit area varies between 0.04-0.16 hectares (Table 11).

The average size of bunded units at lower-middle and tail sub-commands of the large-scale system is almost double than the head sub-system (Table 13). The percent farmers in the lower-middle and tail sub-commands having 3 bunded units or less are 71 and 77%, respectively. The percent farmers at the upper-middle and head sub-commands having 3 bunded units or less are 57 and 21%, respectively (Table 14). This shows that farmers have tried their best to expand the command area to the maximum possible extent at the head and upper-middle reaches of the *Kalapani* system due to better availability of water.

2.3.4. Rules

The prevailing rules of land tenure in the command area of the *Kalapani* system are as under:

- The individual tenure of the irrigated land of the *Kalapani* system is recognized by the Land Revenue under the land settlements completed in 1970. The individuals can enjoy both the ownership and proprietary rights of the *Kalapani* command area already settled by the revenue.
- The individual tenure of the mini-catchments adjacent to the irrigated lands of the *Kalapani* is recognized by the local community and individual can enjoy the ownership right. However, formal proprietary rights are not accepted as this tenure is not yet settled by the Revenue department. This land is termed as *Abraize*.
- The communal tenures of rangelands and mountains are well established among and within sub-tribes. The communal tenures are recognized as *Shamlats* by the Revenue department but the ownership and proprietary rights of individuals for this land are not accepted. If community allows, an individual can use a part of the communal tenure without proprietary rights.
- 1/5th of the total irrigated area of the large-scale *Kalapani* systems is considered as an ownership of the Leghari Tribal Chief and his family since the British Rule, which is still accepted by the farmers. But practically the family is neither having any possession of these lands nor getting any share of the produce. These lands are cultivated and managed by the *Kaloi* sub-tribe.

Initially, in the small-scale system, land was cleared and water conveyance system was built by the ancestors of *Ramadani* sub-tribes and they are considered original owners

of the land. The other sub-tribes purchased the land from the *Ramadani* sub-tribe. This rule is followed only for the irrigated land. The un-irrigated land around the existing command area falls under communal tenure. The communal land is normally used for grazing. If any one is interested to expand the irrigated land along the periphery of the existing command area, he has to get formal permission from the community. Even, the permission is granted to a person for clearing and forming the land for irrigation, no water rights are given for the new lands. The farmer has to use the existing rights of water for expanded area. Similar rules are followed for the un-irrigated and non-perennial *Sailaba* areas. Except for the *Sailaba* area, there is a conflict on the ownership of runoff water harvested from the surrounding catchments as *Ramadani's* claim that they are the owner of the runoff water coming from the mountains. Therefore, the ownership rights of mountains are still claimed by *Ramadanis*.

The inhabitants of the *Thakdaf* sub-command of the small-scale system are increasing the number of irrigated bunded units through clearing and forming of lands around the sub-command area as they still have more water for irrigation compared to their requirement.

If a person is interested to bring new area under cultivation by clearing a part of the communal land, he is only allowed if the community permits. But he is not assigned water rights for the new area. The best example is the *Soharbun* sub-commands of the large-scale system which has been brought under cultivation by the *Hajbanis* during the last two decades. The persons who cleared the lands in *Soharbun* have not been allocated additional water. They are also having lands in the *Dholi* and the *Kothi* sub-commands. So they can use their water share at place of their choice.

The community used to provide labour voluntarily for a person who intended to bring new area under cultivation. It is called *Hashar*. But *Hashar* is not commonly practiced since the introduction of mechanization.

Land tenancy by share croppers is a common practice in the area. Presently 47% of the farmers in the small- and large-scale systems are categorized as land owner cum tenant, 48% are land owners while 4% are tenant but landless. Only 1% is landless and not acting as tenant (Table 10). The major tenancy rules prevailing in the *Kalapani* system are:

- The owner and tenant equally share all the expenditure encountered for seed, fertilizer, tillage, threshing, etc. The marketable produce is equally distributed between the owner and the tenant. The tenant is responsible for seedbed preparation, cultural practices and irrigation. If bullocks are used for seedbed preparation and seeding, the tenant is responsible for the expenditure. On the other hand, if tractor is used for cultivation, the owner shares 50% of the expenditure.

- The owner provides fertilizer, seed and thresher, while activities like ploughing, sowing, harvesting and irrigation are responsibility of the tenant. In this case, the produce is equally distributed among the owner and the tenant.
- The owner only leases the land to the tenant and does not contribute anything towards expenditure (seed, fertilizer, etc.). In this case, the owner gets 1/3rd of the produce while the 2/3rd goes to the tenant.
- The owner bears all the expenditure like seed, fertilizer, tractor and thresher, while tenant is responsible for activities like sowing, harvesting, irrigation and other cultural practices. In this case, the tenant takes 1/3rd of the marketable produce and 2/3rd share is given to the owner.
- The owner leases out the land to a tenant for some fixed period and fixed amount of rent in kind. This amount has to be paid by the tenant irrespective of the crop yield. This is locally named as *Mutta*, and is normally 1423 kg of wheat grain per hectare.
- Sometime the owner hires a servant mainly for agricultural purpose. He is locally termed as *Rakh* who is only responsible for labour related to ploughing, hoeing, irrigation, plant protection, etc. The tenant receives only 1/8th share of the marketable produce. This is practiced since long and there is no change in the share of *Rakh*. The owner is responsible for all inputs and other expenditures.

The prevailing rule of tenancy mostly followed in the command area is 50:50% distribution of marketable produce and same share in expenses between landowner and tenant. This tenancy rule provides motivation to both the owner and the tenant to produce more and maintain profitability of input-output system.

2.3.5. Surveillance

The community is well interwoven due to the social structure of the tribal system and thus there is hardly any problem encountered in relation to land tenure in terms of individual ownership. However, there are some problems in the area in relation to communal tenures, where any individual interested in establishing the individual tenure must get permission from the community.

Sometime the land tenure problems resulted into major conflicts due to either construction of house or cultivation in the communal tenures. However, the tribal system is responsive to watch these problems and try to resolve through *Biradari*, otherwise the affected party takes the issue to the BMP and eventually to the judiciary in D.G. Khan.

2.3.6. Conflicts and Conflict Resolutions

The type of conflicts related to land tenure are summarized as under:

- The conflicts on individual tenure are not common, they hardly occur during division

of land.

! The conflicts on community tenure are common. Such conflicts occur on the occupation of communal tenures which sometime resulted into armed clashes.

For example, nine months ago there was a severe conflict between the *Hajwani* and the *Bajarani* sub-tribes for the possession of communal lands in the small-scale *Kalapani* system. It resulted in armed clash between the two factions claiming a life and injuring two. Problem could not be resolved by the local authorities and the matter was taken up to the Border Military Police (BMP), which is responsible for maintaining law and order in the tribal area.

The conflicts are normally resolved in the local body termed as *Muchi* or *Biradari* which comprised of selected notables. If the conflict is beyond the *Muchi* then these are referred to the Border Military Police at the Rakhi Munh. The police registers the case and submits to the judiciary in D.G. Khan. Most of the minor cases are resolved by the *Muchi*.

2.3.7. Adaptations

The leader of each sub-tribe is named as *Moqadem*. In case of problems, farmers approach the *Moqadem*, who helped to organize the *Muchi* meeting, if he could not resolve the problem. Inter-tribal conflicts (particularly related to communal land) are resolved by holding a meeting of *Moqadems* and notables of both the sub-tribes.

One of the most important problem was lack of road and difficult access to the area. The farmers were facing difficulty to transport inputs for agriculture. They use donkeys for transport of inputs. Seeds are managed locally for sowing of crops. However, the construction of hill tract since the last three years enabled them to transport agricultural inputs by using tractor trolleys.

Regarding agricultural problems, the farmers have been organized at the *Mauza* level and Village Organization (VO) helps to solve their problems. Furthermore, VO helps the farmers to link them with input delivery channels.

The system of mutual agreements is still prevailing in the area, where the community members pay due respect to the elder members and notables of the community. Therefore, major problems faced by the community are resolved through dialogues and mutual agreements, where the power of the community is a force behind implementation of the adjustments and adaptations.

2.4. Water Rights

2.4.1. Background

There is a categoric difference in water rights in spate irrigation systems and neighbouring perennial systems in arid lands (Varisco 1983). The *Kalapani* system of the

Mithanwan watershed, normally considered a part of the spate irrigation, is actually different from that of the spate irrigation. This system is basically originated from the source of water from springs fed by the groundwater system but it is perennial and subjected to devastations caused by the flood water from hill torrents which provide water for spate irrigation. Therefore, *Kalapani* system should be considered as perennial flows but in relation to the flood water from hill-torrents. The water rights of the *Kalapani* system are often sharply defined in fixed and even exchangeable proportions of the flow and allowed usage time compared to the spate irrigation (*Sailaba* system) where water rights are reactive. However, the water rights of the *Kalapani* system are also disturbed in terms of availability of water at the source or at any point in the conveyance channel due to medium term changes in the river morphology, scouring, siltation and change of river course. But these changes of water availability do not affect the time bound rights of the sub-tribes or individuals.

Small-scale Isolated *Kalapani* System

Agriculture in the *Irsind* small-scale system mainly depends on irrigation from the *Kalapani* system. The main irrigation stream at *Khuldan* receives water from 25 springs of different sizes. The access to this water source is very difficult due to rugged and steep slopes. The water from the main source at *Khuldan* is diverted into irrigation channels through loose stone diversion structures. The water is conveyed in an earthen channel along the contours to irrigate a particular sub-command and then conveyed through field channels to irrigate fields. The water at *Khuldan* is diverted into three independent channels serving the *Thakdaf*, *Rahndan* and *Irsind* sub-commands for head, middle and tail-end reaches of the system, respectively.

Large-scale Contiguous *Kalapani* System

Agriculture of *Dholi, Kothi, Soharbun* and *Khand* sub-systems of the large system mainly rely upon irrigation from *Kalapani* (perennial water) system. The source of water lies at a place *Bazdee* in the Sulaiman ranges and inflow is coming from several springs. After traversing the distance of 3-4 kms through hills, it emerges out at a place known *Bandha* from where it is diverted into irrigation channel by erecting a loose stone diversion structure. The water is diverted by a channel along the slopes to provide irrigation to the four sub-commands.

Total length of water channel from diversion structure upto the head of the *Khand* sub-system is 8.0 km. The length of water channel from diversion structure upto the head of different sub-systems is 1.6, 5.4, 5.6 and 8.0 kms for the *Dholi, Kothi, Soharbun* and *Khand* sub-systems, respectively.

***Dholi* sub-system:** Water rights of the sub-system are 2 Bails (24 hours) which are fixed

without consideration of the sub-command area. Out of 2 Bails, water allocation time for the *Hajbanis* is 1.50 Bails (18 hours) and that of the *Kaloi* sub-tribe is 0.5 Bails (6 hours).

By virtue of its location at the head of the system, the conveyance losses are less and thus water availability is better than any other sub-system. Moreover, sub-system is also having an access to an additional water source from a spring with discharge of around 11 litres per second. It contributes to the main water channel, thus enhancing water supply to all the sub-systems. The spring provides assured water supply.

***Kothi* sub-system:** The main watercourse is extended from the *Dholi* sub-system to the *Kothi* sub-system. It reaches *Kothi* sub-command after a distance of 3.8 km within the dry bed of *Siri* nullah. Water supply to the sub-system is interrupted by flash floods in the *Siri* nullah. Moreover, water losses in the water channel are high due to overspills and breaches. The water channel improvements using lining of sensitive reaches, plastic lining and installation of panel control structures, and field inlets by WRRI-NARC helped to reduce the conveyance losses. The water allocation to the sub-system is based on allocations made for the *Hajbani* and the *Kaloi* sub-tribes.

***Soharbun* sub-system:** The *Soharbun* sub-system is relatively a new command which has been brought under irrigation for the last 10-15 years. Thus, water rights do not exist. However, farmers having land in other sub-systems can use their water allocations for irrigating lands in this sub-system.

Water diverted from the water channel irrigates the *Soharbun* sub-system prior to the delivery to the *Khand* sub-system. A part of this water channel lies within the bed of the *Siri* nullah and is damaged during torrent floods, thus the water supply is discontinued to the *Soharbun* and *Khand* sub-systems.

Apart from irrigated area, the sub-system is also having rainfed area. Rain water is harvested from adjacent mini-catchments for irrigation by constructing earthen bunds across the slopes. The surplus water is allowed to irrigate the successive fields. Sorghum and millets are grown in such areas. The ownership of *Abraize* mainly belongs to the *Hajbani* sub-tribe.

Inspite, there is no restriction on the exploitation of communal land yet both the sections of the *Kaloi* sub-tribe (*Dodani* and *Chakrani*) avoid to utilize each other's area because of tribal hostility.

***Khand* sub-system:** The sub-system is located at the tail of the large *Kalapani* system. Thus, the water users are facing problems of water deficiency. The water users of the *Chakrani* sub-tribe residing at the tail of the sub-system are having less share of water. The length of water channel is around 8 km from the diversion structure which further adds to the water shortage due to water conveyance losses.

2.4.2. Local Institutions

The farmers in the area still practice *Hashar* where they join for community actions to repair or maintain the water conveyance system. The *Hashar* presently followed is within the *Mauza* for the small-scale system and jointly by the four *Mauzas* in the large-scale system. Cash is collected based on the landholdings and used for arranging a meal which is served at the end of the day. This institution is quite active and further strengthened by the Village Organizations of the five *Mauzas*.

Biradari is an institution comprised of the heads of families or various clan groups of the sub-tribes. Issues like construction and repair of water channel, allocation of water turn and suggestions of penalty for water thefts are dealt with by the *Biradari*. In addition, social problems of minor nature are also handled by the *Biradari*.

The *Muchi* is an institution responsible for joint meetings where selected notables try to resolve issues related to water rights or land tenures. This institution is still functional even after the formulation of Village Organization. Actually, concept of Village Organization has been introduced by the FAO Project without understanding of the existing institutions in the area. The decisions made by *Muchi* and *Biradari* are still given much importance even after the formulation of Village Organizations. Probably the reason is that *Muchi* and *Biradari* system is being practiced since the time of their ancestors and the community is well acquainted to these indigenous institutions.

Jirgah was comprised of Chiefs of several tribes and *Moqadems* of sub-tribes. *Jirgah* meeting was usually held at Fort Munro. It dealt with the armed clashes between the tribes, murder cases and other conflicts of very serious nature among and within the sub-tribes. But it is no more functional since 1971.

Union Council created during 1979 elections is supposed to undertake the day to day developmental activities of the local people. However, it is not a conflict resolving body.

Village Organizations established in 1994 are mainly involved in resolving the communal issues related to agriculture and water conveyance and application. The main achievement of these organizations is that they have linked the community with input delivery channels.

Ofcourse, one should not over-estimate the functional and organizational capabilities of these institutions. Nevertheless, they do play a vital role in resolving daily issues.

2.4.3. Inheritance System and Fragmentation

The water rights are normally linked to the land. However, in certain cases, where the land is not transferred through the court system, sometimes the landowners do not sell

all the water rights. If the case is registered in the court by any affectee then the water rights have to be sold with the land. The water rights of *Kalapani* system are linked with lands which were registered after land settlements of 1970.

The division of land due to inheritance resulted into fragmentation and similarly the water rights are divided proportionately. The fragmentation of land linked with the random sequences of water turn are posing serious concerns for efficient irrigation. However, no concern has been shown by the water users because water is still adequate for most of the users in all the three sub-commands of the small-scale isolated *Kalapani* system. The water users do practice exchange of water turn in case any user feel problem in irrigating a particular field for complete irrigation. Some of the water users provide water to others in case excess water is available with anyone within the stipulated water rights.

The fragmentation of land in the four sub-commands of the large-scale contiguous *Kalapani* system is posing serious concerns as water users are already facing problems of water shortage. Therefore, inadequacy of water is a major factor instead of the size of the bunded units.

If some landless clears the land and makes it cultivable, the community shows helping attitude towards him. For example, a person named Bashir was previously landless and does not have any water share. Community not only helped him in making the land but also by contributing some of their own water share for irrigation in the large-scale *Kalapani* system where water is in short supply.

2.4.4. Rules

The rules concerning water rights of the small-scale isolated and large-scale contiguous *Kalapani* systems are:

- the construction of a diversion structure and obligations to increase height of the weir; presently, there are no obligations because of the adequate rather excess availability of water at the diversion of the small-scale isolated system, however, diversion of water in the large-scale contiguous system is limited by the capacity of the structure and availability of water;
- the sequence and proportions for water flow to various channels emerging from the source; presently there is no division at the source due to excess availability of water and very little chances of increasing the command area except at the head reaches of the *Thakdaf* sub-command in the small-scale isolated system, however, for large-scale contiguous system a turn of 9 days is being practiced to provide water to the four sub-commands;
- normative rules on water usage, like the entitlement to expand the command area; any user can expand the command area within allocated water rights;

- rights of tribes or individuals based on prior-appropriation;
- rights of sub-tribes within the command area, or landholders if there is only one sub-tribe in a command area;
- agreements on transfer of water rights fully or partially with the transfer or sale of land; and
- rights of riparians and agreements on the disposal of excess or unused water.

The water rights are fixed with allocations made for various sub-tribes or landholders and do not change in space and time. Thus, these water rights to some extent are similar to the perennial canal flow systems in contrary to the non-perennial spate irrigation.

There are several water distribution rules and it is usual to find that two or three are applied simultaneously. These rules are basically emerged from the water rights and more or less fixed. The repertoire of water distribution rules as practiced in the *Kalapani* system is as under:

- demarcation of the command area that is entitled for diversion of Kalapani water; presently three sub-commands like *Thakdaf*, *Rahndan* and *Irsind* have been earmarked in the small-scale isolated system; whereas four sub-systems have been earmarked under the large-scale system with water rights and distribution rules for the three sub-systems, as no water rights are given to *Soharbun* sub-system but water users can use their water allocations from other sub-systems;
- the proportion of flow diverted to various channels; no rules exist as there is excess water in the small-scale isolated system; whereas a turn of 9 days rotation is followed in the large-scale contiguous system;
- the proportionate distribution of water allocation to various sub-tribes of the command area; this rule is practiced in the small-scale isolated system where water turn of 12 days is followed (24 *Bails* each *Bail* of 12 hours) and *Bails* are proportionately allocated to various sub-tribes of the *Irsind* sub-command; for large-scale contiguous system water distribution is based on 9 days rotation (18 *Bails*) where fixed time is allocated for each sub-system, fixed allocated time of irrigation to a particular *Mauza Dholi* irrespective of the landholdings (*Mauza Dholi* is allocated 2 Bails of water i.e. 6 hours for *Kaloi* and 18 hours for *Hajbanis*);
- the proportionate distribution of allocated water turn to various landholders within a sub-tribe; this is followed in both the *Kalapani* systems;
- the proportionate distribution of available water to various landholders in a command area where only one sub-tribe exists; this rule is practiced in the *Thakdaf* sub-command of the small-scale isolated system where water turn of 6 days is followed (12 *Bails* each *Bail* of 12 hours) and *Bails* are equally divided - thus two

Bails per landholder are allocated;

- random sequence in which different water turns are scheduled to different landholders; presently random allocation procedure for water turn is followed irrespective of the location of bunded units owned by a landholder in the command area which pose some concerns for efficient utilization of water; a procedure of draw is followed for random sequence among the sub-tribes (*Hajbani* and *Kaloi*) for first water turn, the draw is valid for a crop season, the water turn within a sub-tribe is commonly decided by mutual consensus;
- allocated time based on landholding within a sub-tribe and no restrictions for depth of irrigation, partial irrigation, exchange of water among water users, etc.

Water Distribution of Small-scale System

The water distribution among various tribes which follows a rotation of 12 days (24 *Bails*, one *Bail* of 12 hours) is being practiced in the *Irsind* sub-command of the small-scale isolated system (Table 15).

The water is used during day and night time. The allocated water turn to sub-tribes is further divided to various landholders in the small-scale *Kalapani* system. The landholders from various sub-tribes form groups of water users based on their convenience due to spatial requirements of water utilization. Draws are normally made for water turns of various water users' groups which is a good indication of their mutual agreements. The details of water allocation time and draws made for water turns are presented in Table 16. The water turn as modified for various users groups in the *Irsind* small-scale system is for 12 days period. The water users can exchange their water turn within the users groups.

Water Distribution of Large-scale System

The water rights of large-scale contiguous system are allocated to the sub-tribes according to the usage time by their ancestors and still followed strictly. The water turn in the large-scale contiguous system is of 9 days (18 *Bails*) which is subsequently distributed among the sub-tribes and their sections. Water distribution among various beneficiaries is given in Table 17.

Demolishing of diversion structure by hill torrent flows or breaching of channel makes the water availability uncertain. But it does not affect the time bound rights of the sub-tribes or the individual.

The *Bhawani* and *Qasmani* sub-tribes have left the area permanently and their water share (1 Bail) is being used by the *Kalois*. The water share (1 Bail) of the Chief of the Leghari family is also being used by the *Kaloi* sub-tribe.

The duration of water turn is 18 Bails, out of which 9.5 Bails are assigned to the *Hajbanis* and 8.5 Bails are for *Kalois*. This water is further distributed among several offshoots of the *Hajbani* and the *Kaloi* sub-tribes. Water allocated time for several clans of

the *HaJbani* sub-tribe is given in Table 18. *Madranis*, a section of *Hajbani* sub-tribe, sold their lands and 2 Bails of water to their fellow sub-tribe. Water allocated time for several clans of the *Kaloi* sub-tribe is given in Table 19.

The water is applied to fields both at day and night time depending upon the turn. A draw is made for the water turn among the *Hajbani* and *Kaloi* sub-tribes. But within the sub-tribes normally draw is not made and water turn is allocated with mutual consensus. However, there is no compromise on water allocation time. The water allocation time of a water user starts from the diversion point irrespective of channel length or any sort of losses. This creates problems for water users particularly those with limited duration of allocated turn. Therefore, water users very often form irrigation groups to avoid un-necessary wastage of time of irrigation turn. If the water supply is interrupted during the irrigation, it restarts from the same field after the supply is restored. This break is locally termed as *Nanga*.

The construction of diversion structure and repair of water channel is jointly undertaken by the *Kaloi* and the *Hajbani* sub-tribes. The work is started in October-November before the onset of *Rabi* (winter cropping) season. The water users gather at *Mauza Kothi*, have a lunch together and decide the day and time to start the maintenance work. The re-construction of diversion structure and repair of channel is normally divided into four phases. Each phase needs a day for completion and ultimately the whole maintenance work is completed in four days. Every day they slaughter a sheep or goat for a combined dinner. The collective maintenance work is undertaken upto *Mauza Kothi* and then onward is the job of individual sub-tribe or water user group to repair and maintain the water channel.

2.4.5. Surveillance

The community is well interconnected due to the tribal system and thus try to keep an eye on the happenings related to issues and unpleasant acts happened in the area. The joint actions regarding monitoring of the water system and repair and maintenance are still effective. The water users jointly enter into an oath that they will not enter into issues related to water theft or any other actions which disturb the water distribution schedules or affect water rights.

Water theft is reported many times in the area but the penalty for that is not of severe nature. In this case the affectee starts tracing the stealer and after confirmation, brings the matter before the *Muchi* or *Biradari*. According to the decision, the stealer has to compensate the affectee by giving twice of the water he had stolen or serving the *Muchi* with a feast or as agreed upon. Sometimes they just rely upon rebuking the culprit. Nevertheless, there is one precedent of severe punishment for water theft. The stealer had

to compensate the affectee by giving him a share from his produce.

2.4.6. Conflicts and Conflict Resolutions

There is no conflict reported on water yet in the small-scale isolated system. The mutual and joint actions still followed by the water users provide effective means to resolve the minor issues which emerge from time to time.

Conflicts related to water distribution in the large-scale contiguous system are casually reported. Sometimes the conflict arise between the buyer and the seller after the transfer of land. The transfer of land is documented in the Revenue record while the transfer of water is not documented but verbally committed in the presence of some witnesses to avoid possible reversion by the seller. In such cases, the community and the witnesses turn against the reverter and force him to abide by his commitment.

2.4.7. Adaptations

The most critical event in water conveyance of the small-scale isolated system is the maintenance of the system to take care of siltation and landslide problems which is done through joint community actions. About 15 persons are required at a time to maintain the system. The community has already lost lives of 6 persons in repair and maintenance. The draw of water turn is enforced for a crop season and then it changes for the next season. The one draw is for 4 Bails (48 hours) consisting of a group or a part of the water users' groups. The decision regarding allocation of water turn for various landholders within a draw or water users' group is again decided through a draw. Therefore, the option for change of turn from night-time to day-time is dependent on the probability of the draw. Thus water users are enjoying the chance of getting the turn on day-time or night-time. This is not an equitable system in terms of water turn for day and night timings.

In the large-scale contiguous system, the draw for water turn is implemented for a crop season. The decision regarding the allocation of water turn among various landholders of same lineage group is made with mutual consensus. The turn is exchangeable depending upon the convenience. If a farmer is having one Bail (12 hours) of water share, he will be having his turn after 9th day and the farmer adopts accordingly.

The duration of irrigation turn of a farmer starts from the diversion point irrespective of channel length or losses. Farmers with limited irrigation turn face difficulty. Such farmers have made irrigation groups to handle the situation.

2.5. Resource Management

2.5.1. Predictability and Adequacy

Availability of *Kalapani* depends on three things: a) availability or flow of water from the source - flow provided by springs which is affected due to recharge to the groundwater because of temporal variability in rainfall; b) state of the diversion structure against the flow

line; and c) damages caused by the torrents flood water e.g. during high floods the diversion structures are affected. The availability from source to the command area is dependent on the operation and maintenance of the channels which might be affected due to heavy rainfall and landslides.

The farmers use water during day and night times. The management of water application is more difficult at night time due to snake bites, illegal cuts and thefts. The farmers also use water at night time. The excess, or unused water is either provided to other water users' on mutual consent or allowed to flow from the tail-end to the *Siri* nullah. The exchange of water turn is common on mutual grounds.

There is some excess water at the source of the small-scale isolated system which after 200-300 ft just enter into the ground and flows as underflow until it again starts flowing as surface flows at *Masah* village. The water management in global context seems satisfactory, however, there are chances of improvements in the localized context. The small-scale isolated system represents conditions where water is adequate as there is no rotation practiced at the channel diversion. The water users of each channel can have continued access to water. However, adequacy is due to limitation of expansion of the command area.

The large-scale contiguous system is an example where water is in short supplies, as water allocations to various sub-systems are based on a rotation of 9 days. This means that water users of the *Dholi* sub-system would get water after every 9th day. The command area in the four sub-systems has been expanded considerably in the past which makes the system water short. According to initial estimates, the minimum diversion at the head of the large-scale conveyance system is around 60 litres/sec which is almost same to the water allowance in the perennial canal system in the Punjab province, where 22 litres/sec are allocated per 100 ha.

2.5.2. Equity

The water distribution rules are based on allocation of fixed duration for various sub-tribes or landholders. In case of sub-tribes, the water users feel that allocation is based on land area, whereas in case of equal allocation of time among various water users in a sub-tribe does not consider the land area as a criteria for water allocation. In fact, the water rights are observed based on prior appropriation and fixed duration instead of equitable rights in terms of volume or time. However, implementation of fixed duration water rights is observed strictly.

The equity in the large-scale contiguous system is a major concern, as the allocation is made on prior appropriation and fixed duration for each sub-tribe. Within sub-tribe, it is distributed based on land holdings. As the command area is increasing, the fragmentation of land is affecting the equity adversely.

The notables can't affect the fixed rights of water users, similarly, there are no cases observed for conflicts between the head and the tail reaches farmers regarding manipulation of water allocation turns. A simple and practical method of draw is followed for allocating water turns which maintain a random sequence for day- and night-time turns.

2.5.3. Reliability

The water rights and distribution rules are sharply defined and practiced in the area. The water users' organization continuously monitor the just implementation of the defined rules and conventions. The reliability in water supply is maintained by the water users' groups as they are regularly monitoring the conveyance system.

Though the water supply is disturbed during flash floods due to dismantling of diversion structure or water channel yet the reliability of source is undoubted. The community is sure about the restoration of water supply after the construction of diversion structure and maintenance of water channel. After the supply is restored, water is distributed among the sub-tribes and their sections according to already sharply defined distribution rules about which community is very much sensitive and vigilant.

2.5.4. Efficiency

The efficiency of water use is low. About 1/2 - 2/3rd water is wasted in the channel during conveyance. The application efficiency is also low and it is not more than 60%. Therefore, the overall irrigation efficiency might be around 20-25%. Thus there is a scope for improvements but farmers are not facing any problem of water shortage in the small-scale isolated system, whereas shortage is a problem in the large-scale contiguous system. Farmers of the large-scale contiguous system are interested to improve efficiency as they are cooperating very well with WRRI-NARC for improvement of water channel.

2.5.5. Sustainability

The major problems affecting the stability of the *Kalapani* system are: a) channel erosion in *Siri*-nullah which is affecting the stability of the diversion and conveyance system of the *Kalapani*; b) surface runoff and landslides from the upstream areas affect the sections of the earthen channels and either block the flow of water or result in breaches; and c) heavy sediment loads sometime demand quick desilting of the channel.

The overgrazing in the catchments and rangelands has resulted to a point where major rehabilitation are required. The farmers do migrate to other areas in search of better pastures.

The sedimentation in the channel bed is a common problem and farmers accord high priority for desiltation . They also prefer that sediments should enter into fields as they are aware of the benefits of silt especially for their gravelly and sandy soils.

Breaches of water are common as water in the small-scale isolated system is conveyed from very steep and rugged mountainous region where these occur due to

landslides and channel erosion. The farmers jointly work for repair and maintenance of the main channel, whereas individual farmer is responsible for repair and maintenance of the field channels. The main channel at the section of aqueduct was breached about 10 times during 1997. This shows high repair and maintenance requirement for aqueduct sections. Every water user contributes proportionate labour days based on his land area.

The problems affecting the sustainability of water supply in the large-scale contiguous system are: a) periodic dismantling of diversion structure by hill-torrent flows; b) breaching of channel by upslope runoff and land slides; c) demolishing of channel by bank collapse in Siri Nullah; and d) major part of the *Kalapani* water channel for three *Mauzas* (*Kothi, Soharbun* and *Khand*) lies in the dry bed of Siri Nullah. This water is wasted during hill-torrent floods in the nullah and the supply of *Kalapani* is discontinued. Commonly occurring breaches in the channel also affect the sustainability of water supply. However, these breaches are repaired time to time by the water users. Desilting of the main water channel is undertaken as a joint venture by the farmers, whereas the branch channels are repaired and maintained by the individual farmers.

2.6. Productivity

The yield of wheat crop varies between 518-4618 kg/ha based on the inputs used and the productivity of the cropped area. The yield of millets varies between 250-1897 kg/ha based on the harvesting strategy and purpose of planting for fodders, grain or both. The yield of cotton in the area ranges between 148-1581 kg/ha. The yield data of only those farmers is used where they were sure about the area under a particular crop.

2.7. Profitability

The gross income and expenditure for crops and livestock were estimated for 18 selected farmers in the command area of the small-scale isolated system. The lowest and highest net incomes per household in the command area of the small-scale isolated system are Rs. 12075 and Rs. 68590 per annum, respectively. The highest average income of household is observed for families involved in crops, livestock and labour. Thus livestock is a major source of earning in the command area, in addition to crop production (Table 20).

The gross income and expenditure for livestock and crops based on a sample of 70 farmers of large-scale *Kalapani* system were estimated. The lowest and highest net income is Rs. 5256 and Rs. 172097 per annum, respectively. The highest average income of Rs. 57422 per annum is observed for households having livelihood from crops, livestock and off-farm sources. It revealed that off-farm income contributes significantly towards livelihood sources of income in the four sub-systems (Table 21). The income of an individual farmer is based on actual production of an owner or share of the tenant whereas cost is based on expenditure of tillage, seed, fertilizer, harvesting and threshing.

3. IMPLICATIONS AND CHALLENGES

3.1. Implications on Resource Management

The water users do not have sufficient feel of their land area. Furthermore, water rights are not defined based on either volume or time equity, as they were fixed by the *Ramadani* tribe sometime around 250 years ago in the small-scale isolated system. The increase in command area with passage of time resulted into more inequity in terms of unit volume of water per unit area. Thus there are serious implications on management of land and water in the area, which require awareness and training of farmers in having feel about measurement of land area and water losses.

Local institutions like *Biradari* or *Muchi* take care of water allocation, its distribution and maintenance of the irrigation system. At the same time the community of the area is having feel of lesser number of bunded units which inspired them towards clearing of land. Obviously, it increased water requirement and in turn the management of irrigation system. Previously they were only reconstructing the diversion structure before the *Rabi* season for growing of wheat. For the last three years, they have started growing crops in the *Kharif* season as well. As a result the management of water channel particularly at critical points is more. Nonetheless, the realization regarding water losses still needs to be promoted.

3.2. Impacts on Resource Base

The settlement of land during 1970 and fixed water rights resulted into having proprietary rights of water users and landholders. The irrigated lands helped farmers to grow more grain and fodders. Therefore, issues of food security and sustainability were not that serious. The farmers were able to feed green fodder, dry wheat straw, etc to their animals. The production of forage trees in the irrigated area helped the farmers to lop the forage and feed to small ruminants. More fuelwood is now available to the farmers. These developments overall resulted in reducing some of the burden on the degraded rangelands.

Now, the farmers have reached to a point, where large improvements in irrigated agriculture are only possible through improving productivity and efficiency of the *Kalapani* system.

3.3. Challenges Faced by Farmers

The challenges faced by farmers in the *Kalapani* system are:

- stability of the water conveyance system due to heavy breaches and landslides;
- shortage of water availability in dry spells or drought years when groundwater recharge is low;
- lack of enforcement of communal tenure rules;
- lack of improvements in water rights and water distribution rules to make these

more responsive to equitable availability of water per unit of area;

- lack of capital with farmers and joint action to enter into high efficiency orchards farming;
- degradation of rangelands due to uncontrolled grazing and soil erosion;
- lack of availability of agricultural machinery;
- lack of veterinary facilities and high mortality rate;
- lack of sufficient quantity and quality of water for stockwater; and
- lack of credit facility.

4. LOCAL ADJUSTMENTS AND ADAPTATION STRATEGIES

4.1. Local Adjustments

The local adjustments made by farmers to overcome problems related to land tenure and water rights are:

- joint community action for repair and maintenance of the main channel under the local tradition of *Hashar*;
- to have a fair and unbiased adjustment for changing day-time and night-time water turns, a procedure of draw is practiced to follow random sequence of water turn;
- mutual agreements for fragmentation of lands under inheritance system;
- mutual agreements for utilization of communal tenures by any of the landholder;
- mutual agreements for not allowing outside graziers to graze their communal lands, however, the local population have a right to graze their animals; and
- mutual agreements for exchange of water turns or donations if water is in excess with any of the water user.

4.2. Adaptation Strategies

4.2.1. Extensification

The farmers are still trying, if possible, to extend their command area through clearing of uncommanded land having mutual agreement with the community. However, there is a little potential to add more lands under command except at tail-end or head reaches of the *Thakdaf* sub-command of the small-scale system.

Out of the four sub-systems of the large contiguous system, *Soharbun* and *Khand* and to some extent *Kothi* have capacity to expand the irrigated area. The farmers are increasing the command area by clearing communal lands by mutual consensus.

It is important to mention that out of two *Mauzas* with expansion capacity the *Soharbun* sub-system at the middle reaches is not having water rights, while the other one *Khand* is at the tail reaches where water is already in short supply.

Inspite of this, in general, the overall trend towards expansion could be visualised in

the area. According to the community, the area under agriculture has increased 3 times during the last 10 years.

4.2.2. Intensification

The use of improved seed and fertilizers helped farmers to increase productivity of their lands. Further through land forming and development by removing stones, crop stand has been increased tremendously. Therefore, both extensification and intensification strategies are being adopted by the farmers. The same is true for the *Kharif* season where now farmers started using water for raising of summer crops due to availability of water because of improved management especially at the diversion structure.

The farmers have been availing only the *Rabi* season by growing local wheat varieties. But now they are growing improved wheat varieties as a result of introduction of improved varieties by the FAO project. They are growing vegetables as well. They are also trying to enhance the productivity of their lands through land forming and removing of stones. Farmers are struggling hard to get maximum yield out of their small landholdings. They have started growing *Kharif* crops like cotton due to improved water supply through improved water management interventions by the WRRI-NARC especially by constructing aqueducts over the ephemeral streams.

The community of the small-scale isolated system categorically stated that the assured supply of water in the crop season resulted into many fold increase of yield and cropped area in the last 3 years.

Table 1. Command area of small- and large-scale *Kalapani* systems of the Dholi Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

System Size	Name of Sub-command	Command Area (ha)	System Command Area (ha)
Irsind	***Thakdaf***	**3.0**	**36.8**
	Rahndan	**1.6**	
	Irsind	**32.2**	
Dholi	***Dholi***	**88.3**	**265.1**
	Kothi	**97.2**	
	Soharbun	**21.5**	
	Khand	**58.1**	
Total		**301.9**	**301.9**

Table 2. Mean meteorological data of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Month	Daily Max Temp (bC)	Daily Min. Temp (bC)	Rainfall (mm)	Mean Evap. (mm)	Mean Sunshine (hrs)	Mean Humidity (%)
January	**16.6**	**7.0**	**14.3**	**2.0**	**7.3**	**52.9**
February	**19.7**	**10.0**	**6.4**	**3.2**	**8.2**	**53.2**
March	**24.1**	**15.3**	**35.3**	**4.1**	**8.5**	**56.5**
April	**30.7**	**21.9**	**49.5**	**7.3**	**9.0**	**46.3**
May	**34.3**	**26.3**	**110.1**	**8.9**	**9.4**	**43.1**
June	**37.0**	**28.6**	**56.1**	**8.7**	**10.5**	**54.3**
July	**36.7**	**29.9**	**49.3**	**7.8**	**10.3**	**63.7**
August	**34.9**	**27.2**	**87.4**	**6.5**	**9.6**	**68.4**
September	**34.7**	**26.6**	**14.1**	**6.3**	**8.9**	**60.3**
October	**28.2**	**19.7**	**18.9**	**3.9**	**7.3**	**63.9**
November	**23.4**	**14.8**	**2.4**	**2.9**	**5.7**	**62.6**
December	**18.8**	**9.1**	**2.8**	**1.9**	**3.9**	**85.7**

Total			**446.6**	**1933**		

Table 3. Households and population of various settlements of small-scale *Kalapani* system of the *Mauza Irsind*, Mithanwan watershed, D.G. Khan, Pakistan.

Settlements	Number of Households	Population		
		Male	Female	Total
Rahndan	7	24	26	50
Thakdaf	6	22	38	60
Irsind	50	245	189	434
Sarsand	6	34	33	67
Total	69	325	286	611

Table 4. Distribution of family size based on samples taken from five sub-commands of two selected systems at the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Family Size (Number)	Number of Families	Percent Families
< 10	34	39
10 - 12	26	29
13 - 15	10	11
16 - 17	6	7
18 - 20	5	6
> 20	7	8
Total	88	100

Table 5. Mauzawise educated persons of *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Mauza	No. of Persons with Matric	No. of Persons under Matric
Irsind	**3**	**5**
Dholi	**9**	**13**
Kothi	**3**	**3**
Soharbun	**0**	**1**
Khand	**7**	**9**
Total:	**22**	**31**

Table 6. Average livestock holding per household in the *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Systems	Settlements	Small Ruminants		Large Ruminants	Donkeys	Total
		Sheep	Goat			
Small	***Irsind***	31	19	4	1	55
Large	***Dholi***	25	20	9	2	56
	Kothi	18	13	5	1	37
	Soharbun	15	10	7	1	33
	Khand	22	10	4	2	38

Table 7. Cropping intensity and harvesting intensity of selected farmers of the small and large *Kalapani* systems of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

System	Sub System	Cropping Intensity (%)	Number of Farmers	Percent Farmers	Harvest Intensity (%)	Number of Farmers	Percent Farmers
Small	*Irsind*	@ 100	7	39	@ 100	9	50
		101-150	2	11	101-150	3	17
		200	9	50	151-200	6	33
	Sub-total		18	100		18	100
Large	*Dholi*	@ 100	1	6	@ 100	9	47
		101-150	9	47	101-150	6	32
		151-200	9	47	151-200	4	21
	Sub-total		19	100		19	100
	Kothi	@ 100	2	18	@ 100	4	36
		101-150	4	36	101-150	6	55
		151-200	5	46	151-200	1	9
	Sub-total		11	100		11	100
	Soharbun	@ 100	3	25	@ 100	3	25
		101-150	4	33	101-150	5	42
		151-200	5	42	151-200	4	33
	Sub-total		12	100		12	100
	Khand	@ 100	12	52	@ 100	12	52
		101-150	8	35	101-150	9	39
		151-200	3	13	151-200	2	9
	Sub-total		23	100		23	100

Table 8. Cropping intensity of large *Kalapani* system as affected by distance from source of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Sub-system	Location	Average Cropping Intensity (%)		
		Rabi	***Kharif***	**Total**
Dholi	**Head**	**94**	**62**	**156**

Kothi	**Upper middle**	**99**	**44**	**143**
Soharbun	**Lower middle**	**90**	**52**	**142**
Khand	**Tail**	**94**	**34**	**128**

Table 9. Cropping pattern as affected by distance from source in the large-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Cropping System	Cropping Pattern	Percent Farmers (%)			
		Dholi (Head)	*Kothi* (Middle)	*Soharbun* (Middle)	*Khand* (Tail)
Single Cropping System	F-W	5	9	-	25
	C-F	5	-	8	-
	F-W1	-	-	8	21
	Sub-total	10	9	16	46
Double Cropping System	M-W	22	9	-	4
	C-W	9	18	8	8
	Sub-total	31	27	8	12
Double Cropping System with Crop Mix	M-W1	9	-	-	4
	C-W1	14	9	17	13
	C1-W	9	-	-	-
	C1-W1	27	55	59	25
	Sub-total	59	64	76	42
Total:		100	100	100	100

* F-W fallow-wheat
C-F cotton-fallow
F-W1 fallow-wheat,onion,berseem
M-W millets-wheat
C-W cotton-wheat
M-W1 millets-wheat,onions,berseem
C-W1 cotton-wheat,onions,berseem
C1-W cotton,millets,vegetables-wheat
C1-W1 cotton,millets,vegetables-wheat,onion,berseem

Table 10. Land tenures of various sub-systems of the *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

System	Sub-system Commands	Percent Farmers in Sub-systems			
		Land Owners*	Tenants	Land Owner cum Tenants**	Landless
Small	*Irsind*	42	4	54	0
Large	*Dholi* (Head)	61	0	35	4
	Kothi (Middle)	36	18	46	0
	Soharbun (Middle)	58	0	42	0
	Khand (Tail)	54	0	46	0
Average		48	4	47	1

* involved in self cultivation only.
** involved in self cultivation and as tenant.

Table 11. Land bunded units under three sub-commands of the *Irsind* small-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

System Sub-Commands	Location	Command Area (ha)	Number of Bunded Units	Average Size of the Bunded Unit (ha)
Thakdaf	Head	2.99	32	0.09
Rahndan	Middle	1.62	39	0.04
Irsind	Tail	32.2	204	0.16
Total		36.81	275	0.13

Table 12. Distribution of bunded units owned by different farmers at the *Irsind* small-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Number of Bunded Units	Number of Farmers	Percent of Farmers in the Command Area
1	11	19
2 - 3	19	33
4 - 6	17	30
7 - 9	4	7
10 - 12	4	7
13 - 15	2	4
Total	57	100

Table 13. Land bunded units at four sub-commands of the large-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

System Sub-Commands	Location	Command Area (ha)	Number of Bunded Units	Average Size of the Bunded Unit (ha)
Dholi	Head	44.34	507	0.09
Kothi	Upper-middle	44.33	346	0.13
Soharbun	Lower-middle	12.32	67	0.18
Khand	Tail	33.60	192	0.18
Total		134.59	1112	0.12

Table 14. Distribution of bunded units owned by different farmers of four sub-commands of the large-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Number of Bunded Units	Percent Farmers in Sub-commands				
	Head	Upper-middle	Lower-middle	Tail	Average
1	9	29	29	27	23
2-3	12	28	42	50	32
4-6	25	20	24	19	21
7-9	16	14	0	0	9
10-12	11	1	0	3	4
13-15	9	3	5	1	4
> 16	18	5	0	0	7
Total	100	100	100	100	100

Table 15. Water distribution time allocated to various sub-tribes in the *Irsind* small-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Sub-tribes	Water Allocation Time	
	Bails*	Hours
Ramadani	7.92	95
Smailani	5.75	69

Bijarani	**5.50**	**66**
Shahwani	**3.00**	**36**
Zanglani	**1.83**	**22**
Total	**24.00**	**288**

*** 1 Bail = 12 hrs.**

Table 16. Water allocation time and draws for different sub-tribes of the *Irsind* small-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Water Users Groups	Sub-tribe	Water Allocation Time (hours)	Number of Draws
I	***Bijarani***	48	1
II	***Bijarani***	12	1
	Shahwani	36	
III	***Ramdani***	95	2
	Bijarani	1	
IV	***Smailani-Mandwani***	34.5	1
	Zanglani	12	
V	***Samilani-Jangyani***	37.5	1
	Zanglani	10	
	Bijarani	2	
Total:		288	6

Table 17. Water distribution among various sub-tribes in the large-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Name of beneficiary	Water Allocation Time	
	(Bails)*	(hours)
Hajbani* in *Mauza Dholi	1.5	18
Kaloi* in *Mauza Dholi	0.5	6

Chief of Leghari tribe and family	**1.0**	**12**
***Kaloi* in *Kothi* and *Khand* sub-commands**	**6.0**	**72**
***Hajbani* in *Kothi* and *Khand* sub-commands**	**8.0**	**96**
Bhawani & Qasmani in *Kothi* and *Khand* sub-commands	**1.0**	**12**
Total:	**18.0**	**216**

*** 1 Bail = 12 hrs.**

Table 18. Water distribution time between various clans of the *Hajbani* sub-tribe of large-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Offshoots of the Sub-tribe	Water Allocation Time	
	(Bails)*	(hours)
Saskani	**2.375**	**28.5**
Kalani	**2.375**	**28.5**
Shahlani Rahwani Chhalkani Abdalani	**2.375**	**28.5**
Madrani	**2.375**	**28.5**
Total:	**9.5**	**114**

*** 1 Bail = 12 hrs.**

Table 19. Water distribution among various clans of the *Kaloi* sub-tribe of the large-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Name of Offshoot	Water Allocation Time

	(Bails)*	(hours)
Chakrani	2.50	30.00
Jamalani	4.67	56.04
Noorani	1.00	12.00
Kamalani	0.27	3.24
Aliani	0.06	0.72
Total:	8.50	102.00

* 1 Bail = 12 hrs.

Table 20. Distribution of household net income per annum in small-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Income	Number of Farmers	Net Income Per Annum (Rs.)		
		Minimum	Maximum	Average
Crops only	1	-	-	3570
Crops + livestock	9	16670	50932	31890
Crops + livestock + other sources	8	12075	68590	33769

Table 21. Distribution of household net income (Rs.) per annum in the large-scale *Kalapani* system of the *Dholi* Target Area, Mithanwan watershed, D.G. Khan, Pakistan.

Income	Number of Farmers	Net Income per Annum (Rs.)		
		Minimum	Maximum	Average

Crops only	**0**	**-**	**-**	**-**
Crops + Livestock	**8**	**5256**	**47532**	**20925**
Crops + Off-farm	**4**	**12915**	**172097**	**53825**
Crops + Livestock + Off-farm	**57**	**9561**	**263312**	**57422**
Off-farm + Livestock	**1**	**-**	**-**	**3192**

LOCATION

1 - Head
2 - Middle
3 - Tail

CROPS

0 - No crop
1 - Wheat
2 - Berseem
3 - Onion
4 - Fallow
5 - Brassica
6 - Oats
7 - Chillies
8 - Vegetables
9 - Millets
10 - Cotton
11 - Sorghum

CROPPING PATTERN

0 - No crop
1 - fallow-wheat
2 - cotton-fallow
3 - fallow-wheat,onion,berseem
4 - millets-wheat
5 - cotton-wheat
6 - millets-wheat,onion,berseem
7 - cotton-wheat,onion,berseem
8 - cotton,millets,vegetables-wheat
9 - cotton,millets,vegetables-wheat,onion,berseem

WATER AVAILABILITY

1 - Short
2 - Sufficient
3 - Nil
4 - Less
5 - Donated by others

AGRICULTURAL MACHINERY

0 - No Machinery
1 - Tractor
2 - Trolley
3 - Thresher
4 - Cultivator

LAND TENURE & TENANCY

1 - Self cultivation
2 - Tenant
3 - Lessor
4 - Land less